Assessment of Breeding Practice and Statues of Estrus Synchronization and Mass Insemination Conception Rate of Dairy Cattle in North Shewa Zone, Ethiopia.

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Abstract

Background

Assisted reproductive biotechnology like oestrus synchronization mass insemination(OSMI), and artificial insemination (AI) are the most important bio techniques for improving the reproductive and productive performance of dairy cattle including enhancing overall profit in Ethiopia. In North Shewa zone different study were conducted. However, there is no study conducted on breeding practice, and status of OSMI conception rate of dairy cattle. Therefore the aim of this study to assess breeding practice, and status of OSMI conception rate of dairy cattle in North Shewa zone.

Methods

Out of 27 districts, three district and 135 respondents were selected purposive followed by random sampling techniques per each district. Data were analyzed using SPSS version 20 and Ms-Excel (2010).

Result

Milk yield, High growth rate, body weight, fertility and udder size were the major traits perceived by farmers. Breed preference of the respondents were HHFC and HFC in Basonaworena and Angolelanatera ranked first. Breeding objective and rearing system of cattle were milk production with sale of calves and all cattle categories reared together except HHFC and lactating cows respectively. Most of the respondents were used AI mating system due to rapid genetic improvement. HHFC and HJERC bulls breed were not available in the study area as a result alternative strategies taken by the respondents was take cows in other kebele. Reproductive performance of dairy cattle per district and breeds were statistically significant. 86.6% of respondents were not maintained mating and pedigree records due to lack of awareness. Heat detection problem and AIT efficiency were the major factor that affect CR in OSMI program. The perception and satisfaction of farmer on CR of OSMI (34.4%) was not good and (67.1%) not satisfied respectively. The selection criteria of cows for OSMI program (58.9%) of respondents were not aware. The status of CR and NSPC per district, breed and year were vary ($p < 0.05$) in table16 in OSMI program.

Conclusion

In conclusion that the status of CR was increasing starting 2013/14-2015/16 in OSMI. In addition creation of farmer's awareness on breeding aspects as well as OSMI is mandatory. Finally empowering the AI technician efficiency and procurement of the necessary facilities should be in place before implementing an OSMI.

Introduction

Assisted reproductive technologies (ART) such as oestrus synchronization, super ovulation and artificial insemination (AI) are some of the important bio techniques for improving the reproductive and thereafter the lifetime productivity of the cattle thereby enhancing the overall profit from cattle farming (Webb *et al.*, 2003). Oestrus synchronization involves manipulating the oestrus cycle of females, so they can be bred at approximately the same time, thereby saving both time and logistics (Rick and Gene, 2013). This bio technique also involves regulating the follicular development thereby inducing oestrus cycle (Rasby and Deutche 2013). Synchronization programs are selected from several predesigned protocols which have been scientifically/clinically proven to regulate the follicular development (IAARD-IJAVS-2015). Oestrus synchronization and mass insemination(OSMI) under smallholder context can be used as a tool to effectively use the natural resources when available abundantly to parturates healthy calves and also to evade the period when there is shortages of feed and fodder (Azageet *al*,2016) . In addition, synchronization of oestrus contributes to optimizing the use of time, labour, and financial resources by shortening the calving season (Kefyalew and Addis, 2015).

Oestrus synchronization assists in the accomplishment of faster livestock improvement programs such as fixed time artificial insemination (FTAI) and super ovulation of cows, thus minimizing the costs, time and labour required for oestrus detection in cows and does away with buying superior dams and sires.

However the wide application and success of OSMI across the developed world and its success in Africa and other developed country is still low owing to technical inefficiencies besides managerial and other infrastructure related issues (Azage *et al.*, 1995). It has been reported by Dekeba *et al.* (2006) the efficiency of the AI service is declining due to inconsistent service especially among the small holder livestock production system of Ethiopian highlands. This could also be related to controlling of oestrus especially under conditions of small holder management and in many cases they are unable to identify the signs of oestrus (Woldu *et al.*, 2011).

The qualities of the semen, its storage across different stages of handling besides the skill of the inseminators play important roles in the success of the whole program (Gebremedhin, 2005). This could further influence the efficiency of the oestrus OSMI process especially under the management of smallholder farmers (Woldu *et al.*, 2011). Detection of oestrus is usually faulty as many of the farmers are not aware of its signs and also there are cases of silent oestrus in the zebu cattle (Tsadik *et al*, 2008, Jane *et al.*, 2009). In many cases, the oestrus occurs during the night hours and therefore difficult to access especially at the late night hours and by the time the inseminators are informed and they respond to the call, the prime time for insemination is long overdue (Aulakh, 2008).The estimated overall mean calving interval of dairy cow in Ethiopia is 12.2 to 26

(Mukasa Mugerwa, 1989) but in ideal world strategy of calving interval is “One calf per year per cow”, in order to achieve this strategy in the country, the calving interval need to be optimized (Perez *et al.* 2012). As a result to solve those problem OSMI technology is the key point. On this program different studies were performed in different parts of Ethiopia, in Amhara region (Yeshimebt *et. al.*, 2017), Oromia region (Bainesagn, 2015), and SNNP Region (Debir, 2016) and Tigray regions (Destalem, 2015) with the conception rate of 59.6%, 59.16%, 42.2% and 36.12% respectively. In this context, OSMI as reproductive management tool was initiated in 2013 in north Shewa zone of Amhara region as a pilot scale by the Bureau of Agriculture in Siyadebrnawayu, Tarmaber, Angolelanatera, Debre Birehan town, and Basonaworena districts. Records till 2017 indicated that in those districts of North Shewa zone 9097 cows were synchronized and 5074 dairy cows inseminated by the Bureau of Agriculture. However in this study areas, they did not see the status of OSMI conception rate (CR) with related to breeding practice by detailed comprehensive assessment analysis (BoZLFDA, 2013-2017). As a result the present study was initiated to perform detailed comprehensive assessment of the overall breeding practice and, status of OSMI, s CR, in dairy cattle with the following specific objectives

- To determine breeding practice of dairy cows
- To evaluate the constraints of oestrus synchronization and mass insemination
- To identify farmer's perception about oestrus synchronization and mass insemination
- To determine status of OSMI CR in the study areas

Materials And Methods

3.1. Description of the Study Areas

A cross sectional study was conducted in DebreBirhan milk shed area of North Shewa zone. North Shewa Zone is bordering on the south and the west by the Oromia region, on the north by DebubWollo Zone and on the east by the Afar Region. Its latitude and longitude are 90° 40' 19.3"N and 390° 31' 45.3" E, respectively (Google map satellite). The zone has 27 districts and 436 kebeles (ZLFDA, 2013). According to (WADR, 2013), its climatic conditions are (32.02% highland, 45.58% midland and 21.95 % lowland).

3.2. Sampling Procedures

Based on number of synchronized dairy cows, AI practice, attitude of farmers to adopt OSMI technology, accessibility of infrastructure out of 27 districts three districts were selected namely Siyadebrnawayu, Basonaworena, and Angolelatera. Thereafter 9 kebeles from the selected districts, were selected using multi-stage stratified purposive sampling followed by random sampling technique. The number of farmers involved in the OSMI was identified from districts record data and from these farmers 405 total respondents were selected randomly. Based on the Yemane (1967) sample formula with 95% confidence level.

3.3. Data Collection method

Data were collected from primary and secondary sources. Primary data was collected using structured questionnaire. Interview was done by the enumerators together with researcher and supervisor. Focus group discussion was also organized in each selected kebeles.

Secondary data was collected from zonal, districts and kebeles agricultural administrates documents three consecutive year recorded data.

3.4. Data Analysis

After all the data were collected fed to Ms-Excel (2010) and transferred to SPSS thereafter analyzed by SPSS version 20 and Ms-Excel (2010). Quantitative data was analyzed by using one way ANOVA. Whereas qualitative data analyzed by chi-square using cross tabulation. Ranking also analyzed by using Ms-Excel (2010).

The reproductive performance of the dairy cows as computed the following formula:

$$CR(\%) = \frac{\text{number of conceived cows/heifers}}{\text{number of inseminated cows/heifers}} * 100$$

$$NSPC = \frac{\text{number of conceived cows/heifers}}{\text{number of inseminated cows/heifers}}$$

Where CR: conception rate, NSPC = number of service per conception rate

The Model used for reproductive performance of dairy cows

$$Y_{ij} = \mu + a_i + b_j + e_{ij}$$

Where y_{ij} =response variable (AFS, LL, DO, CI, NSPC) Where AFS: age at first service, LL= lactation length, DO= day open, NSPC =number of service per conception rate

μ =Overall mean

a_i =fixed effect of i^{th} districts ($i=3$: Angolelanatera, Basonaworena and Siyadebrnawayu)

b_j = fixed effect of j^{th} breeds ($j=3$: Native, HFC, HHFC)

e_{ij} = residual error

Index was calculated based on the following formula

$$\text{Index} = [R_n \times C_1 + R_{n-1} \times C_2 \dots + R_1 \times C_n] / [\sum (R_n \times C_1 + R_{n-1} \times C_2 + \dots + R_1 \times C_n)]$$

Where, R_n = the last rank (example if the last rank is 5th, then $R_n = 5$, $R_{n-1} = 4$, $R_1 = 1$).

C_n = percent of respondents in the last rank, C_1 = percent of respondents ranked first

Results

4.1. Assessment of Breeding Practice

4.1.1. Source of replacement of dairy cow

The finding pertaining that the source of cattle being used as a replacement in the herd in Table 1. In Basonaworena (B) district the replacement cattle are generally upgraded followed by those which were home bred. The results further show that at Siyadebrnawayu (S) district the replacement stock was generally get from house while at Angolelanatera (A) district the replacement was from upgrading using house herd.

Table 1
Source of replacement dairy cows in the study areas (N=405)

Districts				
Source of replacement	Basonaworena (%)	Siyadebrnawayu (%)	Angolelanatera (%)	Overall
Raised at the home	20	54.1	13.3	29.13
Procured from other farm	1.5	0	7.4	2.97
Upgrading	26.7	18.5	40.7	28.63
Buying upgrading	7.4	1.5	11.1	6.67
Home+ Upgrade	44.4	25.9	27.5	32.6
<i>N=total number of respondents in the study areas</i>				

4.1.2. Ranking of Breed preference of respondents

Table 2 pertain to the preference of the respondents from the three districts towards selection of a particular genotype of cattle. The study indicates that the ranked order of the respondents from B and S districts prefer to rear Holstein Friesian crosses, followed by HHFC plus HHFC and HFC. The results from the respondents of A district preferred HHFC first and the second preference was HFC plus HHFC and HFC.

Table 2
Ranking of breed preference of respondents per districts (N=405)

Districts	Breed type	1st	2nd	3rd	4th	5th	index	Rank
Basonaworena	HFC	41.9	47	11.1	0	0	0.28	1
	HHFC	48	21.8	23.7	3.5	3	0.26	2
	HHFC+HFC	39	14.5	10.6	35.9	0	0.23	3
	JERC	0.7	5.9	47.4	33.3	12.7	0.16	4
	Local	0	3.52	1.48	0	95	0.07	5
Siyadebrnawayu	HFC	50.8	48.5	0.7	0	0	0.29	1
	HHFC+HFC	44	54.7	1.48	0	0	0.28	2
	HHFC	0.7	33	11.9	47	7.4	0.17	3
	Local	3	0.48	63	26.52	7	0.17	4
	JERC	3.7	2.3	0	23	71	0.09	5
Angolelanatera	HHFC	48	25.8	16	10.2	0	0.29	1
	HFC	10.5	42	47.5	0	0	0.26	2
	HHFC+HFC	0	43.7	36.3	20	0	0.23	3
	JERC	0	0	6.7	93.3	0	0.15	4
	Local	0	0.48	0	3.52	96	0.07	5
Index=the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1times fifth order) for individual variables divided by the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1 times fifth order) for all variables, JERC= Jersey cross, HFC=Holstein Frisian cross, HHFC, higher Holstein Frisian cross (>75% exotic blood level).								

4.1.3. Selection Criteria and trait preference of dairy cattle in the study area

The selection criteria of cattle based on preferred traits are presented in Table 3, 4 and 5 for the three districts. The respondents from B district preferred to select cattle based on their milk yield followed by their High growth rate and body weight. The findings also indicate that the respondents from S district preferred selecting cattle based on their High growth rate, followed by bodyweight and milk yield. The study further shows that the respondents from A district indicated that the cattle were selected based on their High growth rate, milk yield and body weight in ranking.

Table 3
Ranking of trait preference farmers for dairy cattle in Basonaworena

Traits	1st	2nd	3rd	4th	5th	index	rank
Milk yield	46.66	23.3	13.3	10.04	6.7	0.26	1
High growth rate	13.3	36.67	16.67	23.33	10.03	0.21	2
Body weight	13.33	16.7	36.67	20	13.3	0.19	3
Fertility	3.3	20.2	33.3	39.9	3.3	0.18	4
Udder size	10.04	23.3	13.3	6.7	46.66	0.16	5

Index=the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1times fifth order for individual variables divided by the sum of ((5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1times fifth order))

Table 4
Ranking of trait preference of farmers for dairy cattle in Siyadebrnawayu districts

Traits	1st	2nd	3rd	4th	5th	Index	Rank
High growth rate	46.67	26.67	20	6.667	0	0.24	1
Udder size	3.33	40.01	26.67	30	26.7	0.19	4
Milk yield	30	23.3	29.97	13.3	3.3	0.21	2
Fertility	20	3.3	16.67	60.01	0	0.16	5
Body weight	33.33	26.67	16.67	13.3	10	0.20	3

Index=the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1times fifth order for individual variables divided by the sum of ((5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1times fifth order))

Table 5
Ranking of trait preference of farmers for dairy cattle in Angolelanatera

	1st	2nd	3rd	4th	5th	Index	Rank
High growth rate	73.34	26.67	0	0	0	0.25	1
Udder size	0	23.3	29.97	16.67	30	0.13	5
Fertility	10	23.3	30	30	6.67	0.16	4
Body weight	60	33.3	3.3	3.3	0	0.24	2
Milk yield	46.67	40	13.3	0	0	0.22	3

4.1.4. Breeding objective and rearing system of cattle in the study areas

The breeding objective of cattle were presented in Table 6. The findings show that respondents reared their cattle for milk production followed by sale of calves and cattle. The study further indicates that all age categories of cattle was reared together; however HHFC breed and lactating cows are reared separately so that management is better for them.

Table 6
Breeding objective and rearing system of cattle in the study areas (%).

Districts	Basonaworena (n=135)	Siyadebrnawayu (n=135)	Angolelanatera (n=135)	Overall
Overall Purpose	***	***	***	***
Milk production	2.5	4.1	7.4	4.7
Sale of oxen	0.8	9.9	2.5	4.4
Manure	0.8	—	—	
Milk production ,sale of calve and cattle	67.8	82.7	59.2	69.9
Milk production &manure	28.1	3.3	30.9	20.8
Cattle rearing system	***	***	***	
All categories are reared together except HHFC breeds & dairy cows	96.3	95.56	85.9	92.6
Cows reared separately from Bulls	1.5	—	7.4	2.97
All categories are reared separately	2.2	4.44	6.7	4.45
* Means with the different superscripts under the same row for the same parameter is significantly different at *** p=0.001, n=number of respondents, HHFC= higher Holstein Frisian cross —= none				

4.1.5. Mating systems

Mating systems in the study areas were presented in (Table 7).The major mating practices revealed that in the study areas were natural (20.7%), AI(33.8%), both (AI+ natural) 31.4%, AI with estrus synchronization (14.1%) of respondents. The current result was indicated that in Angolelanatera district 55.6% of respondents use AI technology through AI technicians. The remaining two districts are lower as compared to Angolelanatera

districts. The application of AI and AI+ estrus synchronization hormone technology was lower in Siyadebrnawayu districts as compared to the two districts.

Table 7
General characteristics of mating practice per districts (n=405)

Districts				
	Basonaworena%	Siyadebrnawayu %	Angolelanatera%	overall
Mating practice				
Natural	13.3	40.7	8.1	20.7
AI	31.8	14.11	55.6	33.8
Both	39.29	40.79	14.1	31.4
AI+ OSMI	15.61	4.4	22.2	14.1
Reason to prefer AI	%	%	%	%
No need rearing bulls	0	0	3	1.1
Safe without any hassle	8	4	4	5.3
Rapid genetic improvement	90	91	90	90.3
Born calves are good	2	5	3	3.3
<i>a-b show that significant at $p<0.05$ between dry and wet seasons within districts ,n=number of respondents per districts</i>				

4.1.6. Availability of breeding bulls per breed in the study areas

Table 8 shows that respondents get different breeding bulls for mating purpose. The overall percentage (94%) of respondents did not get HHFC and HJER breed bull. While 19 and 6% of respondents were obtained HFC, JERC and HHFC, HJER breeding bull respectively.

Table 8
General characteristics of breeding bulls per districts (%).

Districts					
	Breed type	Basonaworena	Siyadebrnawayu	Angolelanatera	Overall
Bull availability					
Available	HFC, JERC	25.9	7.4	23.4	19
Not available	HFC, JERC	74.1	92.6	76.6	81
Available	HHFC, HJER	10.1	0	8.15	6
Not available	HHFC HJER	89.9	100	91.85	94
Bull service cost (Birr)	HFC, JERC	free	free	Free	free
	HHFC,	15	0	10-50	37.5
HFC=Holstein Friesian cross, JERC= Jersey cross, HHFC=higher Holstein Frisian cross (>75% exotic blood level), HJERC=higher jersey cross (>75% exotic blood level),					

4.1.7. Alternative strategies when breeding bulls are not available

The result shows that most respondents tried to solve shortage of breeding bulls through different alternative strategies like taking a cow to other Keeble's breeding bulls (24.7%), use any available bull (7.6%), extend for the next estrus, (5.63%), use AI by calling for AITs or take a cow in their station in long distance (21.5%), goes to research center (24%), use their bull (3.2%), use AI (8.17%) and use communal bull (5.2%) of respondents in the study areas (Table 9). About 40% of the respondents in Siyadebrnawayu district take their cows to AI center in long distance this might be one of the mechanism conception failure due to pass of insemination time (Table 9).

Table 9
Alternative strategies of farmers when breeding bulls are not available (%)

Districts				
Alternative strategy	Basonaworena	Siyadebrnawayu	Angolelanatera	Overall
Take a cow in other kebeles	38.52	14.8	20.74	24.7
Use any available bull	0	22.9	0	7.6
Use AI by calling or take a cow in their station in long distance	17.8	40	6.71	21.5
Extend for the next estrus	14.68	1.5	0.7	5.63
Goes to nearest research center	20.1	0	51.85	24
Use AI	7.4	17.1	0	8.17
Use my bull	1.5	3.7	4.4	3.2
Use communal bull	0	0	15.6	5.2

4.1.8. Maintaining of mating and pedigree record

Maintaining of mating and pedigree record were presented in the Table 10. The overall percentage about 44.5 and 10.34% of respondents in the study areas maintain mating and pedigree records respectively. Among those 30.6 and 13.87% of respondents maintained mating record through recalling and in notebook recording system respectively and 2.45 and 7.89% of the respondents in the study areas maintain pedigree record through in notebook and recalling system respectively. On the other hand 89.6 and 95.6, 83.78% of respondents in Basonaworena, Siyadebrnawayu, and Angolelanatera districts are not maintained pedigree record respectively.

Table 10
Maintaining of mating and pedigree records per districts

	Maintaining of mating and pedigree record (%)	Basonaworena (n=135)		Siyadebrnawayu (n=135)		Angolelanatera (n=135)		Overall (N=405)	
		mating	pedigree	mating	pedigree	mating	pedigree	mating	pedigree
Yes		In a note book	19.3 8.9	6.7	4.4	15.6		10.37	13.9 7.89
Recalling	34.1	1.5	17.7 0		40	5.85	30.6	2.45	
No		46.6	89.6 75.6	95.6	44.4		83.78	55.5	89.66
Why not to do so									
Lack of awareness		85.8	85	94.12	100	98.3	100	92.7	95
Lack of education		7.9	8.3	4.9	0	1.7	0	4.8	2.8
Busy to record		6.3	0	0.98	0	0	0	2.5	0
Lack of facility		0	6.7 0	0	0		0 0	2.2	
N=total number of respondents and n=number of respondents per districts									

4.2. Reproductive Performance of Dairy Cattle per District

4.2.1. Age at first service (AFS)

The age at first service of native cattle show that the breed varied ($P<0.05$) across the studied districts with better values (42.83 ± 5.27) month reported among the native cattle reared in A district as compared to the rest districts. The mean plus standard deviation AFS of HFC was better 30.1 ± 10.15 and (31.32 ± 6.41) month in B and A districts respectively compared to S district. This difference might be due to management condition and lack of awareness how to manage the cross breed cows in S district. While there were no differences between B and S district in HHFC.

4.2.2. Calving interval (CI)

The overall mean value of CI of native breed was 19.81 ± 4.9 in month and it was too varied per district as well as per breed. CI was (21.8 ± 5.59) month higher among native cattle reared at S districts in the same way the mean value of CI was 18.91 ± 4.2 month recorded among the HFC cows

rared at A district this might be due to genetic makeup of the animal and management practice. On the other side the higher CI of HHFC was recorded in Angolelanatera district. The remaining two districts were recorded lower value.

4.2.3. Lactation length (LL)

The overall mean value of LL native, HFC and HHFC breed was 8.57 ± 3.1 , 9.27 ± 1.97 and 9.33 ± 3.1 month respectively. The average lactation length (LL) of cows were different breed reared across the studied districts this difference due to the purpose of selling milk in A and B districts. The findings show that among the districts native cows the values were higher ($P < 0.05$) reared at S, while there were no differences among the three districts in the studied HFC genotypes. The mean value of LL of HHFC breed was 7.00 ± 1.32 month in S district where as 9.13 ± 2.95 and 9.67 ± 3.26 in A and B districts.

4.2.4. Days open (DO)

The mean value of DO native breed per district was 5.80 ± 2.9 , 7.35 ± 3.35 and 5.21 ± 3.1 month B, S and A districts respectively. Day open (DO) indicate variations across the genotypes and also across districts within a particular genotype. The findings show that between native genotypes, the values were higher ($P < 0.05$) those reared at S district while in HFC was same observed among the cows reared at A. The higher DO value of HHFC was recorded in Band S districts.

4.2.5. Number of service per conception (NSPC)

The overall mean plus standard deviation of NSPC native, HFC and HHFC breed was $1.42 \pm .85$, $1.40 \pm .531$ and $1.50 \pm .69$ month respectively. NSPC results indicated that the values were similar across all the studied districts within a particular genotype which mean there is no significance difference per district and breeds due to the mating system in the study area was artificial insemination.

Table 11
Mean $\pm$ standard deviation of reproductive performance of dairy cow per districts in month

Breeds	Districts	AFS	CI	LL	DO	NSPC
Native	Basonaworena	45.40 ± 9.1^{ab}	19.5 ± 3.95^a	8.50 ± 3.0^b	5.80 ± 2.9^a	$1.36 \pm .48^a$
	Siyadebrnawayu	46.46 ± 6.75^b	21.8 ± 5.59^b	9.5 ± 3.13^b	7.35 ± 3.35^b	$1.37 \pm .56^a$
	Angolelanatera	42.83 ± 5.27^a	18.13 ± 3.6^a	7.71 ± 2.53^a	5.21 ± 3.1^a	1.75 ± 1.85^a
	Overall	44.8 ± 7.48	19.81 ± 4.9	8.57 ± 3.1	6.12 ± 3.29	$1.42 \pm .85$
HFC	Basonaworena	30.1 ± 10.15^a	15.85 ± 4.1^a	9.10 ± 1.92^a	3.89 ± 1.97^a	$1.38 \pm .49^a$
	Siyadebrnawayu	35.82 ± 5.7^b	16.3 ± 4.22^a	9.15 ± 2.1^a	5.04 ± 2.76^b	$1.37 \pm .55^a$
	Angolelanatera	31.32 ± 6.41^a	18.91 ± 4.2^b	9.54 ± 1.98^a	6.39 ± 3.14^c	$1.43 \pm .56^a$
	Overall	32.20 ± 8.1	17.10 ± 4.4	9.27 ± 1.97	5.13 ± 2.86	$1.40 \pm .531$
HHFC	Basonaworena	19.75 ± 7.67^a	13.9 ± 4.12^a	9.13 ± 2.95^b	$4.81 \pm .75^a$	$1.14 \pm .38^a$
	Siyadebrnawyu	18.00 ± 1.17^a	12 ± 3.14^a	7.00 ± 1.32^a	$5.00 \pm .00^a$	$1.00 \pm .00^a$
	Angolelanatera	20.17 ± 2.6^{ba}	15.3 ± 4.14^b	9.67 ± 3.26^b	7.58 ± 3.18^b	$1.75 \pm .75^b$
	Overall	19.90 ± 4.96	16.9 ± 4.9	9.33 ± 3.1	5.12 ± 3.78	$1.50 \pm .69$

a-b means with the different superscripts under the same column for the same parameter is significantly different at $p < 0.05$ SD-standard deviation, AFS=age at first service, CI=calving interval, LL=lactation length, DO=days open, NSPC=number of service per conception, HFC=Holstein Frisian cross, HHFC, higher Holstein Frisian cross (>75% blood level).

4.3. Factor Affecting Conception Rates of OSMI in Dairy Cows

The overall percentage of respondents agreed that heat detection problem (13.38%), AI technician efficiency (14.57%), distance of AI center (11.61%), absence of AIT (7.897%), disease problem (4.94), service charge (0.99), time of insemination (14.8%), semen quality (11.34%) body condition of the cows (9.873%) and communication 10.6% are the major factors that influence the successful CR of OSMI in the study areas (Table 12).

Table 12
Perceived factor affecting conception rates of OSMI in the study areas (n=135)

Districts				
Factors of OSMI	Basonaworena%	Siyadebrnawayu%	Angolelanatera %	Overall
Heat detection problem	11.1	11.9	17.13	13.38
AI technician efficiency	17.8	11.1	14.8	14.57
Distance of AI center	12.6	17.8	4.44	11.61
Absence of AIT	5.19	14.8	3.7	7.897
Disease problem	5.93	5.19	3.7	4.94
Service charge	2.22	0.74	0	0.99
Timing of insemination	12.6	17	14.8	14.8
Semen quality	17	5.93	11.1	11.34
Body condition of the cows	8.89	11.1	9.63	9.873
Communication	6.67	4.44	20.7	10.6
n=number of respondents per districts				

4.4. Perception and satisfaction of Farmers towards the OSMI Technology

The results revealed that 34.4% of respondents agreed that OSMI is not good While 32.3% and 33.3% of respondents agreed that very good and good respectively with positive circumstance (Table 13). On the satisfaction of outcome of OSMI 67.1% not satisfied reported by respondents.

Table 13
Farmer perception and satisfaction about OSMI in the study areas (N=270)

Districts				
Perception of farmer on OSMI	Basonaworena%	Siyadebrnawayu	Angolelanatera%	overall
Very good	36.7	10.0	50.0	32.3.
Good	23.3	35.6	41.1	33.3
Not good	40	54.4	8.9	34.4
Satisfaction of OSMI result	***	***	***	
Yes	32.2	22.2	44.4	32.9
No	67.8	77.8	55.6	67.1
* There is significance difference across the districts at*** $p=0.0001$, N=total numbers of respondents				

4.5. Respondents Selection Criteria of Cows and Heifer for OSMI

The present study showed that the main selection criteria of cows and heifers for OSMI application about 58.9% of farmers had no their own selection criteria of cows. As a result provide any type of cows and heifers for OSMI whether emaciate or none fertile cows then selected by AITs while 37% of respondents were provide their cows with animals with optimum body condition for OSMI (Table 14).

Table 14
Respondents Selection criteria of cows and heifer for OSMI (%) N=405

Select criteria	Districts			
	Basonaworena	Siyadebrnawayu	Angolelanatera	Overall
By looking their body size	1.1	5.6	5.6	4.10
Animals with optimum body condition	38.9	35.5	36.6	37.
No criteria	60.0	58.9	57.8	58.9

4.6. Opportunities for the Application of OSMI per Districts

According to the respondents from B and A districts availability of improved genotypes and presence of milk union in the area were the major one. While, the respondents in S district opined that the herds were well managed, feed was available year around in the area besides the farmers had accepted the OSMI program with open heart.

Table 15
Opportunities for the application of OSMI per districts in the study areas

Districts					
Opportunity	Basonaworena	Siyadebrnawayu		Angolelanatera	Over all
%% Availability of improved breed	31.1	3.6	35.6		28.1
Availability of milk receiver union	36.7	—	47.8		28.2
Availability of good management	14.4	28.9	16.6		19.63
Veterinary service	17.8	28.6	—		11.1
Farmer needs to accept OSMI	—	38.9	—		12.97
— = not available					

4.7. Status of OSMI per Years, District, Breeds, in CR, NSPC

The conception rate varied across the years with higher conception recorded among the cows inseminated in the year 2015/16. The findings also show that numbers of services per conception (NSPC) did not vary across the years. The study also shows that the status of OSMI per Years and per district was slightly varied. Regarding districts indicated that the conception too varied across the studied locations with lowest conception rate was recorded among the cattle reared in Siyadebrnawayu district. The status of OSMI CR was significantly increases per Years. The conception rate per breed, of cross breed was higher as compared to native breed.

Table 16
Status of OSMI per Years, districts, breeds in CR and NSPC in the previous three consecutive years (N=405)

		Synchronized (N)	Inseminated (N)	Conceived (N)	CR (%)	NSPC (mean)
Year	2013/14	418	98	15	15.3	2.8
	2014/15	255	171	35	20.46	2.6
	2015/16	347	191	46	24.08	2.15
	Overall mean	340	153.3	32	19.95	2.55
	Basonaworena	359	181	42	23.2	2.3
Districts	Siyadebrnawayu	280	121	22	18.18	2.7
	Angolelanatera	381	158	32	20.25	2.3
	Overall mean	340	150	20.67	20.54	2.4
	Exotic	736	318	83	26.1	2.22
Breeds	Native	284	142	13	9.15	2.12
CR= conception rate, NSPC= number of service per conception, N=number of cows						

Source zonal, districts and kebeles agriculture office records data

Discussion

5.1. Assessment of Breeding Practice

5.1.2. Source of replacement of dairy cow

The findings from Table (1) indicate that most of the replacement herd major of the cases were home born. The findings are in close agreement with those of (Alemshet (2014); Zelalem *et al.* (2017)). The replacement of herd by home born cattle while is beneficial at one end, because the respondents are not aware of the pedigree of the cattle and that it comes at no cost. It often can lead to high amount of inbreeding in absence of proper recording and management (Lori A. Smith, 1997). This is all the more true when the cattle are inseminated artificially. Thus, a proper

recording system has to be put in place a copy of which has to be in hand with the rearers themselves. Proper recording system is usually lacking in the tropical countries and Ethiopia being no exception (ICAR, 2000; Philipson and Rege, 2003). Respondents need to be made aware of the same and simple yet effective recording system needs to be put in place.

5.1.3. Traits preferred in selection of cattle in the studied locations

The results as pertaining to the traits preferred by the respondents across the studied locations are more or less similar. Milk yield of the cattle was preferred which is in close accordance with those of Bainesagn (2016) in Oromia Region. This is because of established milk processing units in the vicinity except S district. The High growth rate of the cattle are associated with its fertility and the trait as a whole is lowly heritable. Thus, selection of this trait is closely associated with the management of the cattle and the nutrition available. Inclusion of High growth rate as a selection criteria have also been reported by (Godadaw *et al.*, 2014). This trait is closely associated with the lifetime calf crop production which in turn is also associated with the lifetime milk yield of the cattle (Debir, 2016). The inclusion of body weight as a selection criteria as indicated in the study are also correlated with the above two traits. Cattle with optimum body weight usually have a better reproduction ability and also milk yield (Karume, 2013). However, higher body weight of cattle is also correlated with high maintenance requirements and there of high feed requirements (karume, 2013). Thus, cattle with low maintenance requirements will be those which are favourable under small holder farmers in the Ethiopian scenario (Philipsson and Rege, 2003).

5.1.4. Breeding objective and rearing system of cattle in the study areas

In Table 6 is indicative that most of the native cattle are reared for milk followed by those of sale of calves and oxen for fattening purposes, the findings are in close agreement with those of (Destalem, 2015). The sale of native bull calves as oxen purposes too have been reported by Zewdu, (2004) this is primarily for agrarian purposes and thereafter for beef purposes (CSA, 2016/17). The results pertaining to the objectives for rearing the HFC cattle indicate that they are raised for milk production, sale of calves, the findings too are in close agreement with those of (Destalem, 2015). The HFC crosses are high yielders and therefore preferred by the farmers all over the country (Azage, 1989). The crossbred calves are in high demand by the investors in urban and peri urban locations as the numbers of crossbreds are usually less in the country as a whole (FAO, 2010). The findings also show that most of the farmers in Ethiopia depend on organic manure for agrarian purposes (Bainesagn, 2015). The study also shows that most of the higher Holstein Friesian crosses are raised for milk purposes which too is in close agreement with the findings of (Alemshet, 2014; Destalem, 2015). However the numbers of HHFC are very few and most of them are females.

5.1.5. Matting Systems

The findings pertaining that the participants use AI and natural mating interchangeably, this is in accordance with the findings of (LeeKim, 2014) from Asela town of Oromia Region and (Getie *et al.* 2015; Destalem 2015). This may be because of the fact that sometimes the AI technicians may not be available which may force the respondents to revert back to natural mating of their cattle (Destalem, 2015). It has also been reported in several studies that at times cattle which do not conceive using several AI do so under natural mating (Destalem, 2015). This is ascribed to the fact that many times cattle develop allergy towards the chemicals used in semen preservations especially ethylene glycol and thus impair fertilization and many times the growth of the embryo (Generose *et al.*, 1988). The study further indicates that the participants under the project usually select the bulls based on predefined criteria set up by the project officials. It has also been reported that some of the participants also select bulls based on traditional methods which basically comes with experience.

The participants were also aware of the fact that genetic improvement through AI is quite rapid vis-a-vis that of the natural mating. Moreover, many of the respondents were aware of the slow genetic progress ascribed to inbreeding (Alazar *et al.*, 2015). The study also shows that many of the respondents were forced to revert back to natural mating of their cattle, primarily based on poor conception and lack of AI technicians, these observations are in close accordance with those of (Desalegn, 2008; Destalem, 2015). It has been reported in several studies that one of the biggest drawbacks of success of AI in Ethiopian scenario is the lack of proper oestrus detection and consecutively improper timing of insemination (Azage *et al.*, 2012). This leads to poor conception rate and thereafter the respondents have no other option but to revert back to natural mating.

5.1.6. Availability of breeding bulls per breed in the study areas

The finding show that most of the rearers are well experienced in phenotypic traits associated with a good breeding bull; this may be fallout of their experience in cattle husbandry and also trainings received under the OSMI project.

The results also show that most of the respondents complained that the availability of crossbred bulls are wanting in all the studied locations, which is in close accordance with those of (Gatew *et al.* 2017). It has been reported that in AdisAbeba of Ethiopia that one of the major hindrances in development of dairy industry of the country is lack of crossbred bulls in the country (Yilma *et al.*, 2011). The study further indicates that semen of HFC bulls are available by cost which too is in close accordance with those of (Tadesse, 2010) and (Desalegn, 2008) who reported that the AI is provided by public sector office. Similarly the current study further indicated that the cost of inseminating the cows with the HHFC bulls was expensive which may at times be out of reach from the small holder farmers. It has been reported that the higher crosses need special care and may not be possible for the small holder farmers to manage (Aynalem *et al.*, 2009; Guatam *et al.*, 2010). Hence, it is advisable to provide the HHFC or higher crosses of Jersey only to farmers who have the resources to manage them. The farmers rearing higher crosses should be so selected who have adequate provisions for feed resources and veterinary care, besides those who are financially capable to provide the emergency necessities for

rearing higher blood levels of the crossbreds. This would prevent the cattle from succumbing to tropical degeneration and hence the producing and reproduction capability of the cattle are maintained.

5.1.7 Alternative strategies when breeding bulls are not available

Table 9 is indicative of the fact that in absence of the facilities of artificial insemination the respondents search for good bulls in the nearby vicinity and when not available try to get their cattle covered with any bulls available at hand. These observations are in close accordance with those of (Azage *et al.*, 2010) who reported that the farmers in Ethiopia have no other choice but to get the cows covered with any bulls at hand. This often leads to negative selection among the herd which is detrimental to the development of cattle husbandry in the region. It has also been reported that the scrub bulls are usually of poor parentage and may be responsible for transmitting many venereal diseases within the herd/s (Thomas, 1999). Travelling long distance with cattle in estrus too is not preferred as such cattle usually are stressed (due to the estrus itself and travelling) and many times have poor conception (Fitsum, 2017). It has also been reported that many times the respondents from A district take their cows (in oestrus) to the nearby research centre, these observations are in close accordance with those of (Alemshet, 2014). This is preferred over covering them with the scrub bulls, however the respondents need to plan the same in advance so that the appropriate time of mating is not lapsed and also that records are maintained so that inbreeding can be avoided

5.5.8 Maintaining of records among the herds

The findings in Table 10 indicate that in spite of the fact that most of the respondents are not aware of the ill effects of inbreeding, yet they do not practice maintaining of records among their farm animals. The present findings are in close accordance with the findings Destale (2015) in central zone of Tigray who reported that most of the respondents are unaware of the ill effects of inbreeding among livestock. The study further indicates that most of the respondents did not maintain any sorts of records which are similar to the observations of (Getie *et al.*, 2015; Nibret, 2014). The findings also indicate that a very miniscule section of the respondents had some sought of did so depended on recall methods, which is seldom correct (karume, 2013). Studies by (Solomon *et al.*, 2013) have indicated that record keeping is one of the primordial requirements of modern livestock breeding. In absence of proper records the development that has occurred over period of time through implementation of livestock breeding techniques are seldom accurate (Lori, 1997). Thus awareness creation pertaining to importance of livestock recording needs to be created among the rearers. Simple yet effective record keeping methods need to be developed keeping into account that a large section of the beneficiaries are not literate.

5.2. Reproductive Performance of Dairy Cattle across the Three Districts of North Shewa Zone

The overall estimated average age at first service (AFS) of native dairy cows is presented in Table 11. The AFS of the native cattle too varied across the locations which can be ascribed to both their genotype and the management (Shiferaw *et al.*, 2003; Perera, 1999). It has also been reported that if the management of the cattle are good the heifers mature early. Cattle with low AFS usually have high calf crop production and ultimately higher lifetime lactate yield. The AFS as recorded in this study area in close agreement with those of (Debir, 2016). However, AFS of the native cattle as observed lower than those of reported by Mulugeta and Belayneh (2013) from Angolelanatera woreda.

The AFS of HFC and HHFC cattle indicated variations across locations, which is may also be attributed to the management and feed available to the cattle (Shiferaw *et al.*, 2003). The results show that the values are lower at B district it may be endorsed to availability of the feed in the area. The study also show that the AFS of HFC as recorded too are in close accordance with the findings of Nibret, (2012), Desalegn, (2016) while lower AFS was reported in a study by Belay *et al.* (2012) from in Jima Town and Zewdie (2010) in the highlands and central rift Valley of Ethiopia.

The calving interval (CI) of the cattle too varied across the studied locations which may be ascribed to the management of the cattle and also their genotype (Shiferaw *et al.*, 2003; Debir, 2016). Cattle with longer CI are unprofitable to rear and are subjected to culling (Graves, 2009; De Vries, 2005). Longer CI also leads to fewer numbers of calves and lifetime milk yield (suhail *et al.*, 2010). The CI of the native cattle as reported in the study area in close accordance with those of Assemu *et al.* (2016) Fogera breed. The study also indicates that CI of the HFC too is in close accordance with those of Emebet and Zeleke (2007) in Dire-Dawa and (Hailemariam *et al.*, 1993). The results are however lower than those reported by (Bekele *et al.*, 1991) from central highland parts of the country. The findings also show that the CI of the HFC as recorded too are higher than those recorded by (Desalegn *et al.*, 2016; and Yifat *et al.* 2009). The CI of the HHFC is in close agreement with those of Melku, (2016) and Negussie (2006) in Mekelle city which too are higher than those reported by (Kiwuwa *et al.*, 1983).

The lactation length (LL) as a trait too has its own economic importance, however cattle with longer LL does not mean that it is profitable (Fikre Lobago *et al.*, 2007). Cattle with lower LL are usually not profitable (Fikre Lobago *et al.*, 2007). It has been reported that the appropriate LL of the cattle are usually around 10 months (Desalegn *et al.*, 2016). The LL of the cattle too is influenced by several non-genetic factors especially the feed available and also the diseases prevailing in the area (Perera, 1999). The LL of the native cattle as reported in the study are in close accordance with those of Dejene, 2014, however lower LL of the cattle have been recorded in a study by (CSA, 2016/17; Ouda *et al.* (2001) and Trail *et al.* (1984) from Kenya. The LL of the HFC cattle are in close accordance with the findings of Belay *et al.* (2012); Desalegn *et al.* (2016), the values are higher than those recorded in a study by (Mulugeta, 2005) in yerer milk shed in Addis Ababa. However, the LL of the HFC cattle are lower than those reported by (Mulugeta and Belayneh (2013) from Angolelanatera woreda. The LL of the HHFC as reported in this study area in close accordance with those of

(Bainesagn,2015). The values are lower than those reported by (Aynalem *et al.*(2011) and Gabriel *et al.* (1983) from Arsi districts. This may be ascribed to the fact that the HHFC require better management, feed and also veterinary care which is difficult to be provided by the small holder farmers.

The values for days open (DO) is also an economic importance as cattle with longer DO usually have fewer life time calf crop (De Vries, 2006). Longer the DO means that the cattle are prone to longer dry period and lower profitability (De Vries, 2005). It has also been reported that the trait too is influenced by the non-genetic factors viz. feed and the reproductive health of the cattle (Belay *et al.*, 2012). The DO of the native cattle, HFC and HHFC are in close agreement with those of Niraj Kumar *et al.* (2017) and Belay *et al.* (2012) respectively. However, the values are lower than those reported by Addisu *et al.* (2015) from Gondar town and Mulugta and Belayneh,2013 from Angolelanatera woreda for HFC.

The findings also show that the numbers of services per conception (NSPC) in native cow is in close accordance with the values reported by (Belay *et al.*, 2012). Optimum NSPC is correlated with the profitability of the animals (Mukassa-Mugrewa, 1983). More numbers of services are indicative of poor reproductive health (Mukassa-Mugrewa, 1983). The values are however lower than those reported by Yifat *et al.* (2009), 1.67 as reported from mid Rift valley parts of the country. It has been recorded that HHFC usually require more numbers of services which can be associated with higher productivity Kabir and Kisku, 2013). The NSPC is also influenced by oestrus detection especially of the cattle mated through AI and hence the respondents need to be made aware of the signs associated with oestrus detection. There have also been reported that the HHFC show signs of silent heat especially in the summer months and hence require more numbers of services to conceive (Gebrekidan *et al.*, 2012).

5.3. Factor Affecting Conception Rates of OSMI in Dairy Cows

The major constraints pertaining to the success of OSMI program in the study areas presented in Table 12. Study by (Desalegn, 2008) have indicated that poor conception is one of the major problems associated with AI in Ethiopia. The factors which were identified by the respondents were pertinent and multifarious, which too accords with the observations of (Desalegn, 2008). The respondents indicated that there were problems pertaining to the heat detection especially among the crossbreds, this may correlate with the poor body condition of the animals. Findings of a study by (Harris and Kolver, 2001) have shown that silent heat is commonly observed among the higher crosses especially when they receive improper nutrition. This is also followed by problems associated with the non-availability of AI technicians (Mekonnen *et al.*, 2010), distance of AI centres from the dwellings of the respondents and consecutively timing of insemination (Azage *et al.*, 2012)

5.4. Perception and satisfaction of Farmers towards the OSMI Technology

The perception of the respondents in the study area pertaining to OSMI show that except for respondents from A district the remaining two district's most respondents were disappointed the outcomes of the OSMI CR. These are in close accordance with those of (Destalem, 2015; Ahmed, 2017). As indicated ahead the success of the OSMI program is a fallout of several factors and unless the factors are met with there are very less chances that the program will accomplish its goals .Another foremost criteria for the project to meet its goal is to select the cattle with average body condition besides, should be free from any reproductive disorders (Azage *et al.*, 2016).

In case of crossbreds the maintenance requirement is high therefore; nutrition has to be provided appropriately otherwise there are chances that there can be adverse effect on the nutrient balance of the cattle. Under such condition the overall benefits from OSMI program may not be achieved, hence the respondents need to be appraised.

5.5. Respondents' Selection Criteria of Cows and Heifer for OSMI

There were (in most of the cases) no predefined criteria for selecting the representative cattle under the program, the findings are in close agreement with those of (Azage *et al.*, 2016). It is imperative that the cattle included in such program be properly screened for any physical and gynecological defects, the respondent's be made aware of the pros and cons of the project. The respondents should be also appraised regularly by the experts from the Research station/s and Universities so that the cattle are properly managed and fed on balanced diet (Short *et al.*, 1990; Destalem, 2015). Care also has to be taken to ensure that the cattle receive proper veterinary care both during and after pregnancy (Short *et al.*, 1990; Miller, 1991).

5.6. Opportunities towards Implementation of OSMI

The possible opportunities associated with the selection of the districts under OSMI program are multifarious. However, the presence of milk union for off take of milk along with presence of crossbreds have been identified by the respondents in B and A districts, while both the factors are favorable but absence of proper feed is again a big challenge in both the areas. Thus, the milk unions can play a big role in augmenting the feed problem in the areas in form of trainings to the farmers in form of fodder conservation techniques. Taking experience from many developing countries, the milk unions can also establish a feed processing plant which can cater to the feed requirements for the cattle reared by the union members. Experience from Anan Milk Union Limited (AMUL) indicates that establishment of feed manufacturing unit is imperative for success of any milk union and a part of the payment for the farmers is made available in form of feed for their cattle (Nisa, 2016; Dinesh, 2011).

Findings also indicate that at S district in spite of having plenty of feed, lack of crossbreds and milk union needs to be addressed so that the advantage pertaining to the feed availability can be properly utilized. Establishment of feed processing unit too need to be set up so that the available feed can be properly carried out throughout the year.

5.7. Status of OSMI per Years, Districts Breeds, CR, and NSPC

The status of OSMI in years, breed conception rate and NSPC presented in Table 16 indicate that there were differences across the year's districts and breeds. This may be ascribed to the non-genetic factors associated with the same; the findings are in close agreement with those of (Destalem, 2015).

Summary And Conclusion

The most important preferred traits and selection criteria perceived by farmers were milk yield, High growth rate, body weight, in order of importance. The main objective of dairy cattle breeding was for milk production to generate cash income, while the least was for milk consumption. HFC and HHFC were the major breeds preferred by farmers in the study areas and their major source of replacement stock was through raised at home with upgrading their cattle.

Regard to breeding practice, AI is the major mating system in North Shewa zone. The opportunities for AI and mass synchronization of dairy production in the study area were presence of veterinary service, availability of improved breeds, and availability of milk receiver union, the presence of trained man powers and extension service. Generally, Trends of oestrus synchronization and mass insemination in the last 3 years was on CR increased slightly starting to 2013/14-2015/16 in the study areas. From the present study, concluded that the status of estrus synchronization and mass insemination technology gradually farmers accept if properly done. The results further indicated that the overall reproductive performance across all the breeds and Districts was sub-optimum.

7. RECOMMENDATIONS

- Creation of farmers' awareness on management practice of dairy cattle and also it avoid misunderstanding of different managerial and breeding aspects which are practiced by farmers traditionally.
- Limited number of AI technician and their efficiency is the major problem in the study area; as a result the number of AITs could be increased per kebele and give training for AITs so as to satisfy farmers demand.
- Participatory and sustainable breeding strategy could be undertaken through incorporating indigenous knowledge of farmers and by including trait preference of the dairy owners to improve productivity of dairying.
- In the study areas, insemination was carried out only at the third days after hormone injection. However, some cows come to oestrus after three days and hence farmers have not access to AITs at that time. As a result it is better to AITs to wait until three up to eight days after hormone injection in their kebele.
- To improve efficiency of dairy cattle productivity and practicing OSMI:
- Improving oestrus detection method, time of insemination, management practice are mandatory.
- Semen handling, providing full inseminator equipment, improve AITs efficiency of detected oestrus and appropriate animal selection should be considered before implementing OSMI program.

Declarations

1. Ethics approval and consent to participate: Before any attempt to collect sample, the protocols were checked and approved appropriately and correctly
2. Consent for publication : not applicable
3. Availability of data and materials: it is available in the hand of corresponding author if want by any third person
4. **The conflicts of interest were disclose based** on financial cost, as a result based on this no any institute or person complain for publication process.
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6. **Author contribution:** sharew Mekonnen perform the whole research process the next two author doctor Simret Betisha and doctor Sandip Banerjee participated in encouragement, insight, guidance, and professional expertise the completion of this work.
7. **ETHICAL CONSIDERATION**
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