# ASSESSMENT OF BREEDING PRACTICE AND EVALUATION OF ESTRUS SYNCHRONIZATION OF DAIRY CATTLE IN SIDAMA ZONE, SOUTHERN ETHIOPIA

**M.Sc. THESIS**

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**HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA**

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**A THESIS SUBMITTED TO SCHOOL OF ANIMAL AND RANGE SCIENCES, COLLEGE OF AGRICUTURE, SCHOOL OF GRADUATE STUDIES, HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA**

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## DEDICATION

I dedicate this thesis manuscript to my beloved husband Mr. GeneneTsegaye and my children Beteal and Kaleb Genenen, for nursing me with affection and love and for their encouragement and moral support in the success of my life career.

## STATEMENT OF THE AUTHOR

First, I declare that this thesis is my own fieldwork and that all sources of materials used for this thesis have duly acknowledged. This thesis has submitted in partial fulfillment of the requirements for MSc degree at the Hawassa University. I declare that the thesis will deposit at the Hawassa University and Hawasa Agricultural Research Center Library to be available to readers and borrowers under the rule of the libraries. I strictly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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Place: College of Agriculture, Hawassa University, Hawassa

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## ABBREVATIONS

| | |
|---|---|
| ADY | Average daily milk yield |
| AFC | Age at fist calving |
| AFS | Age at first service |
| AI | Artificial insemination |
| AIT | Artificial insemination technician |
| BCS | Body condition scores |
| CL | Corpus latium |
| CR | Conception rate |
| CSA | Central Statistics Authority |
| EM | Embryonic mortality |
| ER | Estrus response |
| GnRH | Gonadotropin-releasing hormone |
| ILRI | International Livestock Research Institute |
| IPMS | Improving Productivity and Market Success |
| LIVES | Livestock and Irrigation Value Chains of Ethiopian Smallholders |
| Ng /ml | Nonogram per milliliter |
| OSMI | Oestrus synchronization and mass insemination |
| NLDP | National Livestock Development Program |
| NSPC | Number of service per conception |
| SDC | Sidama Development Corporation |
| SNNPR | Southern Nations Nationalities and Peoples' Region |
| SPSS | Statistical Package for Social Science |

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*ABSTRACT*

*Breeding practices, evaluation of estrus synchronization and milk progesterone profile study was conducted in Sidama zone. The study was conducted at two agro ecological zones (highland and midland) of the zone to assess the prevailing cattle breeding practices. Data was collected using semi structured questionnaire and focus group discussion. A total of 180 respondents were randomly selected from the 9 kebeles and included in the study. The survey results indicated that the average age at first service for native and crossbred heifers were (42.2±4.4 and* 30.3±4.4*) months. The average age at first calving for native and crossbred was (51.9±5.9and 39.3±3.9 months). Panmectic mating system was common in the study area. Most of the respondents do not own their own bulls but rely on the bulls owned by their acquaintances. The study further indicated that the respondents selected animals based on their higher milk yield, followed by breeding ability, growth rate and low intake of feed. There was lack of awareness among the respondents in estrus detection and time of insemination. Thus in most of the cases the AM/PM rule for insemination is not followed. Majority of the respondents were not satisfied with the results of the estrus synchronization and mass insemination (OSMI) program as the conception rate in the cattle was much below their expectation. The results pertaining to the evaluation of the synchronized cattle under the mass insemination program indicated that the estrus response interval differed ($P<0.05$) among the native and the crossbred cattle while the values were (68.6±1.9) hours among the native and (56.0±2.0) hours among the crossbred cattle. The average number of services per conception was higher among the native cattle (2.4) when compared to that of the crossbreds (1.83). However, the conception rate was higher among the crossbreds vis-a vis that of the native cattle. The results further indicate that the conception varied across the agro ecologies with the values being higher in the 1$^{st\ parity}$ among the cattle reared in the midlands while the same was higher in the 2$^{nd}$ parity among the cattle reared in the highlands. The body condition score was higher ($P<0.05$) among the cattle with exhibited better conception rate. Conception rate varied across the agro ecologies with higher rate of conception observed among the cattle reared in the highlands. Conception also varied across the age of the cow with higher values observed among those aged between 5-7 years or in the second parity. The optimum conception was observed among the cows inseminated between 10-15 hours after the onset of estrus. The rate of conception too varied ($P<0.05$) across the bulls whose semen was used to artificially inseminated cows. The rate of estrus response was higher in the action research when compared to those involved in the mass insemination. Pregnancy diagnosis following milk progesterone profile using Hormonst micro-lab farmer test kit indicated that most of the early embryonic mortalities were observed within 28 to 46$^{th}$ days post insemination. The effect of genetic and non-genetic factors contributed to the success of conception in cattle. Use of Hormonst micro-lab farmertest can be an effective tool to identify the pregnancy status of the cattle much ahead of the traditional rectal palpation method.*

***Key words. estrus synchronization, cattle, genetic and non-genetic factors influencing conception rate, milk progesterone levels, Sidama zone, Ethiopia***

# 1. INTRODUCTION

Agriculture is the major economic activity in Ethiopia. Among the agricultural activities, livestock sector plays a significant role in the economic, social and cultural development of the agrarian community. Cattle comprise the majority of the livestock population and are reared across all the agro-ecologies. As indicated in a report by CSA (2014) most of the cattle in the country reared by the agrarian community are of native breeds/ecotypes (98.71%).

The distribution of native cattle populations across the different agro-ecologies of the country provide various options for tangible and non-tangible use of livestock products to the smallholder farmers and pastoral communities (CSA, 2014). Cattle are reared for various tangible commodities like, milk, meat, hide and draft power and intangible commodities for social prestige and savings for the rearers. However, the productivity of the native cattle is low due to their genetic makeup, low level of inputs, and traditional husbandry practice besides environmental stress *(*Azage *et al*., 2010). Despite the importance of this subsistence sector, scanty information is available on the status of the national dairy cattle genetic improvement program that guide policy makers, development planners and breeders to redesign appropriate breeding programs that respond to the current scenarios in Ethiopia (Kefena *et al.,* 2011). These native cattle are well adapted to in their place of origin and hence preferred by the keepers. They are low yielders but they have adaptive traits for disease resistance, heat tolerance, ability to utilize poor quality feed and soundly fit with farmers farming condition, which they have acquired through natural selection via countless generations (Tadesse *et al.,* 2014).

Artificial insemination (AI) is a proven bio-technique, which is used globally to improve the genetic makeup of the cattle and thereby improve their production and reproduction traits (Noakes, 2009). However, the overall impact of AI can only be achieved when it is coupled with proper animal husbandry practices. Over the years, there have been efforts to improve the productivity of native breeds through the introduction of AI program with improved exotic dairy breed (Ali *et al.,* 2013). However, the success of such programs so far is far from satisfactory due to numerous factors, which includes substandard nutrition, poor management and infrastructure status. Thus, dairy producers have been complaining about poor reproductive performance in cattle, which were exposed to AI (Lemma and Kebede, 2011).

According to Haileyesus (2006), the average number of services per conception (NSPC) among local and crossbreed cow was 2.54 and 2.38, respectively. A study by Hamid (2012) too revealed that the average NSPC of dairy cattle in Seltie zone was 2.34. The efficiency of reproduction is influenced by several genetic and non-genetic factors with major roles being played by both growth and the management of the animal (Jones and Hennessy, 2000). The efficiency of the AI service in Ethiopia is one of the lowest among the developing countries, this might be attributed to poor heat detection, improper timing of insemination and embryonic mortalities besides inadequate infrastructure, managerial, and financial constraints (Shiferaw *et al.,* 2003).

One of the ways to overcome the challenges of low conception rates and less efficient AI service is by using hormones for estrous synchronization thus facilitating the practical use of artificial insemination and this can positively influence the productive and reproductive efficiency of dairy cattle (Murugavel *et al.,* 2010). Use of reproductive hormones can help in planning of AI in a way that it coincides with planned parturitions in a specific period. Thus in order to synchronize the estrus cycle of cattle PGF2α or its analogue is commonly used hormone, the functionality of which depends on the presence of at least a functional corpus leuteum (CL) in the diestrus stage of the estrous cycle (day 7 to 17 of the cycle) (Cordova-Izquierdo *et al.,* 2009). The effectiveness of the estrus synchronization programs depends on the presence of a functional CL followed by monitoring of the levels of progesterone hormone in the blood/milk (Murugavel *et al.,* 2010).

Embryonic mortality significantly contributes to reproductive inefficiency because fertility assessed at any point of time during the pregnancy is a function of both conception rate and embryonic mortality (Fricke, 2002). Embryonic/fetal loss has devastating effects on economic success in dairy cattle so has poor conception rate (Fricke, 2002). Monitoring of the progesterone levels in milk used to detect the time of estrus especially during the early pregnancy. It also serve as a tool to assess the embryonic mortality in dairy cattle, as the level of progesterone is important in maintaining the pregnancy by stalling further ovulation, decrease in progesterone level correlates with fetal death and subsequent increase in estrogen level in the milk/blood, thus inducing the cattle for further reproductive activities (Sreenan, 1986).

Rectal palpation at early stage of conception by non-practitioner could be also for loss of early pregnancy (Romano *et al.,* 2007). After the introduction of Hormonost®-Microlab Farmertest which is a semi-automatic method to assess the progesterone level in the milk of dairy cows as early as 18 days post insemination to assess whether the animal has conceived or not. It is easy to monitor the pregnancy status and early embryonic mortality of a cow at an early stage (Daniel and Klaus, 2014). The levels of progesterone can help in assessing the diffusion of embryonic death among lactating dairy cows and thus help in identification of the pregnant cows.

Thus, a joint project pertaining to estrus synchronization and mass insemination of cows/heifers was launched by SARI with collaboration of ILRI- IPMS project and Bureau of Agriculture in 2011. Initially, in 2010 in a pilot action research, about 171 dairy cattle were synchronized and 57.7 % of them were positive in pregnancy at Dale district (Azage *et al.,* 2012). The regional Bureau of Agriculture in collaboration with SARI scaled up the technology at 15 district of Sidama zones to achieve optimum levels of fertility and to have calving spread the year around.

However, there is lack of comprehensive assessment and evaluation of mass synchronized and inseminated dairy cattle reproductive performance attributed to synchronization intervention for future planning. There are no scientific studies on problems associated with infertility of cows, misconceptions on estrus detection, embryonic mortality at early stages of pregnancy, traits used by cattle keepers in the study area. Thus, this study was conducted with the following objectives: assessment of cattle breeding practices and perceptions, evaluating estrus synchronization and mass insemination (OSMAI), and re-evaluating synchronization through action research and testing progesterone profiling (using Hormonst micro-lab farmertest) for early pregnancy diagnosis and embryonic mortality.

# 2. LITERATURE REVIEW

## 2.1. Livestock production system

Livestock have diverse functions in the livelihood of the agrarian society in Ethiopia (Belete *et al.,* 2010). Among the various livestock species, cattle have a significant contribution to the livelihoods of the farmers. They serve as a source of draught power for the agrarian population, by contributing towards the supply of milk, meat, manure besides being a source of ready cash, cattle also contribute significantly role to the socio-cultural values of the society (Mekonen *et al.,* 2012). Ethiopia is believed to have the largest livestock population in Africa and its total cattle population is estimated to be about 55.03 million (CSA, 2014).

## 2.2. Socioeconomic contribution of cattle in Ethiopia

A study made by Asrat *et al.* (2013) indicated that under the mixed crop-livestock production system, dual-purpose cattle of indigenous breeds are reared to produce milk for household consumption and bull calves are important source of draft power. In addition, livestock are important source of income and play an important role in ensuring food security (Sintayehu *et al.,* 2008; Banerjee *et al.,* 2014). Manure production is also considered important by most crop-livestock and agro-pastoralist farmers, but with the development of modern agronomic practices the role of manure is more or less secondary in nature as more and more farmers are relying on chemical fertilizers, the use of which is increasing over the years. However, the pastoralists rear cattle as a source of income besides milk yield. As reported in a study by Shiferaw (2006) indicated that Karayu cattle are reared for their milking potential. As indicated in a study by

Belete *et al.* (2010) indicated that the cattle play a primordial role in sustaining millions of resource-challenged farmers under different agro-ecological environments, ranging from pastoral and agro-pastoral to mixed farming systems depend on draft animals for the cultivation of crops.

### 2.3. Dairy production systems in Ethiopia

Although Ethiopia does not have any specialized dairy cattle breed still dairying is a part and parcel of agrarian society of the country (Addis and Godadw, 2014). Dairy production systems in Ethiopia; can be broadly classified into rural dairy system (part of the subsistence farming system which also includes pastoralists, agro-pastoralists), mixed crop–livestock producers and the peri-urban; and urban dairy systems (Dereje *et al.,* 2005). The Ethiopian highlands cover over 40% of the country here dairying is nearly always part of the subsistence, smallholder mixed crop and livestock farming (CSA, 2011). As indicated in a study by Belete *et al.* (2010) the average lactation yield of indigenous cattle breeds range between 400 to 680 kg, whereas those of the crossbred cows range between 1200 to 2500 liters of milk over a lactation period of 279 days. The low milk yield of the native cattle breeds can be attributed to lack of proper supplementary feeding, poor nutritive value of pastures and forages offered to the animals besides the genetic makeup of the cattle as a whole (Ayantu, 2006).

### 2.4. Cattle holding in Ethiopia

In Ethiopia cattle were found to be the dominant livestock species around 70% to 90% of livestock owning households have at least one or two numbers, however vary across the production zone, and thus cattle dominate smallholder income generation and meat-milk production in all production zones lowland and highland, as well as in specialized commercial scale production systems (CSA, 2014). In western Oromia of highland and midland agro-ecological areas farmers possessed more cattle than other livestock species (Mekonnen *et al.,* 2012). Most of the cattle holdings in the country are with the smallholder farmers, about 51.62% have 1 to 4 cattle, and 20.59% of the holdings possess 5-9 cattle (CSA, 2014). Moreover, cattle aged 3 to 10 years reared for the purposes of meat is 0.77 %, milk 12.13 %, draught 25.02 %, and breeding 22.35 % (CSA, 2014). The cattle herd size in Ethiopia presented in Table 1.

Table1. Average cattle herd size status in Ethiopia

| Location | Agro-ecology | Herd size Mean±SD | Source |
|---|---|---|---|
| West Welewga | Highland | 11.7± 0.55 | Mokonen *et al.*(2012) |
| | Midland | 14.7 ± 0.55 | |
| Segene Zone | Higland | 13.7±2 | Seid & Birhan (2014) |
| | Midland | 11.6±1 | |
| | Lowland | 29.3±2.5 | |
| Borana Zone | Midland | 2.4+1.6 | Dejene (2014) |
| | Lowland | 15.8+2.4 | |

## 2.5. Land holding and land use system in Ethiopia

A study by Yitaye *et al.* (2007) revealed that in the highland areas of Amhara region, the average land holding is around 3.3 hectare. The findings of a study by Yeshitila (2008) indicated that the average land holding in Halaba district of Southern Region is about 2.5 hectare. On the other hand, the average land holding in the SNNPR region was only 0.76 hectare that is much below the national average of 1.2 ha (CSA, 2010). Results of a study by Azage *et al.* (2013) indicated that the size of land allocated for grazing in the rural areas of Fogera and Bure is very small compared to land allocated for crop production.

### 2.6. Feed and water source of livestock

The common feed sources of livestock in Ethiopia are natural pasture and crop residues (Beyene *et al.,* 2011). As the landholdings and the communal pasture are diminishing, the crop residues are becoming important sources of feed resources in the country (Desta, 2002). The study by Zewdie (2010) also indicated the main source of water for cattle in Jimma and Sebeta was tap water, while in Debre Birhan 95% of water source is rivers. Similarly, a study by Sintayehu *et al.* (2008) in Shashemene-Dilla area indicates that the major source of water for livestock is rivers. However, in the Central Rift Valley, (around Ziway) there are various sources of water for cattle; these sources include pond water, rivulet besides water from well, Beyene *et al.* (2011).

Watering frequency of dairy cattle depends on the access to water sources, the age structure of the herd, physiological stage of the livestock besides the season determine the watering frequency (Zewdiue, 2010). Frequency of providing water to animal influenced by different factors viz. season of the year, accessibility to the watering point, predominant feed and feeding systems. In the mixed crop–livestock system, more farmers provide water to their cattle once a day during dry season (Sintayehu *et al.,* 2008).

## 2.7. Reproductive and productive performance of dairy cattle

### 2.7.1. Age at first service

According to Gidey (2001), age at first service (AFS) is the age at which heifers attain body condition and sexual maturity for accepting service for the first time. By showing estrous as early as possible, a female animal can contribute more to the economy of the farm. Age at first maturity of some zebu and crossbred dairy cattle are presented in Table 2.

Table 2 Average age at first service of Zebu and crossbred dairy cattle

| Breed | Location | Age at first maturity(months) | Sources |
|---|---|---|---|
| Horro | Ethiopia | 47.52 (male) and 53.3 (female) | Jiregna (2007) |
| Horro | Ethiopia | 46.56 (male) and 48.42 (female) | Mekonen *et al.*(2012) |
| Semen and Wegera | Ethiopia | 55.6 (male) and 57 (female) | Zewdu (2004) |
| Horro | Ethiopia | 46.56 (male) and 48.42 (female) | Mekonen *et al.* (2012) |
| HorroX Jersey | Ethiopia | 33.3±10.9 | Demissu *et al.* (2013) |
| Frisian X Fogera | Ethiopia | 36.8±0.8 | Gebeyehu *et al.*(2005) |

### 2.7.2. Age at first calving

Age at first calving determines the beginning of the cow's productive life and influences her lifetime productivity (Ojango and Pollott, 2001). Reproductive efficiency of dairy cows is influence by different factors including genetic, season, age, production system, nutrition, housing and management, environment and disease (Shiferaw *et al.,* 2003). A recent study reported that dietary supplementation of heifers during their period of growth reduces the interval from birth to age at first service and birth to age at first calving (Amin *et al.*, 2013). Age at first calving of Bos indices Zebu breeds and crossbred cattle presented in Table 3.

Table 3. Age at first calving of Bos indices Zebu breeds and crossbred cattle

| Breed | Location | Age at first calving ( months ±SE) | Sources |
|---|---|---|---|
| Horro | Ethiopia | 58.08±0.07 | Mekonnen *et al.*(2012) |
| Fogera | Ethiopia | 50.8± 0.36 | Menal *et al.* (2011) |
| Local/Dandi | Ethiopia | 50.59±6.94 | Duguma *et al.* (2012 |
| Horro X Jersey | Ethiopia | 42.2±11.45 | Demissu *et al.* (2013) |
| Fresian X Zebu (F1) | Ethiopia | 36 | Belay *et al.* (2012) |

### 2.7.3. Milk yield

Milk production is influenced by several genetic and environmental factors. Among the environmental factors, the quantity and quality of available feed resources are the major ones (Zewdie, 2010). Other factors influencing the trait are the breeding goals viz. breeding for draught purpose, disease resistance, tolerance to tropical climates besides poor nutrition and management of the cattle are some of the factors influencing lower milk yield (Desta, 2002). Milk yield performance of some zebu and crossbred dairy cattle are presented in Table 5.

Table 4 Average milk yield performance of Zebu breeds and crossbred cattle

| Breed | Location | Daily milk yield in liters | Sources |
|---|---|---|---|
| Horro | Ethiopia | 1.5±0.03 | Demissu *et al.* (2014) |
| Native | Ethiopia | 1.37 | CSA ( 2014) |
| Butana | Sudan | 6.10±0.41 | Musa *et al.*(2005) |
| Friesian x Arsi | Ethiopia | 6.38± 0.09 | Wassie *et al.* (2014) |
| Friesian x Boran | Ethiopia | 7.02± 0.11 | Wassie *et al.*(2014) |
| Horro x Jersey | Ethiopia | 5.6±0.07 | Demissu *et al.* (2014) |
| Fresian x Native | Gambia | 4.4 ± 1.2 | Diack *et al.*(2005) |

#### 2.7.4. Lactation length

In most dairy farms, a lactation length of 305 days is commonly accepted as a standard. However, such a standard lactation length might not be feasible for smallholder dairy cows where in most cases the lactation length is extended considerably (Msangi *et al.,* 2005). Lactation length of animals depends mostly on the management objective of the herder; the herder may prolong the lactation length for the sake of continuous milk supply to the household or dry off the cow at early stage of lactation for breeding purpose (Msangi *et al.,* 2005). Lactation performance of some zebu and crossbred dairy cattle are presented in table 5.

Table 5 Average lactation length of Zebu and crossbred cattle

| Breed | Location | LL in days | Sources |
|---|---|---|---|
| Naive | Ethiopia | 247.11±22.64 | Kumar *et al.* (2014) |
| Boran | Ethiopia | 211.1±7.1 | Gebrgziabher *et al.*(2013) |
| Begait | Ethiopia | 247.11±22.64 | Kumar *et al.*(2014) |
| Native | Zimbabwe | 201±21 | Ngongoni, *et al.*(2006) |
| Native x Frisian | Ethiopia | 273.9 | Belay *et al.*(2012) |
| Friesian x Arsi | Ethiopia | 306.94±3.58 | Wassie *et al.* (2014) |
| Friesian x Boran | Ethiopia | 307.47 ±3.92 | Wassie *et al.* (2014) |
| Crossbred | Zimbabwe | 269±24.8 | Ngongoni, *et al.* (2006) |
| Crossbred | Nigeria | 338.1±27.2 | Ogundipe and Adeoye **(**2013) |

LL=lactation length

### 2.8. Traits considered for selection of cattle in Ethiopia

Cattle keepers in Ethiopian prefer to select their herd based on marketable traits such as milk yield, growth rate and reproductive performances of the heifers/cows, steers/bulls however traits such as coat color and adaptability too are traditionally consider into account (Mekonnen *et al.,* 2012). The interventions by the modern breeders hence should take into adaptive traits for overall improvement of the herds. As indicated in a study by Mekonen *et al.* (2012), Horro cattle are traditionally rear for high fat percentage in their milk. On the contrary, Shiferaw (2006) reported that the owners of the Kereyu cattle prefer to rear cattle with high milk yield, which they consume fresh milk by the pastoral community. Similarly, Godadaw *et al.*(2014) in their studies from Fogera, Dembia and Wogera districts of North Amhara region observed that milk yield, growth rate and breeding ability ranked as the first, third and fourth, preferred traits by most of the farmers. Similarly, Kelay (2002) also indicated that majority of the cattle rearers at Mulo-Sululta, Degem Addis Ababa selected cows which were high milk yielders. A study by Tekele (2005) indicated that farmers in Bench Maji zone select cattle based on the milk yield. Similarly, a study by Chinogaramombe *et al.* (2008) indicated that farmers in Zimbabwe consider adaptability and milk yields as most important traits when selecting cattle.

### 2.9. Breeding practices of dairy cattle

Mating in the context of animal breeding means pairing of female and male animals for the purpose of reproduction on a farm using natural or artificial (AI) methods (Willam and Simianer, 2011). Breeding structures provide systems for gathering information about the assessment of animals in the production system and conditions that allow selection of parents (males and females) of the future progeny, besides the mating of these livestock in a desired manner (Van Der Werf, 2004).

An efficient, systematic and operational breeding strategy is necessary to bring about any substantial improvement in the dairy sector. Development of the dairy sector in Ethiopia as in any other developing countries can further be augment with the selection within the native cattle besides crossbreeding (Yilma, 2011). However, any formal pedigree and performance recording systems are virtually non-existent with the traditional rearers in most of the tropical countries, thus under those condition the only option left is to select animals based on their phenotypic traits like body size, udder size etc. (Bebe, 2003). For effective breeding practice, one should consider techniques and options of improving the genetic performance of cattle.

### 2.9.1. Sources of breeding bull

The use of bulls for natural service remains widespread in Ethiopia. As indicated in a study by Mekonnen *et al.* (2012) and Azage *et al.* (2013) panmectic mating predominates under the extensive livestock husbandry system especially in the rural areas. Findings of a study by Solomon *et al.* (2014) also indicated that majority of the farmers in Metekel zone depend on natural mating in absence of artificial insemination facilities. Finding by Asrat *et al.* (2013) indicates that under mixed crop-livestock production system of Boditti woreda most of the households depend on natural mating using native bulls, while other households depend on AI. However, there are reported instances where both (natural service and artificial insemination) are used interchangeably.

Studies by Malik *et al.* (2012) indicate that cows mated naturally conceive earlier than those mated using AI because bulls have a natural advantage of stimulating estrus activity and detecting estrus in cows. A study made by Desta (2002) indicate that many farmers in Ethiopia prefer natural mating as the conception results from the AI services is not successful. In a study by Zewudu (2004) and also Zewdu *et al.* (2006), it was also reported that majority of the farmers in Dembia and Fogera region and in north western Ethiopia respectively, obtained their replacement (breeding) animals from their own farm and sometimes from their relatives and neighbors. In the rural lowland areas of Metema, majority farmers breed their cow with any scrub bull in the village, this is because most of the farmers do not own breeding bulls and they use bulls from neighbors or use open mating in the communal grazing (Azage, 2013).

### 2.9.2. Artificial insemination

Artificial insemination (AI) is a process in which sperm is collect from male animals and artificially introduced into the female reproductive tract for the purpose of fertilization (Ball and peter, 2004). Artificial insemination offers several potential advantages over natural service, of these, the reason most commonly advocated is as a means of genetic improvement and others include cost effectiveness, disease control, safety breeding, flexibility, and fertility management ( Ball and peter, 2004; Gebremedhin, 2005; Holm *et al.,* 2008).

In Ethiopia, AI was first introduced in 1938 in Asmara, then part of Ethiopia, however the process was interrupted due to the 2nd World War and restarted in 1952 (Yemane *et al.,* 1993). It was again discontinued due to unaffordable expenses of importing semen, liquid nitrogen and other related inputs In 1967, an independent service was again restarted in the then Arssi Region, Chilalo Awraja under the Swedish International Development Agency (SIDA). The present National Artificial Insemination Center (NAIC) at Kality, Addis Ababa was established in 1984 to coordinate the overall AI operation of the country (Gebre Medhin, 2005).

#### 2.9.2.1. The status of AI delivery system in Ethiopia

The efficiency of AI delivery system in the country, however, has remained at a very low level. This can be attributed to infrastructure, managerial, and financial constraints and also due to poor estrus detection, improper timing of insemination, lack of readily available inputs, besides overall logistics and management of the system at the official level this is further quantified with poor health management of the cattle and embryonic death (Shiferaw, 2003; Hayleyesus, 2006). Inappropriate selection and management of AI bulls along with poor motivations and skills of the inseminators (Dessalegn, 2008) further aggravate the problem associated with the efficiency of the system. Some farmers due to long distance of the AI centers from the beneficiaries, they faced problems of delivering their animals for the service and technicians also challenged with absence of transport facilities to offer the service on time of insemination (Tadesse *et al.,* 2014).

#### 2.9.2.2. Time of insemination

Knowledge of estrus behavior and the estrus to ovulation interval is essential for estimating the best time to artificially inseminated cattle (Reolofs *et al.,* 2010). Inaccurate estrus detection leads to delayed insemination, reduced conception rates and thus extended calving intervals (Daris, 1998). Livestock rearers visually observe the signs of estrus and thus with experience can accurately estimate the time of the standing estrus, insemination by the AM /PM rule usually is helpful in having the highest conception rates (Peter and ball, 2004).

Findings by Miah *et al.* (2004) indicate that if insemination is carried out later than 22 hrs from the inception of estrus results in poor conception. A cow that is first seen in estrus in the morning is usually inseminated in the afternoon of the same day, whilst a cow seen in estrus in the afternoon is inseminated early the next day (Arthur, 2001). Time and season of insemination is the most important factors to optimize CR of the cows (Miah *et al.,* 2004). Thus, the author suggested that for the farmers to achieve the desired rate of conception, they should inseminate their cows in spring season during 11 to 14 hrs after the onset of estrus. Similar report by Mufti *et al.* (2010) indicated that the conception were higher when inseminated between 10 to 14 hours after the onset of estrus, but lower CR were observed among the cows inseminated earlier or later than the above mentioned time period. Bhattacharyya *et al.* (2009) reported that higher conception was achieved when the cows inseminated at 16 hrs post estrus detection.

#### 2.9.2.3. Number of service per conception (NSPC)

NSPC is defined as the number of services/ inseminations required for a successful conception (Menale *et al.,* 2011). It depends largely on the breeding system used and influenced by both genetic and non-genetic factors viz. season; that related to availability of feed, semen quality, lactation length and milk yield and parity (Gebrekidan *et al.,* 2012). Fertility of the bulls is commonly measured by calculating the percentage of cows those are pregnant after a single service (Quintela *et al.,* 2004). Numbers of service per conception is presented in Table 6.

Table 6 Number of service per conception (NSPC) of Bos indicus Zebu and cross breed cattle

| Breed | Location | NSPC | Sources |
|---|---|---|---|
| Native | Ethiopia | 2.2 | Kumar *et al.(*2014) |
| Horro | Ethiopia | 2.1 | Demissu *et al. (*2013) |
| Fogera | Ethiopia | 1.28 | Menal *et al. (*2011) |
| Native | Bandladish | 1.44 | Sharifuzzaman *et al.(* 2015) |
| Native-fresian | Bangladish | 1.75 | Sharifuzzaman *et al.(*2015) |
| Horro-Jersey | Ethiopia | 1.8 | Demissu *et al.(* 2013) |
| Fresianx Zebu | Ethiopia | 1.56 | Belay *et al. (*2012) |
| Eastern low lowland Crossbred | Ethiopia | 2.2 | Emebet and Zeleke (2007) |
| Frisian x zebu | Ethiopia | 1.3 | Nibret (2012) |

#### 2.9.2.4. Early embryonic loss

Reproductive failure in inseminated cattle results from poor fertilization and embryo survival (Santos *et al.,* 2004). Fertility assessed at any point during pregnancy is a function of both conception rate and pregnancy loss (Arthur, 2001; Chebel *et al.,* 2004). According to Fikre (2007) factors, such as herd size, production level, incidence of diseases, genetics, housing, and management and heat stress influence the rates of occurrence of various reproductive problems.

A Study by Romano *et al.* (2007) too indicated that rate of embryo /fetal death between 30 and 60 days of post insemination was 14.0%, which may be potential reason for repeat breeding (Singh *et al.,* 2005). Grimard *et al.* (2006) cited that fertilization failure and early embryonic loss, late embryonic/fetal loss, and late abortion represent 20 - 45%, 8 - 17.5% and 1 - 4% of pregnancy failure, respectively. A study made by Inskeep and Dailey (2010) indicated that increase in the levels of estradiol during days 14 to 17 after mating can enhance embryonic mortality in cows. As indicated in a study by Dailey (2008) factors such as dystocia, stillbirth and uterine infection can influence delays of breeding and early embryonic losses. Results of the study by Inskeep and Dailey (2005) further indicated that low progesterone levels between 28 to 37 days of gestation was predictive of greater embryonic and early fetal losses. In another study by Forar *et al.* (1996), it was reported that embryonic mortality was higher between days 31 and 55 of gestation and that the mortality correlated with drop in the concentrations of progesterone in the milk. It was also estimated in a study by Diskin and Sreenan (1980) that estimated loss due to embryonic mortality till 42 after insemination range from 20 to 42 percent respectively in most of the dairy cows.

## 2.10. The status of pregnancy rate/conception rate in Ethiopia

Pregnancy rate/conception rate refers to the percentage of cows /heifers diagnosed pregnant out of total number of cows/ heifers inseminated (Miah *et al.,* 2004). Recent results reported by Hamid (2012) in Siltie zone, Adebebay *et al.* (2013) in Bahir Dar milk shed and Tewodros *et al.* (2015) in Fogera woreda indicated that an average of conception rate was 48.1%, 13.7 % and 31.29%, respectively. Desalgn (2008) also reported that the average national conception rate in Ethiopia is 27%. On the other hand, conception rate found in Bangladesh was 46.2% that reported by Shamsuddin *et al.* (2001), 54.3% in Senegal Abonou (2007), 51.5 % Hossain (2013) in Bangladesh, 57.3% by Paul (2010) in Sirajgonj district. Previously reported studies by Gain (1989) and Samson (2001) an average of conception rate in Ethiopia was 60% and 40%, respectively. Conception/ reproductive performance are associated to either to the management factors (such as husbandry, feeding, estrus detection and time of artificial insemination, semen handling) or cow factors such as age, body condition score, post-parturient problem, disease events, milk yield and genetics (Hudson *et al.,* 2012). Some of the factors affecting conception is discussed below

**Effect of genetic and non-genetic:** it has been reported by Mukasa-Mugerwa (1989) that the cattle reared in the tropics have lower fertility when compared to their temperate counterparts, this may be attributed to environmental differences, including inadequate nutrition, prevalence of diseases and parasites as well as the interaction between the genotype and environment. Miah *et al.* (2004) reported similar observations from Bangladesh. Crossbred cows require better management, feeding and health care than the indigenous zebu cattle for traits pertaining to their reproductive performance and productivity in the tropical climate (Tekleye *et al.,* 1991). Accordingly, the results from a study by Abebe *et al.* (2011) in Hosanna (southern part of Ethiopia) the prevalence of reproductive problem in crossbred is higher than the native cattle. Studies by Miah *et al.* (2004) indicated that there was no significant influence between the native and crossbred cattle when it comes to the rate of conception at the first service.

In contrary to the above, a study by Woldu *et al.* (2011) indicated that there was a significant difference among the (58.6%) crossbreds and (32.8%) native breed under farmers' condition in Ethiopia when it comes to conception rate using AI procedure, the values being significantly favoring the crossbreds. Similarly, Sarder *et al.* (2001) found better pregnancy rates in crossbred cows than that of local counterpart in Rajshahi district. However, a study made by Paul (2010) and Sharifuzzaman *et al.* (2015) indicated that the conception rate of native cattle was higher than Holstein Friesian crossbred.

**Effect of body condition scores:** poor nutritional status directly influences the fertility in cattle especially those maintained on grazing in the subtropical/tropical areas (Bó *et al*., 2003). Providing adequate quantity of balanced diet to animals will help to gain good BCS resulting in satisfactory reproductive performance. Studies by Azage (1989) indicated that conception rates directly correlate with BCS as the effect conception rate directly correlated with BCS as the effect of non-genetic factors such as season, year, feed resources, management are some of the factors influencing the trait of conception rate. In the Boran cow lower conception is generally observed during the dry season when the BCS are usually lower. Result of a finding by Azage (1989) further indicated that BCS improved by providing the cattle with supplementary feed, the supplementation also improved the rate of conception in both the Boran and their crossbreds.

A study by Woldu *et al.* (2011) indicated that supplementation of significantly (P<0.05) improved the body condition of the cows than the un-supplemented groups. Studies by Shamsuddin *et al.* (2001), Emebet and Zeleke (2007) too indicated that animals with optimum body condition at insemination had better fertility than those with poor or higher BCS. Studies by Spitzer *et al.* (1995) and Woldu *et al.*(2011) indicated that cows having a BCS ≥5 at calving helps in return to estrus sooner than cow having lower BCS and cows with a BCS 6 or 7 had higher pregnancy rate compared to cow with a BCS 4 or 5. However, Kaziboni *et al.* (2004) reported that there was no appreciable difference on conception rate among cows with different BCS reared by smallholder farmers in Zimbabwe.

**Effect of age:** infertility is the main problem that influences reproduction in both native and crossbred cows and heifers in Ethiopia (Duguma *et al.,* 2012). Under Ethiopian condition, puberty usually observed at 24 months in Zebu x Friesian crossbred cattle (Duguma, 2012) and, heifers are reported to have an extended later age at first calving. An investigation of post AI conception rate in zebu cows at Shaghata Upazilla of Ghaibandha showed the highest (59.1%) pregnancy rate in cows of 37 to 48 months of age (Mollah, 2011). Most cows reared by the smallholder farmers do not calve every 12 to 13 months after the first calving (Shiferaw *et al.,* 2003). In heifers requirement of nutrients for continued growth and lactation place additional demand on the animal that may influence the CR (Goshu, 2005). Findings by Mukasa-Mugerwa *et al.* (1989) indicate that the useful life of Zebu cattle in the tropical countries was optimum between 4.5 to 8.5 years of age during which the cows parturated around 3 to 5 times. The reduction in the CR with age of the cow could partly attribute to the exposure of the cows to different reproductive diseases besides other similar stress factors (Gebregziabher, 2005).

**Effect of parity**: studies by Buckley *et al.* (2003) indicated that in multiparous cows have low conception rate in comparison to the primiparous cows. However, Molalegne and Shiv (2011) in their study have reported that parity has direct association on the occurrence of reproductive problems. In addition to this, Adane *et al.* (2014) also indicated that parity had influence on the prevalence of reproductive health, as animals with more than three parties are more susceptible to reproductive problems than the heifers.

Due to delayed resumption of ovarian activity after calving (as a result of the longer resting period needed to recover from parturition stress and to cop-up with the increased demand for growth and lactation) among the heifers the conception rate was higher than those of the cows calving for the second and third time. However, the values are higher than from cows with the higher parities (Gebregzibheir, 2005). Studies by several authors (Mukassa *et al.,* 1991; Miah *et al.,* 2004; Quintela *et al.,* 2004; Grimard *et al.,* 2006; Khan *et al.,* 2008 and Bhattacharyya *et al.,* 2009) indicate that conception rate peaked during the second lactation and declines thereafter.

## 2.11. Estrus synchronization in cattle

The history of estrous cycle synchronization and the use of artificial insemination in cattle is a testament to how discoveries in basic science can be apply to advance the techniques used for livestock breeding and management (Beal, 2002). Synchronization of estrus involves manipulating or controlling the estrous cycle of the females, so that they can be breed at approximately the same time (Rick and Gene, 2013). Synchronization of the estrous cycle has the potential to shorten the calving season, increase calf uniformity and enhance the possibilities for utilizing AI (Lamb, 2010). The objective of a synchronization program is to breed a high percentage of the females in a given group of heifers or cows in a short period, using either AI or natural service (bulls) (Noseir, 2003). The use of PGF2α for estrus control has been considered more applicable to tropical herds, possibly owning to problems with estrus detraction and irregularity of the estrus cycle (Voh *et al.,* 1987; Azage 1989). The use of estrus synchronization and heat-detection significantly shorten the time spent observing heat in the heifers/cows; however, the benefits from this method can only be obtained from a reproductively healthy cow.

Non-cycling cows or anestrous cows, a condition where the cow does not cycle due to insufficient natural hormonal stimuli cannot be induced to restore her reproductive cycle using this technique (Pennington, 2013). The technique of estrus synchronization can significantly assists the already existing reproductive management tools. The technology needs to be disseminating to the cattle rearers, veterinarians and industry personnel to ensure they are adopted at the producer level and to provide the necessary technical support to achieve optimum results (Lamb, 2010). The current management, breed, economic, location, and marketing options are producer specific, hence recommendations for the use of the technology have to be location specific (Lamb, 2010).

### 2.11.1. Prostaglandin (PGF2α) hormone

Prostaglandin or its analogue is used to synchronize estrus in dairy cattle operations to improve the efficiency of AI by inducing the regression of the corpus luteum and subsequently lead to the expression of estrus and ovulation with 2 to 5 days after their administration (Holm *et al.,* 2008; Murugavel *et al.,* 2010). Pregnancy rate from 61.4 to 65% in cycling and up to 47% in anestrus cows have been reported after a single injection of PGF2α (Perry, 2005). Use of PGF2α was the first method of heat synchronization that depends on the presence of a functional CL particularly in the diestrus stage of the estrous cycle (day 7 to 17 of the cycle). Each estrus cycle consists of a long luteal phase (1 to 17 days) where the cycle is under the influence of progesterone and a shorter follicular phase (18 to 21 days) where the cycle is under the influence of estrogen. This time of peak estrogen secretion can last from 6 to 24 hrs. with ovulation occurring 24 to 32 hours after the beginning of estrus (Williams *et al.,* 2002). Administering PGF2α or its analogue during the early postpartum period leads to increased conception at the first service it also has several associated benefits of enhancing uterine activity, thereby decreasing the interval between calving and conception (Imwalle *et al.,*1998).

### 2.11.2. Estrus synchronization protocols

Different estrous synchronization protocols are available globally. Some commonly used estrous/ovulation synchronization protocols in dairy cattle includes use of prostaglandin (one-shot method and two-shot method) and progestin and GnRH (Ovsynch and Cosynch) (Rick, 2015), GnRH (gonadotrophin), prostaglandin and progestagen implants (Mattoni and Ouedraogo, 2000). The findings of Baruselli *et al.* (2006) suggested that treatments using progesterone-releasing devices and GnRH/ EB might improve reproductive performance in *Bos indicus* cows due to their beneficial effect on Luteinized hormone pulse frequency, follicular growth and ovulation. Advantages of GnRH use in Ovulation Synchronization allow for synchronized follicular growth and ovulation, not just the synchronization of estrus, induces ovulation and estrous cycles in non-cycling cows. These systems allow producers to artificially inseminate cows with little or no heat detection; eliminating the risk of injury for cattle that are mounting or displaying other estrus behavior (Juan Pablo, 2005).

Studies by Azage *et al.* (2011) in Awassa-Dale milk shed and Girmay *et al.* (2015) in and around WukrokilteAwulaelo district indicated that the rate of estrus response in a single injection of prostaglandin protocol at the farmer level was 97.7% and 91.3%, respectively. Other study made by Bekana *et al.* (2005) on Fogera heifers indicated that the effectiveness of single injection of PGF2α used to synchronize heifers was 82% within 82 hrs from the time of injection. A study conducted by Adebebay *et al.* (2013) in Bahir Dar milk shed indicated that the average response rate of the cows to prostaglandin (PGF2α) injection or its analogue was 89.3%. Results of a study by Diskin *et al.* (2001) indicated oestrus synchronization with PGF2α, results in expression of heat among 85% of the cows within 36 and 60 hours post injection, while Tewodros *et al.* (2015) reported that PGF2α when administered to cows with a functionally mature corpus luteum 98.9% of them show signs of estrus.

A study conducted by Million *et al.* (2011) using the PGF2α protocol based on estradiol benzoate (EB) or gonadotrophin releasing hormone (GnRH) indicated that the average oestrus interval varied between genotypes while it was 70.67 hrs for Boran cows it was observed that the time was 54.58 hrs and for Boran X Holstein Frisian crossbred. The author suggested that the use of EB with Controlled Internal Drug (CID) and PGF2α was more effective than GnRH for increase the number of cows showing estrus behavior and creating tight synchrony. The results from a study by Adebebay *et al.* (2013) using prostaglandin (PGF2α) alone indicated that the average numbers of hrs to estrus interval in cows and heifers post injection was 51 and 50 hrs, respectively in Bahrdar, Azage *et al.* (2012) 13 to 154 hrs in Dale milkshed, Hamid (2012) 57.9 hrs in Siltie zone. The use of Prostaglandin or its analogue (PGF2α) in a synchronization protocol shortens the estrous cycle when used alone and estrus is observed within 2 to 7 days post injecting the hormone (Gupta *et al.*, 2008).

### 2.12. Characterizing the progesterone profile

Progesterone is a steroid hormone, it has an affinity for milk fat; thus a progesterone level in milk is somewhat higher than that in the blood (IAEA, 2007). A low level of progesterone on the day of insemination provides a good indication that the animal was in estrus and there are more chances of conceiving (Bajema*et al.,* 1994). If the cow does not conceive, the CL begins to degenerate from approximately $17^{th}$ day of the cycle and the levels of the progesterone declines to its minimal concentrations on days $20^{th}$ till $23^{rd}$ as the cow returns to heat (O'Connor Michael, 2003). Variation in the concentration of progesterone in milk due to stage of the cycle or pregnancy status is much greater that the effect caused by variation in milk fat content (IAEA, 2007). Since prostaglandin is being used more frequently in synchronization for lactating cattle and the effectiveness of this treatment depends on the presence of a functional CL on the ovary progesterone analysis can be useful in verifying the presence of CL (Perez-Marin & Espana, 2007).

# 3. MATERIALS AND METHODS

## 3.1. Area description

The study was carried out in three woredas namely Bensa, Bona Zuria and Arbegona of Sidama zone of Southern Nations Nationalities and Peoples' Region (SNNPR) located in central part of the region. Geographically Sidama zone is situated between the coordinates of $5^0$45' and $6^0$45' N latitude and $38^0$39' and $38^0$29' E longitude with altitude ranging from 1100 to 3500 meter above sea level (m asl) (SDC, 2000). Rainfall pattern of the zone is bimodal type with small rainfall during the months of February to April followed by the main rainy season from July to September. Sidama zone consists of 19 districts with total area coverage of 10,000 $km^2$. It has a diverse agro ecology classified as highlands (dega), midlands (woinadega) and semi-dry lowlands (kolla) covering 30%, 60% and 10% respectively (SDC, 2000). The farming system of the zone is characterize as mixed crop and livestock farming. The zone endowed with different livestock resources such as cattle, small ruminants, equines, poultry and honeybee. Bensa woreda is situated between $6^0$30'152 and $6^0$31'540''N latitude and $38^0$44'791'' and $38^0$49'298''E longitude. Bona Zuria also situated between $6^0$31'177''and $6^0$32'310''N latitude and $38^0$39'677''and $38^0$42'410''E longitude while Arbegona is located between $6^0$36'421'' and $6^0$41'135''N latitude and $38^0$44'737''and $38^0$43'355''E longitude with altitude for Arbegona ranging from of 2298- 2606, Bensa 1910 -1921 and Bona Zuria 1992 to 2461 m asl.

## 3.2. Survey on assessment of breeding practice of dairy cattle

### 3.2.1. Sampling techniques

Three woredas were selected purposively from the areas already identified by LIVES project, namely Arbegona from highland and Bensa and Bona zuria from midland agro-ecologies. From each woreda three rural kebeles were selected randomly. From each selected kebeles, 30 cattle owning households were randomly selected for the interview, thus the numbers of respondents for the study were 180. Data pertaining to herd size and composition, purposes of rearing cattle, selection criteria and preferred traits, milk production and reproduction performance, mating practices and source of breeding bull, awareness on estrus detection and insemination and farmers perception related to mass synchronization were obtained from the respondents.

### 3.2.2. Data type and collection methods

Both primary and secondary data were collected from primary and secondary data sources. The informal method of data collection methods such as focus group discussion and key informant interview were employed. Moreover, the formal methods of data collection notably questionnaire survey was also used for the primary data collection.

## 3.3. Evaluation of estrus synchronization and mass insemination efficiency

### 3.3.1. Data type and its sources

Secondary data on mass estrus synchronization and artificial insemination (OSMAI) of dairy cattle reared at Bensa and Arbegona woreda was collected from the Agricultural Office of respective woredas and records maintained at Hawassa Agricultural Research Center. Thus, data pertaining to 883 cattle that were included in the synchronization program were used in the study. The rate of conception was assessed based on both genetic and non-genetic variables viz. cattle type, age of the cattle, bull itself, $PGF2_{\alpha}$ hormone response time besides their body condition score and agro ecology.

### 3.4. Evaluating the reproductive performance of synchronized and inseminated cattle

#### 3.4.1. Study design and methodology

In order to assess the effect of synchronization using PGF2α (5 ml Lutalyse™) a total of 126 dairy (65 lactating and 20 non lactating native and 20 lactating and 21 dry crossbred) cattle were purposively selected from Bensa woreda and treated with a single injection of PGF2α. The cows were inseminated artificially after they showed signs of standing estrus (heat) that ranged between 24 to 120 hours post PGF2α administration. The cattle were selected based on the availability of feed, age (3 to 9 years), parity ($1^{st}$ to $5^{th}$ level), health status, non-pregnancy status during synchronization and BCS (1 to 9 scale) (Nicholson and Butterworth, 1986). Moreover, the action research was done after the onset of main rainy season (spring) that primarily pre assumed the availability of animal feed from different sources.

#### 3.4.2. Heat detection and insemination procedure

Before the commencement of estrus synchronization, farmers were trained about how to detect estrus/heat in cattle. The cows were inseminated according to AM/ PM method as suggested by (Peter and Ball, 2004). One well experienced and trained inseminator was assigned for insemination to avoid any ambiguity of differences arising due to question raising on efficiency of inseminators.

The inseminator through rectal palpation assessed the stage of estrus when the cattle were brought to the artificial insemination center. All cows were inseminated at standing estrus. The cows were inseminated using semen from Holstein Friesian bulls frozen semen (100%) stored at -196 $^{o}$ C, the semen were collected from bulls reared at National Artificial Insemination Center, Kality, Addis Ababa. Non-lactating cows were considered as pregnant for non-return of estrus and confirmation was done by rectal palpation of the growing fetus at 60 days of post insemination. The conception/pregnancy status were also assessed using the Hormonost® Micro-lab Farmer test by assessing the level of progesterone hormone in the milk of lactating cows. The milk progesterone hormone status was assessed from 19 to 25 days of post insemination and confirmed by rectal palpation at days 60 of post insemination.  At the end of the study period CR and number of service per conception (NSPC) was determined.

### 3.5. Determining conception & embryonic mortality of inseminated cows

Out of 126 synchronized cows, the level of progesterone in the milk was monitored for 20 lactating cows that were inseminated. Progesterone profile in milk was recorded thrice a week at days 19, 22, 25, 28, 31, 34, 37, 40, 43, 46, 49, 52, 55 and 58 post inseminations. This was done to evaluate the changes in the levels of progesterone hormone post pregnancy and to identify embryonic mortality at early stages.  As indicated by the manufacturer the level of progesterone hormone is measured in nanogram per milliliter (ng/ml) using Hormonost® Micro-lab farmertest that detect the levels of the hormone within a range of 1-30 ng/ml (Müllner, 2009). After all this procedure, rectal palpation method also employed to confirm pregnancy at 60 days of post insemination

### 3.5.1. Milk sampling, testing and progesterone measurement

The milk progesterone level was assessed according to the method suggested by Daniel and Klaus (2014). To identify the milk progesterone level, 100 µl milk sample was used and added to each test tube and then 6 drops of milk diluter (used to dilute the milk) was dropped immediately in to each test tube which was having milk sample. The mixed sample was shaken for 10 seconds and waited for 5 minutes then 100 µl of enzyme **(**progesterone enzyme conjugate) was dropped on the mixture to bind the milk progesterone with the coated antibody on the tube. After the enzyme was added the mixture was shaken for 10 seconds followed by 3 minutes of waiting time between shakings. After mixing the solution the mixture was flowed out from the test tube and washed 6 times by using cold tap water then shaken vigorously for three times to remove the residual water from the tube. All cleaned tubes were then dried and placed in microtherem for 15 second to remove any traces of moisture. Finally, 12 drops of the substrate was added into the dried tubes to determine color and progesterone level of milk sample. All reagents were added and the results were displayed by using Hormonost® Micro-lab farmer test.

## 3.6. Data analysis

Data collected via questionnaire survey was processed in Microsoft Excel and SPSS version 20.0 software for the statistical analysis. For the survey of quantitative data were analyzed using the General Linear Model Procedure (univaraite) and the qualitative data were assessed using non-parametric tests (chi square/$\chi 2$). The efficiency of estrus synchronization and the association between conception rate and its determining factors such as BCS, age, parity, breed, time of insemination and bull was analyzed using chi-square test. The variation between groups was considered significant when the P value was less than 0.05. The result of detection estrus detection time was presented by figures using excel soft ware. Milk progesterone profile result was presented and analyzed by figures and descriptive statistics (Mean, minimum and maximum). The conception rate and numbers of services per conception was calculated according to the method suggested by (Sharifuzzaman *et al.,* 2015**).**

Index analysis was used to calculate the ranking for purpose of keeping livestock and trait preference according to the method suggested by (Kosgey, 2004). The ranking was expressed as an Index = the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + 1 times fifth order) given for an 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.

# 4. RESULTS

## 4.1. Household socio economic characteristics

The results pertaining to the family size, sex, age structure, and educational level of the respondents of the study area are presented in Table 7. The results indicate that there was ($P<0.05$) difference in average family size and age of the household head among the two agro-ecologies. The results also indicate that most of the respondents were illiterate in both the studied agro ecologies. However, households attained grade 7 to 8 and 9 to 12 was found in highland.

Table 7. Socio-economic and demographic characteristics of the households

| Parameters | Highland (n=60) | Midland (n=120) | Overall mean |
|---|---|---|---|
| Family size (mean±SD) | 8.2±2.8 | 7.2±2.3 | 7.5±2.5* |
| Male | 4.4±2.0 | 3.7±1.6 | 4±1.8 |
| Female | 3.7±1.8 | 3.5±1.7 | 3.4±1.8 |
| Age of the household (mean±SD) | 45±12.4 | 41.3±10.6 | 42.5±11.3* |
| Educational level (%) | | | |
| Illiterate | 26.7 | 33.3 | 31.1 |
| 1-6 | 23.3 | 25 | 24.4 |
| 7-8 | 28.3 | 20.8 | 23.3 |
| 9-12 | 21.7 | 20.8 | 21.1 |

SD= standard deviation, n= number of respondents, * $p<0.05$, values across rows for family size and age different.

## 4.2. Land holding

Land holding was insignificant difference among the respondents in the two agro-ecologies. The results further indicated that while the cultivated land was higher (P<0.05) in the midlands the reverse was true for the grazing lands.

Table 8. Land use classification of sample households

| Land use pattern | Highland (n=60) Mean±SD | Midland (n=120) Mean±SD | Overall mean (n=180) |
|---|---|---|---|
| Farm size (ha) | 1.72±.52 | 1.67±.57 | 1.7±0.5 |
| Cropping land (ha) | 0.87±.38 | 1.34±0.48 | 1.18±0.5* |
| Grazing land (ha) | 0.9±.3 | 0.3±0.2 | 0.5±0.4* |

SD= standard deviation, ha= hectare, n= number of respondent, * values across rows differ P<0.05

## 4.3. Cattle feed resources

The results of Table 9 indicated that feeding practices were differed across the agro ecologies and across the seasons. The natural pastures predominate as the feed source in both agro ecologies especially during wet season. The usage of crop residues was too varied across the seasons. Crop residue has higher contribution being observed during the dry season in both the agro ecologies. The cut and carry system of feeding too had similar trend (irrespective of the agro ecologies) as that of the natural pastures. This may be because during the wet season the animals may not be able to go for grazing and hence the only option left for the respondents is to cut and carry the grasses to feed the livestock. The results across the columns indicate that feed from natural pastures predominate in the highlands during the dry season, while crop residues were the major sources of forage in the midlands during the dry season. During the wet season the natural pasture dominates over all the types of feeding practice (in the highlands), in the midlands cut and carry system was more prevalent followed closely by the natural pasture.

Table 9. Feeding practice of sample households in dry and wet seasons (n=180)

| Feed source | Agro-ecology | Season | |
|---|---|---|---|
| | | Dry (%) | Wet (%) |
| Natural pasture | Highland | $91.7^{Aa}$ | $100^{Ba}$ |
| | Midland | $59.2^{Ab}$ | $69.2^{Bb}$ |
| Crop residue | Highland | $85^{Aa}$ | $6.7^{Ba}$ |
| | Midland | $95.8^{Ab}$ | $16.7^{Bb}$ |
| Cut and carry feeding | Highland | $33.3^{Aa}$ | $45^{Ba}$ |
| | Midland | $55.8^{Ab}$ | $70.8^{Bb}$ |

$^{a,b}$ values across columns and $^{A,B}$ values across rows are different P<0.05

### 4.4. Livestock composition and herd size

The numbers of cattle being reared by the respondents are higher in the highland of study area. The findings also indicate that the population of cows, bulls, heifers and calves are higher in the highlands while the populations of the oxen are higher in the midlands (Table 10). The findings also indicated that the population of the sheep are higher (P<0.05) in the highlands, while the reverse was true for the goats. The result also indicate that the population of horses too were higher (P<0.05) in the highlands.

Table 10 Livestock demography and average herd size of the sampled households (n=180)

| Livestock type | Highland (n=60) | Mid land (n=120) | Average (n=180) |
|---|---|---|---|
| Total cattle | 13.2±5.5** | 6.96±2.4 | 9.05±4.8 |
| Cow | 6.73±3.93** | 3.23±1.6 | 4.41±3.09 |
| Ox | 0.28±0.49 | 0.55±0.63* | 0.46±0.60 |
| Bull | 0.75±0.6* | 0.32±0.42 | 0.46±0.52 |
| Heifer | 2.92±1.4** | 1.5±1.1 | 1.99±1.4 |
| Calves | 2.62±1.33** | 1.41±0.95 | 1.8±1.23 |
| Sheep | 2.93±1.4* | 2.09±1.6 | 2.37±1.6 |
| Goat | 1.58±1.03 | 2.22±1.3* | 2.01±1.2 |
| Chicken | 2.62±1.6 | 3.10±2.7 | 2.94±2.4 |
| Donkey | 0.77±0.46 | 0.62±0.52 | 0.67±0.51 |
| Horse | 0.55±0.5* | 0.11±0.3 | 0.26±0.44 |

Values across rows are significant**P<0.01, *P<0.05

### 4.5. Purpose of keeping livestock

The purpose of rearing cattle in the study areas are presented in Table 11. The findings from the highlands indicated that the primary reason for rearing cattle in the area is milk for consumption followed by source of income, social values, manures and traction. In the midlands, the cattle are reared for milk purpose, followed by source of income, manure, social prestige and traction. The index value for traction in midland is relatively high due to farmers engaged more in agricultural activities in midlands when compared to the highlands.

Table 11. Ranking livestock rearing purposes of respondents in highland and midland

| Parameter | Highland | | | | | | | Midland | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1st** | **2nd** | **3rd** | **4th** | **5th** | **index** | Rank | **1st** | **2nd** | **3rd** | **4th** | **5th** | **index** | Rank |
| Milk yield | 73.3 | 26.7 | 0 | 0 | 0 | 0.32 | 1 | 68.3 | 31.2 | 0 | 0 | 0 | 0.31 | 1 |
| Income source | 26.7 | 73.3 | 0 | 0 | 0 | 0.28 | 2 | 31.7 | 65 | 3.3 | 0 | 0 | 0.29 | 2 |
| Social value | 0 | 0 | 88.3 | 8.3 | 3.3 | 0.19 | 3 | 0 | 3.8 | 33.1 | 43.3 | 20 | 0.15 | 4 |
| Manure | 0 | 0 | 5 | 86.7 | 8.3 | 0.13 | 4 | 0 | 0 | 61.7 | 21 | 18.3 | 0.16 | 3 |
| Traction | 0 | 0 | 6.7 | 5 | 88.3 | 0.07 | 5 | 0 | 0 | 1.8 | 35.7 | 61.4 | 0.09 | 5 |

Index=the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + *1 times 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.*

### 4.6. Animal housing and source of water

The findings indicate that in both the agro ecologies most of the respondents prefer rearing the cattle within their own dwellings. Majority of the respondents are dependent on river as a source and followed by that from the streams to provide water to their livestock. Few respondents (in the midlands) indicated that they used pond water for their livestock. The results also indicated that that irrespective of the agro ecologies most of the respondents provide water once a day during the wet season while during the dry season the livestock are provided water twice a day.

Table 12. Animal housing and housing system of sampled households (n=180)

| | Agro-ecology | | |
|---|---|---|---|
| **Factors** | Highland (%) | Midland (%) | Total (%) |
| Animal housing system | | | |
| Main house | 91.7 | 90.8 | 90 |
| Separate house | 8.3 | 10.2 | 10 |
| Major source of water | | | |
| Rivers | 91.7 | 85.8 | 87.8 |
| Streams | 8.3 | 10.8 | 10 |
| Pond | - | 3.3 | 2.2 |
| Watering frequency in wet season | | | |
| Once in a day | 63.3 | 68.3 | 64.4 |
| Twice a day | 18.3 | 23.3 | 22.2 |
| Every other day | 18.3 | 8.3 | 13.3 |
| Watering frequency in dry season | | | |
| Once in a day | 33.3 | 24.2 | 27.2 |
| Twice a day | 66.7 | 75.8 | 72.8 |

## 4.7. Reproductive and productive performance of dairy cattle

As indicated Table 13, there was no significant difference in agro-ecology for the age at first service for the heifers (AFSF) and steers (AFSM). Age at first calving (AFC) in native and crossbred did not differ significantly across the two agro-ecologies. However, AFSF, AFSM and AFC of the current studies were ($P<0.05$) difference among the native and crossbred cattle. The result further indicated that lactation length (LL) was higher ($P<0.05$) among the native cows reared in the highlands. Similarly, LL of crossbred cattle was higher in highland than midland. The results also indicate that the AFSF, AFSM and AFC were higher among the native cattle. While the DMY and LL was higher ($P<0.05$) in HF when compared to the native cattle.

**Table 13. Reproductive and productive performance of dairy cattle**

| **Factor** | AFSF | AFSM | AFC | DMY | LL |
|---|---|---|---|---|---|
| | months | months | months | Liters | days |
| **Cattle type** | | | | | |
| Local | 44.1±5.9[a] | 42.2±4.4[a] | 51.9±5.9[a] | 1.54.5±0.5[c] | 221.4±56.5[b] |
| Crossbred | 30.3±4.4[b] | 27.3±3.9[b] | 39.3±3.2[b] | 4.14±0.7[a] | 293.90±30.1[a] |
| **Agro-ecology** | | | | | |
| Local*highland | 43.9±5.2 | 41.4±4.3 | 51.8±4.5 | 1.65±0.5 | 245.4±50.3[a] |
| Local*midland | 44.2±6.3 | 42.7±4.4 | 52.0.±6.5 | 1.5±0.5 | 207±50.2[b] |
| Crossbred*highland | 29.14±4 | 26.8±4.1 | 38.5±2.4 | 4.23±0.3 | 303.4±36.6 |
| Crossbred*midland | 30.9±4.4 | 27.6±3.9 | 39.7±3.5 | 4.08±0.9 | 288.7±25.6 |

Where AFSF= age at first service female, AFSM= age first service male, AFC= age at first calving, DMY= daily milk yield, LL=lactation length, P<0.05[a, b], values across column for a trait are different.4.8.

### 4.8. Breeding practice

#### 4.8.1. Mating systems and source of bull

The findings pertaining to the type of mating system and source of bull of the respondents were presented in Table 14. The result indicates that natural mating was the common practice of mating in the study area followed by both (natural mating and artificial insemination) methods. The study also revealed that only a few respondents use only AI system for their cattle breeding purpose. The results also indicated irrespective of the agro ecologies most of the respondents depended on bulls reared by their neighbors/friends.

Table 14 Prevalent mating system and source of bull in the study area

| Parameter | Agro-ecology | | |
|---|---|---|---|
| | Highland (n=60) | Midland (n=120) | Average (n=180 |
| Mating system | % | % | % |
| Only AI | 5 | 4.2 | 4.0 |
| Natural mating | 70 | 68.3 | 68.3 |
| Both natural and AI mating | 25 | 27.5 | 27.7 |
| Source of bull | | | |
| Own | 36.7 | 24.2 | 32.2 |
| From Neighbors | 63.3 | 75.8 | 67.8 |

n= number of respondents

### 4.8.2. Trait preference for selection of dairy cattle

The findings pertaining to trait preference of farmers for selection of dairy cattle in the study areas are presented in Tables 15. More respondents reported that a selection trait of animals takes place by considering expected milk production potential. To achieve this, farmers apply their own selection criteria. The findings indicated that from the highland the preferred traits for selecting cattle is milk yield followed by breeding ability, growth rate, feeding behavior, coat color, good temperament and diseases resistance. On the other hand, in the midland the cattle selected based on their milk yield followed by breeding ability, growth rate, feeding behavior, disease resistance, good temperament and coat color. These finding indicated that ranking of trait preference in the study area based on multiple traits and not only based exclusively in the dominance of a single trait. Disease tolerance is an important trait for selecting the cattle in the midland, while coat color is the least preferred. However, in both the agro-ecologies the respondents prefer to rear animals with good temperament.

Table 15.Ttrait preference of farmers for dairy cattle selection in highland and midland area

| Parameter | Highland | | | | | | | Midland | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1st** | **2nd** | **3rd** | **4th** | **5th** | **index** | Rank | **1st** | **2nd** | **3rd** | **4th** | **5th** | **index** | Rank |
| High milk yield | 73.3 | 23.3 | 0 | 3.3 | 0 | 0.31 | 1 | 71.7 | 11.7 | 15 | 1.7 | 0 | 0.30 | 1 |
| Breeding ability | 21.7 | 58.3 | 18.3 | 0 | 1.7 | 0.27 | 2 | 16.7 | 81.6 | 0 | 0 | 0 | 0.27 | 2 |
| High growth rate | 0 | 16.7 | 76.7 | 3.3 | 3.3 | 0.2 | 3 | 11.7 | 5 | 68.3 | 13.3 | 0 | 0.21 | 3 |
| Feeding behavior | 5 | 0 | 1.7 | 55.3 | 1.7 | 0.09 | 4 | 0 | 0 | 3.3 | 63.3 | 18.3 | 0.1 | 4 |
| Good temperament | 0 | 0 | 1.7 | 16.7 | 23.3 | 0.04 | 6 | 0 | 3.3 | 13.3 | 1.7 | 50 | 0.04 | 6 |
| Coat color | 0 | 1.7 | 1.7 | 18.3 | 18.3 | 0.05 | 5 | 0 | 0 | 0 | 0 | 3.3 | 0.02 | 7 |
| Disease resistance | 0 | 0 | 0 | 3.1 | 51.7 | 0.03 | 7 | 0 | 0 | 0 | 20 | 28.3 | 0.05 | 5 |

Index=the sum of (5 times first order + 4 times second order +3 times third order + 2 times fourth order + *1 times 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.*

### 4.8.3. Farmers’ awareness on artificial insemination and time of insemination

More respondents in the study area were not quite aware of the AM/PM method AI time and they prefer to call to the inseminator/take the cattle for insemination at the earliest/late possible time. However, the result indicated that some of the respondents call in for the inseminator at their leisure and in many cases, the inseminator too follows similar trend. Thus, it can be understand that lack of awareness on time of insemination may be a reason for poor success of AI in the study area.

Table 16 Awareness of AI beneficiaries on time of insemination during heat period (n=60)

| Time of insemination | Cows and heifers showing heat in the morning (%) | Cows and heifers shown heat in the afternoon (%) |
|---|---|---|
| After noon of that day | 38.3 | 48.7 |
| Morning of that day | 45.7 | - |
| Morning of the next day | 6.7 | 33.3 |
| After noon of the next day | 4.7 | 9.7 |
| Based on the availability of the AIT | 4.6 | 8.3 |
| Overall | 100 | 100 |

### 4.8.4. Farmer’s perception on estrus synchronization and mass insemination

The involvement and participants’ satisfaction with mass synchronization and problems with the existing AI service in the study area are presented in Table 17. The results revealed that more (68%) respondents were not participating in OSMI. Due to poor estrus response and poor pregnancy, more (61.2%) respondents were not satisfied; while 38.8% were satisfied with positive estrus response and positive pregnancy. With regard to existing AI service problem, repeat breeder, ostrus detection, timely availability of semen, long distance of AI service and shortage of AI technician are the main persistent AI service problems reported by the respondents.

Table 17 Farmers' perception on mass synchronization and constraints of AI service (n=180).

| Parameters | (%) |
|---|---|
| Do you use synchronization | |
| Yes | 32.2 |
| No | 67.8 |
| Satisfaction with the mass synchronization | |
| Satisfied | 38.8 |
| Not satisfied | 61.2 |
| Constraints of existing AI service | |
| AI service not available on time | 22 |
| Repeat breeder | 38 |
| Heat detection | 26.5 |
| Distance of AI station | 4.5 |
| Shortage of AI technicians | 8 |

## 4.9. Evaluation of estrus synchronization and mass insemination (OSMI) efficiency

### 4.9.1. Estrus synchronization

The results pertaining the estrus response rate, interval to oestrus after PGF2α, NSPC and conception rate are presented in Table 18. The result indicated that most of the cattle responded to PGF2α, with no significant differences observed between the native and crossbred cattle. However, the numbers of hours to estrus from injecting PGF2α was longer ($P<0.05$) for native cattle, when compared to those of the crossbred cattle

### 4.9.2. Number of service per conception and conception rate

The present result of OSMI NSPC in crossbred cattle was lower than native cattle (Table 18). Interval to oestrus (after PGF2α) was a significant ($P<0.05$) difference among the genotype. The finding further indicated that first service CR of crossbred cattle was higher than native cattle; however, there was no significant difference in success of first service CR across crossbred and native cattle. However, the value was higher in crossbred cows.

Table 18.Oestrus response rate, response interval, NSPC and conception in dairy cattle (n=883)

| Variables | Genotype | | |
|---|---|---|---|
| | Native | Crossbred | Overall |
| Estruses response rate in % | 87.9 | 86.9 | 87.2 |
| Interval to oestrus (after PGF2α) in hrs | 68.6±1.9* | 56.0±2.0 | 62.1±2 |
| NSPC (mean value) | 2.4 | 1.83 | 2.36 |
| Conception rate in % | 41.3 | 54.7 | 42.2 |

n=Number of synchronized dairy cattle, *$P<0.05$, NSPC=number of service per conception

### 4.10. Factors affecting first service conception rate

The results as presented in Tables 19 and 20 indicated that some of the factors that influencing first conception rate in highland and midland agro-ecology are genotype, parity, BCS, age of the cow, time of insemination and the bull itself. There was no significant difference in conception rate across the two agro ecologies due to differences in genotype. However, conception rate of crossbred cattle was higher (vis -a -vis the native cattle) in both the agro-ecologies. The finding further indicates that conception differ ($P<0.05$) between parities in midland agro-ecologies. However, conception rate was higher in the first parity of midland and second parity of highland and declines with the increase in parity number. The results (irrespective of agro ecologies) indicate that the conception was higher among the cattle with higher BCS and there was a significant (P<0.05) difference among the BCS. Conception rate was a significant difference among the age groups across the highland (P<0.05) and midland (P<0.01). The findings also indicated that in both agro-ecology conception rate was higher for cattle aged 5 to 7 years there after the conception declined.

Table 19 Conception rate and factors affecting conception in synchronized dairy cattle (n=776)

| Variable | Agro-ecology | |
|---|---|---|
| | Highland | Midland |
| | Conception rate (%) | Conception rate (%) |
| Genotype | **NS** | **NS** |
| Native | 44.3 | 39 |
| Crossbred | 60 | 44.4 |
| Parity | NS | * |
| Zero | 46 | 36 |
| One | 49 | 58 |
| Two | 56.7 | 47 |
| Three | 49.2 | 45.3 |
| Four and above | 37.7 | 27.3 |
| Body condition | * | * |
| 4.5 | 33 | 33 |
| 5 | 48 | 39.7 |
| 5.5 | 57.7 | 43.3 |
| 6 | 66.7 | 47.6 |
| Age of animal | * | ** |
| 3 to 4 | 42.8 | 30.6 |
| 5 to 7 | 55.7 | 46.9 |
| Above 7 | 32.0 | 26.1 |

NS=non-significant, * P<0.05, **P<0.01 across column

The results as presented in Table 20 indicate that the conception was highest (P<0.01) for cows inseminated between the interval of >10 to 15 hours after onset of estrus. The Table also indicated that CR decreased (after the $15^{th}$ hrs of estrus) with the increasing time of insemination during the estrus of cattle. The result also indicated that the pedigree of the bull (of similar blood level) influenced the conception rate significantly (P<0.05). Bull number 1(10-202) has higher conception rate than other bull no.

Table 20 Influence of time of the insemination and pedigree of the bull on conception rate

| Variable | Conception rate (%) | P-value |
|---|---|---|
| Time of insemination (hrs) | | |
| 4.9-10 | 43 | ** |
| >10-15 | 49 | |
| >15-20 | 41.3 | |
| >20 | 18.2 | |
| Bull no. | | * |
| 1 | 50 | |
| 2 | 43.6 | |
| 3 | 45 | |
| 4 | 21.3 | |
| 5 | 41.9 | |

* P<0.05, ** P<0.01 significant across column

### 4.11. Evaluating the reproductive performance of synchronized and inseminated cattle

#### 4.11.1. Estrus Synchronization

As shown, the result in Table 21, there is no significant difference in estrus response rate across native and crossbred cattle, but the value was higher in crossbred cattle. Average estrus response interval after PGF2α was significant ($P<0.05$) difference across the native and crossbred cattle. The long time interval was observed in native than crossbred cattle.

#### 4.11.2. Number of service per conception and conception rate in dairy cattle

The results of the finding indicated that the number of service per conception (NSPC) in native is higher than crossbred cow (Table 21). There was no significant difference in success of first service conception rate across the genotypes. However, the conception rate was higher in crossbred cows.

Table21 Oestrus response rate, response interval, NSPC and conception rate in dairy cattle (n=126)

| Variables | Genotype | | |
|---|---|---|---|
| | Native | Crossbred | Overall |
| Oestrus response rate in % | 88.4 | 92.7 | 90 |
| Interval to oestrus ( after injecting PGF2α ) in hrs | 66.3±1.6 | 50.10±2.6* | 61.1±1.2 |
| NSPC (mean value) | 1.9 | 1.5 | 1.7 |
| Conception rate in % | 53.3 | 68.4 | 58.4 |

NSPC=number of service per conception, *P<0.05 across rows

### 4.11.3. Factors affecting first service conception rate in synchronized dairy cattle

Some of the factors affecting conception rate are presented in Table 22 and 23. Conception rate at first service was studied from parity one to fifth parity for native cattle and parity one to third for crossbred cattle (as there were no crossbred cattle with higher parity). The result of the finding indicated that conception rate was higher in primiparous cows and decreased as the parity numbers increased, however there was no significant difference conception rate within the parity groups in native and crossbred cattle. The Table also indicated that conception was better among the cows (both native and crossbred) with higher BCS; however, there was no significant difference among the BCS. The result further indicated that the conception was best among the cows aged around 5 to 7 years thereafter there was a fall in conception rate (Table 22). Age has a significant difference among native ($P<0.05$) and crossbred ($P<0.05$) cattle.

Table 23 indicate that conception was highest ($P<0.01$) the cows which were inseminated between >10 to 15 hrs interval after estrus detection. The result also indicated that there was no significant difference conception among the bull itself, but higher conception rate observed in bull number 1 followed by 3 (10-264 and 10-293). The result presented in Figure 1 indicate that after injecting PGF2α most of the cattle (native and crossbred) showed signs of estrus during the cool hours i.e, in the night and the signs were least during the day time but again increased in the cooler hours of the night.

Table 22 Some factors affecting first service conception rate of of dairy cows (n=116)

| Variables | Dairy cattle | |
|---|---|---|
| | Native | Crossbred |
| | CR% | CR% |
| Parity | | |
| One | 57.8 | 75 |
| Two | 66.7 | 70.6 |
| Three | 45.5 | 61.5 |
| Four | 44.4 | - |
| Five | 40.4 | - |
| BCS | | |
| 4.5 | 42.8 | 44.7 |
| 5 | 57.8 | 62.6 |
| 5.5 | 60.0 | 65.6 |
| 6 | 63.6 | 67.0 |
| Age of dairy cows | * | * |
| 3 to 4 | 48.8 | 55 |
| 5 to 7 | 69.8 | 70.7 |
| Above 7 | 22.7 | 45.5 |

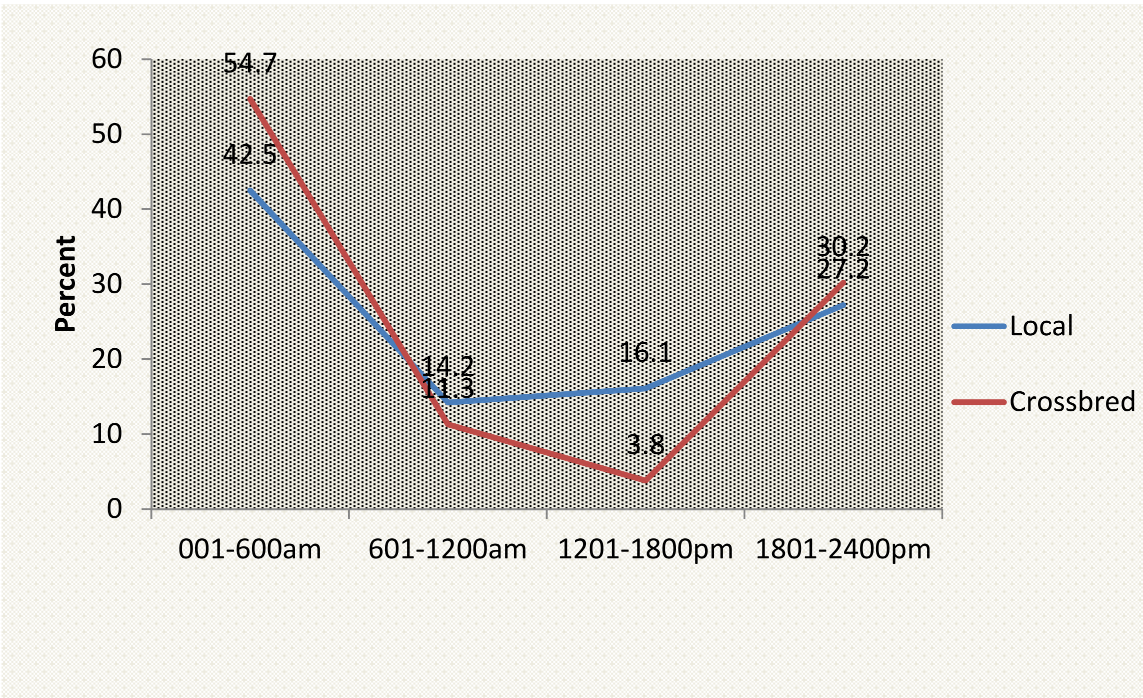
Where BCS= Body Condition Scores, CR= conception rate, *P<0.05 across column

Table 23. Effect of time of insemination and bull on conception rate

| Variables | Conception (%) | P-value |
|---|---|---|
| Time of insemination in hrs | | ** |
| 5.4 - 10 | 48.5 | |
| >10-15 | 76.6 | |
| >15 to 20 | 43.2 | |
| >20 | 20.7 | |
| Bull no. | | |
| 1 | 64.2 | |
| 2 | 48 | |
| 3 | 58.8 | |

CR= conception rate, ** P<0.01 value across column

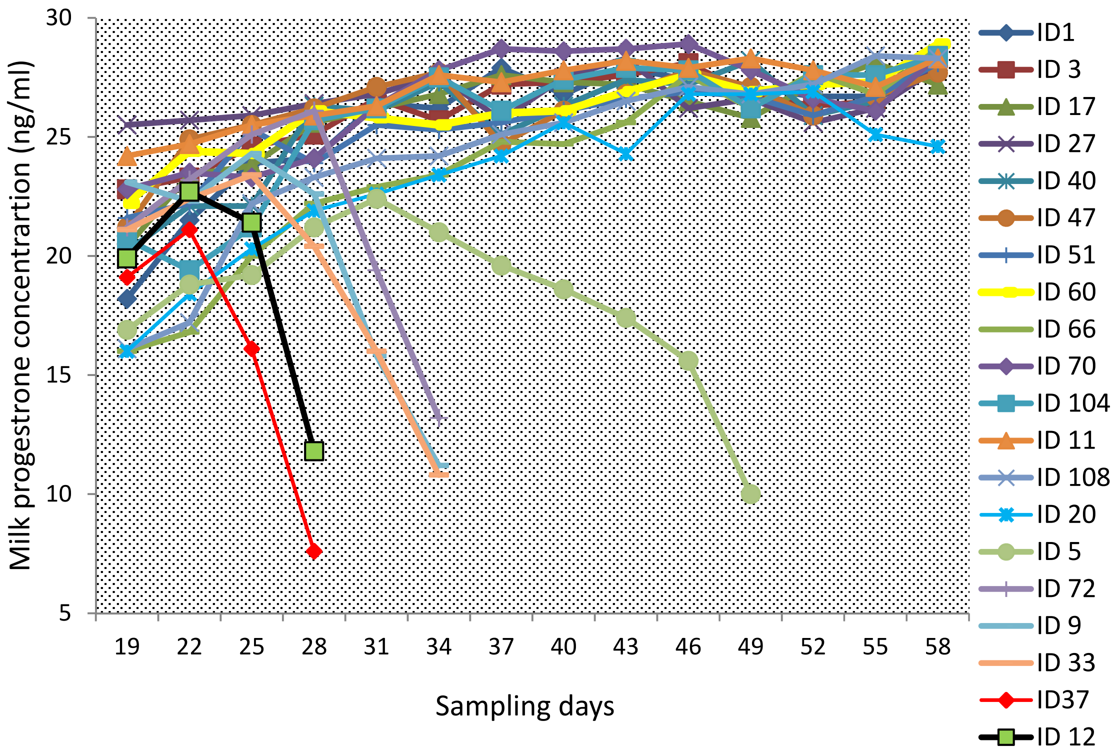
**Figure 1** Estrus detection time



## 4.12. Determining early conception and embryonic mortality in dairy cattle

The levels of progesterone (in milk) of the inseminated cows' result are presented in Figure 2. The figure indicate that among the cows which in spite of conception aborted early were within the range of day 28 to 49, indicating that this was the period between which their loss of pregnancy due to natural causes was highest and there after the chance decrease considerably. The result indicated that six (30%) cows progesterone level in milk is below 16ng/ml which resulted in blue color, while fourteen (70%) cows progesterone level in milk is above 16ng/ml which was colorless, Thus, the level of progestron hormone was more or less similar in all conceived cows after 49$^{th}$ day of post insemination.

Figure 2 Embryo mortality and survival rate after day 25 of gestation in lactating cows



# 5. DISCUSSION

## 5.1. Household characteristics

The average family size found in the present study (Table 7) is comparable to the values reported by Endeshaw (2007) from Dale Woreda of Sidama Zone. However, Zewdie (2010) reported higher family size than those obtained in the present result. The findings also indicate that the family size was higher in the highland when compared to the midlands of the study area that could be attributed to higher involvement of the family members in agrarian activities including dairy husbandry. Average age of household heads as assessed in this study was lower than the values reported by Belet *et al.* (2010) in Fogera Woreda and by Marta (2012) from North Gonder. The findings of literacy status among the respondents are in close agreement with the reports of IAG (2008) and Banerjee *et al.* (2014).

## 5.2. Land holding and feed source

The findings from Table 8 indicate that the average land holding was not significantly different across the agro ecologies. However, the land allocated for crop production in the midland was higher than those of the highland, while the reverse was true for the land allocated for grazing; the findings are contrary to the reports of Azage *et al.* (2013) in Fogera and Bure woreda of Amhara region. The difference as observed may be topography of the area where it was not favorable for agrarian activities in the highlands. Average land holding in the study area was higher than the national average (CSA 2009). The land holdings are however lower than those reported by Yitaye *et al.* (2007) in highland of Amhara region and Yeshitila (2008) in Halaba district. The differences as observed may be attributed to the population pressure and land fragmentation in the study area. Study reported by Solomon *et al.* (2014) over the years land fragmentation can adversely affect the livestock husbandry in Metekel Zone, Northwest Ethiopia.

Natural pasture and crop residues are the main sources of feed for the livestock in study area (Table 9). The observations are in line with the findings of Alemayehu (2004) and Beyene *et al.* (2011). In addition, most of the respondents of the highlands and also the midland use crop residues during dry season. The key informants revealed that wheat, barley and haricot bean straw are the major crop residues used as livestock feed in the highland. Similarly, maize stover, barely, teff and wheat straw are used as animal feed sources in midland of the study area. On the other hand, in the midlands cut and carry feeding system was practiced in both the seasons. According to, the focus group discussion, green feed such as enset, sesbania, elephant and desho (Cintific name) grass are used during the cut and carry feeding system.

### 5.3. Cattle population and their purpose of rearing

The results in Table 10 indicate that the average herd size in the highland is comparable with the result of Seid & Birhan (2014) from the highlands of Segen zuria. However, the average numbers of cattle per household were higher than those reported by Mekonnen *et al.* (2012) from the highland of Western Oromia. On the other hand, the average herd size in the midlands were also higher than those reported by Dejene (2014) from midlands of Borana zone, however the values are significantly lower than those reported by Mekonnen *et al.* (2012) in the midlands of Western

Oromia region The differences in the herd size may be attributed to shortage of gazing land and large share of farm lands which are devoted for agronomic and horticultural crops. The results also indicate that average numbers of sheep per household are higher in highlands, while the reverse was true for the goats; the findings are in accordance with the results from a study by Mekonnen *et al*. (2012). The cooler altitudes of the highlands are favorable for sheep while the relatively warmer climates of the mid altitude regions favor rearing of goats (Endeshaw, 2007).

The households rear the cattle primarily for milk and for other sources of income (Table 11). The livestock are is primordially raised for asset development, which will eventually be used for the fulfilling obligatory needs of the family and also for strengthening of socio cultural bonds (Sintayehu *et al.,* 2008; Mekonen *et al.,*2012; Asrat, 2013; Banerjee *et al.,* 2014). The findings indicating that the respondents owned more cattle than other livestock species indicating that they raise cattle for dairy purposes. The observations are in consonance with the findings of (Shiferaw, 2006; Mekonnen *et al.,* 2012). The use of livestock dropping as an important source of manure and fuel are in close accordance with those of Sintayehu *et al.,* (2008). Thus, the livestock are used for multifarious role and often compliment agriculture operations besides maintaining soil fertility and also help to reduce deforestation.

## 5.4. Water source and housing

The findings from the study (Table 12) indicate that the major source of water for the livestock is from the rivers, the findings are in accordance with those of Zewdie (2010); Beyene *et al.* (2011) from different parts of the country. While, on one hand it ensures that there is no shortage of water in the study area, however there have been reports where river water can be a source of contamination especially of many communicable diseases and parasites (Amenu, 2013). Thus, it is advisable to ensure that the water is clean and safe otherwise contaminated water can be a source of health hazard for both livestock and humans alike. Thus, regular deworming is advised to take care of any parasitic infestations in the livestock. Frequency of watering however varies with the season, with lower frequencies being reported during the rainy seasons. Lower frequencies could be attributed to cooler weather and lush green pasture that results in less requirement of water in the livestock; however, the frequency of watering as observed in the study contradicts the findings of Sintayehu *et al.,* (2008). The results pertaining to the housing of the cattle are in accordance with the findings of Bereda (2012); Asrat *et al.* (2012) and Kelay (2002). A safe house can not only protect the animals from the vagaries of nature but also protect them from thefts and predators. However, the houses have to be comfortable, have to be cleaned and maintained regularly so as to provide a comfort for the livestock staying inside.

### 5.5. Reproduction performance

The average ages at fist service (AFS) of male and female cattle were not significant different across highland and midland, however, the values were shorter in highland (Table 13). The overall average AFS for native cattle (male and female) as in the present study were shorter than that reported by Zewdu (2004); Jiregna (2007) and Mekonnen (2012); however, it was longer than with the report of Kumar (2014) from Mekele, Ethiopia. AFS of native female cattle in the current study was longer than crossbred. Similar result was also reported by Gebeyehu *et al.* (2005 and Demissu *et al,* (2013) indicated that AFS of native was longer than those of Holstein Friesian and Jersey heifers reared in Ethiopia. Management factors especially nutritional status determines pre-pubertal growth rates and reproductive development (Masama *et al.,* 2003). Delay in the attainment of sexual maturity leads to economic loss, due to an additional, non-lactating, unproductive period of the heifer/cow over several months (Mukasa-Mugerwa, 1989). However, the zebu cattle usually have higher AFS when compared to the taurus cattle of the crossbreds, the trait also varies across the breeds and between animals within a breed. However, as the trait is lowly heritable it can improve by management of the cows and heifers (Benton, 2011)

The present study also indicates that the age at first calving (AFC) of native cattle was lower than that reported by Mekonnen *et al.* (2012); however, it was comparable with the result of Duguma *et al.* (2012) and Menal *et al.* (2011). This could be attributed to both management and the genotype of the cattle. On the other hand, AFC of the crossbred as observed in the current study was shorter than with the reported by Demissu (2013) for Horro x Jeresy crossbred and Belay *et al.,* (2012) for HF x Zebu cattle at Jimma Oromia region. Lower AFC among the crossbreds indicates that the lifetime productivity of the cows was higher and more numbers of calves are expecte from such cows, which is again a profitable feature for dairy farming (Kefena *et al.,* 2013). The variation in AFC between genotype and agro-ecologies is probably due to the difference in management and feeding systems, the effect of non-genetic factors Shiferaw *et al.*(2003) have also been reported reproductive efficiency of dairy cows is influenced by different factors including genetic, season, age, production system, nutrition, housing and management, environment and disease (Shiferaw *et al.,* 2003). In addition to genetic variation, the lower AFC of the crossbred may be attributed to their genetics, besides the farmers tend to provide better management and nutrition to the crossbreds when compared to those of the native cattle. The observations are in accordance with those of Masama *et al.* (2003) who reported that management and nutrition status of the cows influences their pre-pubertal growth rates and later their productive and reproductive status.

### 5.6. Milk Yield and lactation length

Daily milk yield (DMY) in a dairy cow is influenced by both genetic and environmental factors (Azage *et al.,* 2010 and Zewdie, 2010). The average DMY of the indigenous cows as assessed in the present study are lower than the national average CSA (2011) and that of Duguma *et al.* (2012) in Dandi district of central Ethiopia. The DMY of the cows in the present study is comparable with the findings of Demissu *et al.* (2014) in Horro cattle of Ethiopia. The DMY of native was lower than the crossbreds in the study area. The findings are in accordance with those of Wassie *et al.* (2014) and Demissu *et al.* (2014). The differences in DMY may be genetic makeup of native cattle and management systems. The present result of average milk yield of crossbred was lower than those of Horro x Jersey and Holstein Frisian x Boran (Demissu *et al.,* 2014; Wassie *et al.,*2014), this may be attributed to the levels of hetrosis (nicking) between the two genotypes besides the influence of several non-genetic factors associated with milk yield.

Lactation length (LL) of native cattle was indicated ($P<0.05$) difference across the agro-ecologies, similarly significant ($P<0.05$) difference was observed among the genotypes (Table 13) i.e. native cattle vis-a-vis the crossbreds. This may be attributed to the genetic makeup of the native cattle and due to the preferential management favoring the crossbreds. The findings also indicate that the native cattle raised in the highlands had longer LL when compared to those reared in the midlands. The difference in LL may be attributed to availability of grazing lands in the higher altitudes and to cooler environment resulting low environmental stress including incidences of diseases and parasites, the findings are in line with the observations of Adiss and Godadaw (2014). The LL of the native cattle are shorter than those reported by Kumar (2014) in Mekele Tigray and longer than those reported by Gebrgziabher *et al.* (2013) for Ethiopia Boran breed and Ngongoni *et al*. (2006) in Zimbabwe.

The average LL of crossbred as observed in the study was shorter than those reported by Wassie *et al.* (2014), Ogundipe and Adeoye (2013), however, it was longer than those reported by Ngongoni *et al.* (2006) and Belay *et al.* (2012). The differences in LL among the studies could be attributed to both genetic and non-genetic factors. Cows with poor conception will usually have longer LL as more days open are expected with delayed conception, on the other hand shorter LL can be attributed to diseases, physiological problems and also at times if the cows are not properly dried out in the previous lactation. An extended lactation period has practical implications to the dairy farmer as it provides compensation for the extended calving interval (Fikre *et al.,* 2007). Therefore, in order to have an optimal LL it is desirable that the respondents be made aware of the consequences of an above and below average LL and how to avoid the same.

## 5.7. Breeding Practice

### 5.7.1. Mating system

Genetic improvement of cattle is the key element in the production of milk and milk products that determines the potential of dairy cattle (Asrat *et al.,* 2013). However, according to the result of the current finding natural mating dominated in both the agro ecologies (Table14). The findings are in line with several authors from the country (Mekonnen *et al.,* 2012; Azage *et al.,* 2013; Solomon, 2014), predominantly natural and panmectic breeding often is a major drawback for genetic improvement of the cattle in the country. However, access to AI service of the current study was higher than those reported by Asrat *et al.* (2013). According to the respondents and focus group discussion the reason for the limited use of AI service in both study area is due to lack of awareness in genetic improvement, timely access AI service, long distance of the AI station, number of services required till conception. Resulting in poor conception in the herd, knowledge of estrus detection and AI service (extension services for genetic improvement were not adequately explained). The findings are similar to the observations of Desta (2002) and Malike *et al.* (2012) indicated that farmers in Ethiopia prefer natural mating as the conception results from the AI services is not successful.

The study further indicates that most of the farmers do not rear any breeding bulls but depend on the bulls being reared by their friends and acquaintances, (Zewdu, 2006; Jirenga, 2007 and Azage *et al.,* 2013). Most respondents would like to have female calf for reproduction and production purpose rather than male calf and that there is a perception that when the cow is inseminated artificially the calf sex ratio is skewed towards the male calves, similar perceptions of the farmers have also been reported (Delesa *et al.,* 2014). As reported by the respondents and in the focus group discussion the natural mating mostly takes place around the grazing area. Thus, most of the farmers did not know the sire of their home breed cattle. However, occasionally they estimate sire of animal based on the coat colors of the calf.

### 5.7.2. Trait preference for selection of dairy cattle

The cattle are selected primarily based on their dairy potential followed by their being regular breeder, higher rate of growth and feeding behavior of the cows in both study area. The importance of the above mentioned traits are in accordance with the findings of several researchers (Kelay, 2002; Takele, 2005 and Godadaw *et al.,* 2014). Studies by Godadaw *et al.,* (2014) too indicated that the regular breeding cows and those with optimum rate growth are other important traits being desired by the dairy farmers of Ethiopia. The results further indicated that some of the adaptive traits viz, disease tolerance and coat color were also considered to select dairy cows, the findings are in accordance with those of (Rege *et al.,* 2001; Kamuanga *et al.,* 2002). The adaptive traits are need to be taken into account in selection of their livestock, especially when the farmers have to face vagaries of nature and have to depend on ethno veterinary medicines for treating the sick animals (Tsedeke and Edrias, 2011).

#### 5.7.3. Farmer's awareness on time of Artificial Insemination

The result as presented in Table 16 indicates that there is lack of awareness among the respondents regarding the appropriate time of insemination, most of the respondents were unaware of the AM/PM approach of inseminating their cattle. This may be attributed to the poor conception in cattle following artificial insemination (AI) as have been reported by most of the respondents. The mis-timing of AI as observed in the study is basically a fallout of poor extension services rendered to the beneficiaries of such program, the observations are in accordance with the findings of Tadesse *et al.,* (2014) and Nuraddis *et al.,* (2014). Studies by Miah *et al.,* (2004) indicate that improper timing of AI services can lead to reduction in conception rate.

#### 5.7.4. Farmer's perception and constraints of estrus synchronization

Most of the respondents in the study area were not satisfied with the mass synchronization program (Table 17). As reported by the respondents in the study area the major cause of dissatisfaction of synchronization was poor conception in dairy cattle, long distance to the AI station, artificial insemination technician were not available in the AI station at most the time, poor estrus detection, repeat breeder. The findings are in accordance with the results of several authors (Hayleyesus, 2006; Zerihun *et al.,* 2013, Nuraddis *et al.,* 2014 and Tadesse *et al.,* 2014). The findings regarding shortage of AI technicians and distance of the AI centers are in close accordance with the findings of Tsegaye *et al.,* (2015). However, studies by Shiferaw *et al.* (2003) and Nuraddis *et al.* (2014) also indicated that increasing numbers of services per conception (NSPC) are a fallout of poor semen handling practices, discontinuation of incentives to AI technicians, season of breeding, management factors, timing of insemination and skill of pregnancy. Findings of a study by Azage *et al.* (2013) also indicates that in spite of the expansion of AI services in the highland areas there is a serious gap in the effectiveness and efficiency of such services in the region.

## 5.8. Evaluation of estrus synchronization and mass insemination (OSMAI) in dairy cattle

### 5.8.1. Estrus Synchronization and hormone response

The overall oestrus response rate as assessed in the present study (Table 18) was lower than those reported in in Hawassa-Dale and milk shed areas (Azage *et al.,* 2012) and also by Tewodros *et al.* (2015) from Fogera woreda. The rate of estrus response was also slightly similar that reported by Adebebay *et al.* (2013) under similar OSMI campaign program. However, the rate of estrus response was higher than that was reported by Bekana (2005). The lower rate of response in this study could be, because the cattle were stressed due to long distance it traveled to the AI center. This may also be collaborated by inappropriate selection of animals (anoestrus), age of the animals, season of the synchronization program and if the corpus luteum fails to regress at the earlier stages of the estrus cycle even after using PGF2α.

The current results of OSMI in the study area indicates that the numbers of hours to estrus interval after injecting PGF2α was longer in the native (zebu) cattle (when compared to the crossbreds). The overall results for the numbers of hours to respond oestrus interval was higher than those reported by Hamid (2012) in Silte zone and Adebebay *et al.* (2013) in Bahirdar, however the value was similar with the report of Azage *et al.* (2012) from Hawassa-Dilla milk shed. However, the interval to oestrus observed in the current study was lower than those reported by Million *et al.* (2011) for Boran cattle, but higher than Holstein Frisian crossbred. The longer or shorter estrus response interval could be due to poorly developed ovaries and early stages of CL during the administration of PGF2α.

### 5.8.2. Number of service per conception (NSPC)

The results of average NSPC in the native cattle was higher than those of the crossbred in the study area (Table 19). The current results of NSPC of native cattle was higher than that reported by (Menale, 2011; Demissu *et al.,* 2013 and Kumar *et al.,* 2014), but it was lower than the report of Hyleyesus (2006). Similarly NSPC of the current result of crossbred cattle was higher than those reported of Belay *et al.* (2012) and Nibret (2012), but, it was lower than the report of Hyleyesus (2006), Emebet and Zeleke (2007) and it is fairly comparable with the result of Demissu *et al.* (2013) and Sharifuzzaman *et al.* (2015). The overall NSPC in the present study was in line with the report of Hamid (2012). High NSPC are the results of problems associated with poor semen quality, poor semen handling and insemination practices (Negussie, 1992). Other factors influencing NSPC can be both due to genetic and managemental factors viz. season; that is related to availability of feed, placenta expulsion time, lactation length, milk yield and parity (Shiferaw *et al.,* 2003; Perez-Marin & España, 2007; Gebrekidan *et al.,* 2012).

### 5.8.3. Conception rate in dairy cattle

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The results in Table 19 indicate that the conception rate (CR) irrespective of the agro ecology and genotype is lower than those reported by several authors (Abonou, 2007; Azage *et al.,* 2012; Hossain, 2013 and Sharifuzzaman *et al.,* 2015), but it was higher than which reported from (Desalegn, 2008, Adebebay *et al.,* 2013 and Tewodros *et al.,* 2015). The result of CR in the present result is in accordance with the report of Hamid (2012) in Silte zone. CR is a lowly heritable trait and hence can be improved through management of the cattle (Benton, 2011). The trait is influenced by several non-genetic factors viz. post calving health, reproductive disorders, errors associated with detection of estrus, insemination related errors, semen quality and handling techniques, long calving interval, level of milk yield, environment, age of the cow and breed (Shamsuddin *et al.,* 2001).

### 5.8.4. Factors affecting conception rate

#### 5.8.4.1. Effect of genotype on conception rate

As indicated in the study genotype has no significant influence on conception rate at the first service . However, higher conception rate was observed among the crossbred. The result of CR in the present result is an accordance with the reports of Sarder *et al.,* (2001), Miah *et al.,* (2004) and Woldu *et al.* (2011). The difference (numerical) favoring the crossbreds may be because of better body condition these animals who are also better managed the observations are in accordance with the findings of several authors (Kaziboni *et al.,* 2004 and Woldu *et al.,* 2011. The other reasons being silent heat that is commonly observed among the zebu cattle (Azage *et al.,* 1989; Mukasa-Mugerwa *et al.,* 1991). However, contradictory to the present result better CR was observed in the native cattle when compared to those of the crossbred cows reared at Bangladesh (Paul, 2010; Khatun, 2012; Sharifuzzaman *et al.,* 2015), the differences may be a fallout of genotype by environmental adjustment favoring the native cows.

#### 5.8.4.2. Effect of parity and age of the cows on conception rate

The present result was observed to be higher among the cows in the second parity reared in the midlands and in the third parity among the cows reared in the highlands. The results are in accordance with the observations of several authors (Mukasa-Mugerwa *et al.,* 1991; Miah *et al.,* 2004, Grimard *et al.,* 2006 and Bhattacharyya *et al.,* 2009). The results further indicate that as the age of the animals increase the CR shows a negative trend, this may be associated with lactation stress and also that the older cows tend to gain weight thereby reducing the chances of fertility. The findings of the observations are in accordance with the findings of Quintela *et al.* (2004) and Khan *et al.,* (2008). The result as indicated in Table 19 also indicate that the CR was the highest among the cows aged between 5 to 7 years; this roughly corresponds to the first and second parity of the cows where the conception was observed to be the highest. The result also indicates that at earlier age the conception rate was lower ($P<0.05$). This may be attributed to yet to develop reproductive organs at an early age. While at an older age the reproductive organs are stressed and more often are unable to bear the stress associated with the conception and pregnancy. It has been observed that there are higher incidences of abortion and miscarriage in cows of older age (Jones 1970; Buck *et al.,* 1976 and Mollah, 2011). Irrespective of all the above conditions pertaining to poor CR among the older ages in cows are in consonance with the studies by Gebregziabher (2005), it was indicated that reduction in probability of conception with increased age of the cow is partly attributed to the exposure of the cows to different reproductive diseases.

#### 5.8.4.3. Effect of body condition scores (BCS) on conception rate

The result of OSMI indicated that irrespective of agro-ecology, BCS had a significant influence on the conception rate, similar studies have indicated that cows with below and above optimum body condition usually have poor conception rate (Azage 1989; Shamsuddin *et al.,* 2001; Emebet and Zeleke, 2007). Good BCS especially during the mating period has been confirmed to have a positive impact on CR (Mukasa-Mugerwa, 1989. Kaziboni *et al.,* 2004). Cows with an optimum BCS usually have adequate body reserves to take care of the stress associated with pregnancy and thereafter the lactation stress, Kaziboni *et al.,* (2004). Studies by Bó *et al.* (2003) and Hossain (2013) indicated that sub optimal BCS can be a fall out of poor nutritional status, which is often observed among the cattle grazing on degraded pastures especially in the tropics. This could be correlated with the inadequate function of the endocrine glands responsible for secretion of the sex hormones thereby resulting in silent heat and poor conception.

#### 5.8.4.4. Effect of time of insemination

Conception rate varied ($P<0.05$) between the time of insemination. The highest CR was observed when insemination time was done between >10–15 hours and lowest when insemination was done after 20 hours after the onset of estrus (Table 20). The Table further indicates that CR decreased with increase in the time of insemination. Time of insemination as observed in this study is in consonance with the result of Miah *et al.*(2004), Bhattacharyya *et al.*(2009) and Mufti *et al.* (2010). Studies by Das *et al.* (1990) also indicated that the conception varied ($P<0.05$) when the cows were inseminated in early, middle and late estrus, respectively.

#### 5.8.4.5. Effect of bull on conception rate

Conception rate had differed ($P<0.05$) between the bulls. The differences in conception rate among bulls could be associated with the age of the bull, difference in semen quantity and quality of the bulls. Several factors such as diseases, climatic conditions of the place where the bulls are reared, nutrition and management of the bulls also influence the fertility among the bulls (West, 2003). Bulls of *Bos taurus* are more susceptible to heat stress in the tropical and subtropical regions, when compared to the *Bos indicus* bulls (West, 2003). Studies by Gebregziabher (2005) have also indicated that not only the bull itself influences the conception rate under AI service, but also by the way of semen collected, processed, transported, handled and inseminated.

## 5.9. Evaluation of the reproductive performance of synchronized and inseminated cow

### 5.9.1. Estrus synchronization

The rate of response to estrus as observed in the current study was lower than what was reported by Azage *et al.* (2012) from Awassa-Dale milk shed, Tewodros *et al.* (2015) in Fogera woreda, Girmay *et al.* (2015) in and around WukrokilteAwulaelo district. However, it was higher than what was reported by Diskin *et al.* (2001), Bekana (2005). However, the rate of oestrus as reported in the current study agreed with the results of Kailasam *et al.* (2003) and Adebebay *et al.* (2013) who confirmed that as many as 70 to 90 % of the cows exhibited signs of estrus within 2 to 5 days of injecting PGF2α to the cows with a functional corpus luteum. A study by Gordon (1996) and Adebebay *et al.* (2013) using PGF2α single injection exhibits estrus response rates among 90 % of the cows. Study by Gordon (1996) stated in his report any methods that can exhibit 90% estrus in the cows should be considered as effective and successful. Accordingly, estrus response obtained in the present study was very encouraged and hence can be used as a protocol. The differences in estrus response among the studies could be attributed body condition score, age of the cow, nutrition and season, anoestrus, disease (Tewodros *et al.,* 2015). Animals in poor body condition or with poorly developed ovaries and tabular genital tract were not feet for prostaglandin synchronization program (Tewodros *et al.,* 2015).

Oestrus response rate in this study was somewhat higher than with that of the OSMI results in the study area. The difference of oestrus response rate among the study could be due to availability of feed prior or during the process of estrus synchronization, optimum BCS, functional corpus luteum, fully developed ovaries and the genital tract favorable for the maintenance of the fetus. Study by Tewodros *et al.* (2015) also indicated that careful selection of animals based on body condition and reproductive tract scores might be contributed for the high rate of cows at heat.

The overall result of interval of oestrus response after PGF2α as obtained in this study was longer than those reported by Diskin *et al.* (2001); Hamid (2012) ; Adebebay *et al.* (2013). However, interval of oestrus response as observed in the current study was lower than what was reported by Bekana *et al.* (2005) and Azage *et al.* (2012). The present result was comparable with the results of

OSMI. The time between induced estrus is inconsistent, but generally it varied from two to five days that too depending on the stage of follicular wave at the time of $PGF_{2}\alpha$ (Holm *et al.,* 2008).

### 5.9.2. Number of service per conception (NSPC)

According to the present finding of NSPC in native cattle was higher than those of the crossbred cattle (Table 22). NSPC of the native cattle was lower than those reported by Hyleyesus (2006), but it was higher than what was reported by several authors (Demissu *et al.,* 2013; Kumar *et al.,* 2014 and Tadele and Nibret, 2014). The findings also indicate that the NSPC for the crossbred cows were higher than what was reported by (Shiferaw *et al.,* 2003; Belay *et al.,* 2012 and Nibret, 2012). However, the value was lower than what was reported by (Emebet and Zeleke, 2007 and Demissu *et al.,* 2013) and it is in agreement with the report of Sharifuzzaman *et al.* (2015). The overall NSPC of the present study was lower than that was reported by Hamid (2012).

The number of service per conception for both the native and crossbred cattle as observed in the study is lower than the result obtained from the synchronization and mass insemination (OSMI) program. This variation among the studies might be attributed to the effect of various management and seasonal factors influencing the breeding, this is besides the efficiency of AITs including the inappropriate semen handling practice, detection of heat and time of insemination. The finding of the present study complies with the report of Negussie, (1992) who in his report indicated that high numbers of services per conception are correlated with the problems associated with poor semen quality, poor semen handling practices and poor insemination practices. Studies by (Shiferaw *et al.,* 2003; Perez-Marin & España, 2007; Gebrekidan *et al.,* 2012) revealed that NSPC can be influenced by both genetic and managemental factors viz. season (environmental stress); availability of feed, time between calving and expulsion of placenta, lactation length and parity

### 5.9.3. Conception rate

Conception rate (CR) at the first service as obtained in the present stud was higher than those reported by (Desalegn, 2008; Woldu, 2011; Adebebay *et al.,* 2013). The result of CR in this study was also slightly higher than with that of Paul (2010) and Azage *et al.* (2012). On the other hand, the results of the present finding are within the range of values as have been previously reported in several studies from Ethiopia (Gaines, 1989, Samson, 2001). The difference among the reports could be attributed to a multitude of factors such as time of insemination, heat detection efficiency, season of breeding, proper semen handling and thawing, intrinsic factors of the cattle itself and lack of experience in the AI campaign. Similar studies were made by Mollal (2011) and Shikder (2011) conception rate depends mainly on skill of the inseminator, accurate estrus detection of the cows, quality and quantity of spermatozoa in semen, proper semen thawing procedure, placement of semen in the uterus, calving to service interval and herd size.

Conception rate in the present action research study was higher as compared to the result of OSMI . The differences in the conception rate between the two studies could be associated with all the factors mentioned ahead besides the poor body condition of the cattle at the time of AI. Moreover, AI was conducted at approximately 12 hrs after the onset of standing heat potentially has lower fertilization rate with increasing embryo degeneration (Roelofs *et al.,* 2010; Dalton, 2011).

### 5.9.4. Factors influencing the conception rate in the synchronized dairy cattle

#### 5.9.4.1. Effect of genotype

In the present study, conception rate was numerically higher among the crossbred cattle when compared to those of the native genotypes. The result is similar with the reports of (Sarder *et al.,* 2001; Kaziboni *et al.,* 2004 and Woldu *et al.,* 2011 and OSMAI, 2015). Contradicting to the present findings, Paul (2010) and Sharifuzzaman *et al.,* (2015) observed higher pregnancy rates among the native cows. The variation in CR among the different studies might be attributed to the variations in the management of the cows, time of insemination, season of breeding, fertility of the cows, early embryonic death, semen handling and appropriate animal selection for breeding purpose. The lower conception rate among the native cattle could be attributed to silent heat observed in many zebu cattle (Azage *et al.,* 1989; Mukasa-Mugerwa *et al.,* 1991). Estrus manifestations have been known to be short, erratic and mostly less evident or silent further requiring a meticulous observation and timely insemination to result in successful pregnancy (Hamid, 2012). Genotypes of the cattle did not influence the rate of conception in both the studies viz. action research study and in OSMI. However, the conception rate was higher in the former when compared to the OSMI study and the result was similar across both the genotypes.

#### 5.9.4.2. Effect of parities

The results as presented in Table 21 indicate that CR was not a significant different across the parities. However, the conception rate is higher among the primiparous cows when compared to that in the multiparous cows. The findings are in line with the reports of Buckley *et al.* (2003) and Gebregzibheir (2005). However, it was inconsistent with other studies who reported that the conception was better among the cows at the second parity (Mukasa-Mugraw *et al.,* 1991; Miah *et al.,* 2004; Quintela *et al.,* 2004; Grimard *et al.,* 2006; Khan *et al.,* 2008; Bhattacharyya *et al.,* 2009). The variation in CR among parties could be due to differences in temporal environmental conditions and conditions that are distinctive to each study.

Finally, the non-significant differences in the conception rate among the different parities were similar with that of OSMI conception. The conception rate in the action research study was higher among the different parity groups when compared to those of the OSMI. The higher value as observed may be attributed to preferential selection of animals' interims of age, BCS while non-genetic factors viz season, time of insemination could also have their own contribution.

#### 5.9.4.3. Effect of body condition scores

The present results indicated that conception rate did not differ significantly due to the body condition score (BCS) of the recipient cattle. However, the result indicated there was a trend to improve the CR as the body condition score of the animal increased. The non-significant differences in conception rate due BSC was similar with the reports of Kaziboni *et al.* (2004) and Miah *et al.* (2004). However, it is differed with the findings of (Shamsuddin *et al.,* 2001 and Grimard *et al.,* 2003). The results of the studies by Grimard *et al.* (2003) indicated that the effectiveness of the AI depends on the BCS of the inseminated cows especially those reared on natural pasture. The variation among the studies could be non-genetic factors viz. availability of feed source, season and year besides assessing the optimal BCS for a particular breed.

This action research result indicated that cattle with uniform BCS had a better conception rate while the BCS of the cattle involved in OSMI varied and thus may have influenced the overall conception. Season of breeding may have had its own contribution for the difference observed as the cows inseminated in the spring season had higher BCS. However, in OSMI the cows/heifers were inseminated during the summer when the feed supply was limited. The findings of the current study was in consonance with the findings of Miah *et al.* (2004) and Poul *et al.*(2011), who reported that conception rate was significantly higher among the cows inseminated in the spring season when compared to those inseminated during the summer and winter seasons. In the summer season, heat stress was significant influence among on conception rate of dairy cattle (Ricardo *et al.,* 2004). Besides the heat stress, inadequate feed intake and decreased utilization of some nutrient leading to poor BCS may result in inadequate secretion of hormones needed for reproduction (Monwar, 2013).

#### 5.9.4.4. Effect of age

The results in Table 22 indicate that higher CR was observed among the cows aged 5 to 7 years and started to decline after 7 years. This is marked on poor body condition and inadequacy of hormonal secretion in the cows with increase in age this leads to decline in fertility in the cow. The result of the current study is in accordance with the reports of Bleach *et al.,* (2004) and Mollal (2011). Findings of a study by Gebregziabher (2005) also indicted that the reduced probability of conception to first service with increased age could partly to attribute to the exposure of the cows to different reproductive diseases.

In all age groups, the CR of the cows associated with action research result was higher than those involved in OSMI. However, age of the cows significantly influenced the conception irrespective of the projects. The difference in conception rate with respect to age might be due to efficiency of oestrus synchronization on the older cows and extended post-partum periods (post-partum anoestrus), it may also be associated with poor BCS, season of breeding, time of insemination, and disease problems. Findings of a study by Paul *et al.* (2011) indicated that as the cattle aged the numbers of services per conception too increased

#### 5.9.4.5. Time of insemination and estrus detection

According to the current finding CR was highest when insemination was carried out between the intervals of 10 to 15 hours after the onset of estrus the CR was however lower when insemination was done after 20 hours after the onset of estrus. Early insemination of the cows (after the onset of estrus) too reduced CR. Probably this interval was too short in relation to the time of ovulation. The observations are in close accordance with the findings of Miah *et al.* (2004), Bhattacharyya *et al.* (2009) and Mufti *et al.* (2010). The variation in conception rate among different studies could be due to inaccuracy of heat detection, time and season of insemination, skills of the AIT. The conception also is closely correlated with the accurate heat detection. Study by Sinishaw (2005) also indicated that animal should inseminate within 24 hours of the onset of heat because late and early insemination may influence the CR of both the heifers and cows.

The results of both studies (action research and OSMI) indicated that conception rate was higher when the cows were inseminated within 10 to 15 hrs intervals after the onset of estrus, indicating the validity of AM/PM approach. The CR among the cows associated with the action research project was higher ($P<0.05$) when compared with those associated with OSMI. Although, the appropriate time of insemination in both studies was between 10 to 15 hours after the onset of estrus, but the differences as observed could be associated with several non-genetic factors as mentioned ahead.

The result as presented in figure 1 indicated that most of the estrus sign observed during the night than days. The observations are in concurrence with the findings of Bekana *et al.* (2005) who observed that in Fogera cattle most of the estrus signs were observed during the cooler hours of the night. Higher CR was also observed when the AI was carried out before noon indicating that CR was better when AI was conducted at cooler hours of the day (Nordin *et al.,* 2004). Proper detection of estrus is difficult especially when the cows exhibit the same during the night hours, thus unless or until the cows are monitored regularly it is difficult to correctly assess the time of standing heat and AI (Henricksh *et al.,* 1971; Aulakh, 2008).

#### 5.9.4.6. Effect of bull

The results shown in Table 23 indicate that there was no significant difference in first service conception rate (CR) among the semen of the bulls used. However, a higher value of CR was observed in bull number 10-264 followed by 10-293. Higher CR also observed among the crossbred cows when compared to those of the native cows served by the same bulls. The difference might be attribute lower intensity of heat, fertility of the cow or simply the nicking between the ovum of the cow and the semen of the bull, or at many times embryonic mortality at an early stage after conception. Study by Mufti *et al.* (2010) indicated that that the effect of thawing at different period of interval on influenced the conception rate significantly. Other studies also indicated that the quality of frozen semen have significant effect on CR (Shamsuddin *et al.*, 2001; Anzar *et al.,* 2003).

In action research of this study cows that had exhibited estrus were inseminated by a single (uniform) inseminator for minimizing ambiguity. However, the inseminators used for mass synchronization and insemination (OSMI) are more than one, which could lead the differences between the skills of the inseminators themselves.

### 5.10. Early embryonic mortality and conception status of cows

Post fertilization failure/embryonic mortality/ at different stages of gestation indicates that the losses were highest during the early stages of pregnancy. The result as presented in Figure 2 indicates that all mortality occurred between 28 to 49$^{th}$ day of post insemination. The findings are in accordance with those reported by Inskeep and Dailey (2005) and Diskin *et al.* (2012) who indicated that late embryonic and early fetal losses has been observed in lactating dairy cows during the attachment phase of the embryo in the uterus and placentation, which usually correlates between day 28 and 45 after mating. Results of the study by Inskeep and Dailey (2005) further indicated that low progesterone levels between 28 to 37 days of gestation was predictive of greater embryonic and early fetal losses. Embryonic mortality of the current study also closer to the report of Forar *et al.* (1996) that reported embryonic mortality was higher between day 31 and 55 days of gestation.

The proportion of embryonic mortality as observed in the current study is within the range of values as have been observed by several authors (Diskin and Sreenan, 1980; Grimard *et al.,* 2006). The possible causes of embryonic mortality in the study area might be due to environmental stress, nutritional imbalance, infectious /toxic substances, hormonal fluctuations, age of the cow and other genetic and non-genetic factors. The cause of embryonic mortality of the current study also coincides with the reports of (Vassal *et al.,* 2005; Fikre, 2007). Any failure could be due a defect in the embryo itself and/or a problem with the maternal environment (Ball and Peters, 2004). Studies by Dailey (2008) also reported that dystocia, stillbirth and uterine infection could influence delays of breeding and early embryonic losses. In a study by Starbuck *et al.*(2004) it was reported that early and late embryonic losses increased with the age of the cows. The exposure to high environmental temperatures resulted in decreased production of estradiol and inhibin by the follicles and decreased rate of cleavage and development to the blastocyst stage (Sartori *et al.,* 2002 and Santos, 2009).

This result is also in accordance with findings of Daniel & Klaus (2014), they reported that if the level of progesterone was < 16ng/ml there was an observable (intermediate blue to deep blue) color change in the test and  the results are assumed to be loss of embryo in the cow. On the other hand, when the test becomes colorless (watery) with values >16ng/ml of progesterone levels in the milk can be considered as the cows are Pregenant. According to the current finding more or less similar levels of progesterone hormone was persistent in all the pregnant cows after $49^{th}$ day of post insemination which was further confirmed through rectal palpation at 60 days of gestation. The result indicated that the reduction in progesterone concentrations in the milk coincides with the infertility of lactating dairy cows. Cows with higher progesterone concentrations after insemination have been reported to be more fertile (Stronge *et al.,* 2005; Demetrio *et al.,* 2007).

# 6. SUMMARY AND CONCLUSION

The lack of comprehensive assessment and evaluation of mass synchronized of dairy cattle, little scientific evidence associated with problem of infertility of cows, misconceptions on estrus detection, embryonic mortality at early stages of pregnancy, traits preferences used by the keepers of dairy cows were major justification for this research. These researches were conducted with the main objectives of assessing farmers breeding practices, efficiency of synchronization and insemination and testing early conception and embryonic mortality. The study was restricted in LIVES districts of Sidama zone namely: Bensa, Arbegona and Bona Zuria. For breeding practices of survey, 180 sampled farmers were selected from nine kebeles randomly.  For the evaluation of OSMI secondary data was collected from 883 cows/heifers from farm record obtained from BoA. For the action research, 126 cows were synchronized cows was evaluated. Hormonost® Micro-lab farmertest was employed to test milk progesterone for early pregnancy diagnosis and embryonic mortality from day19-58 after insemination.

With regard to breeding practice, the most important preferred traits and selection criteria by dairy cow owners were high milk yield, growth rate, adaptation and breeding ability in order of importance. Due to its easy accessibility and higher efficiency in pregnancy, the natural mating is the dominant breeding system over AI service. The rate of estrus response (90%) and conception rate (58.7%) for cows included in the action research was higher than the result obtained from Oestrus synchronization and insemination (OSMI) implemented by BoA. The average number of service per conception (NSPC) of action research result was lower (1.7) than the result (2.36) of BoA OSMAI.  Appropriate time of insemination both action research and BOA and OSMI was 10 to 15 hrs after the onset of estrus, however the percentage (76.6%) of conception in action research was extremely higher than the BoA OSMI result (49%). Inappropriate animal selection (poor body condition score, older age cow, large number of calving), bringing non-cycling cows, inappropriate breeding season, incorrect timing of insemination, lack of awareness to estrus detection, early and/or late report to AI station for insemination and poor semen handling were the major problems contributed for poor efficiency of synchronization and insemination.

Progesterone profile analysis using Hormonost® Micro-lab farmertest is important method to detect estrus, pregnancy and embryonic mortality of dairy cattle. Using progesterone kit high progesterone level in milk after 19- 25$^{th}$ days of insemination considered as positive pregnancy. While low progesterone on day 19 considered as non-pregnant and after day 25 registered as pregnancy loss. From 20 cows included in milk progesterone test from 28 to 49$^{th}$ days of post insemination 30% of embryonic mortality and 70% of pregnancy has observed in the study area.

In conclusion, the action research result indicate that efficiency of OSMAI carried out by BoA could be improved significantly if proper synchronization and AI practices were followed before the commencement of the program. Proper animal selection (appropriate age, BCS, parity), season of breeding, heat detection efficiency of AIT and farmers' awareness to detect heat and on time bringing cattle for insemination, AI technicians presence at AI center should be duly considered for effective synchronization. Progesterone profile analysis is an important tool to check early pregnancy and embryonic mortality of dairy cattle. Embryonic death is the main factor affecting the success of reproductive efficiency in dairy cattle in the study area. Knowledge of embryonic mortality is also important in improvement of the cause of pregnancy loss in dairy cattle and consequently improves reproductive performance of smallholder dairy farmers.

# 7. RECOMMENDATION

Creation of farmers' awareness is an opportunity in improving breeding practice of dairy cattle in Southern region in general and that of the study area in particular. Trait preference of the dairy owners and breeding practices among production systems needs to consider in designing sustainable breeding strategy to improve productivity of dairying.

To improve dairy cattle productivity practicing synchronization and insemination is very important. Improving estrus detection method, proper time of insemination and appropriate animal selection should be considered before implementing estrous synchronization and AI.

Hormonost®-Microlab Farmertest is a new technology for earlier pregnancy diagnosis than palpation per rectum, give immediate information to confirm conception as well as embryonic loss. For achievement of higher economic value in cattle breeding, monitoring and correction of the various causes leading to the manifestation of embryonic death are necessary. To overcome the limitation each potential zones, districts and private dairy farms owners should have Hormonost®-Microlab Farmertest to check up heat detection and early pregnancy diagnosis of dairy cattle.

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## APPENDIX I

Table 16 Average progesterone concentration in different days of sampled cows

| Milk sampling days after AI | N | Average (ng/ml) | Min | Max | EM **(%)** |
|---|---|---|---|---|---|
| 19 | 20 | 20.4 | 16.0 | 25.5 | 0 |
| 22 | 20 | 21.9 | 16.8 | 25.7 | 0 |
| 25 | 20 | 22.8 | 16.1 | 26.3 | 0 |
| 28 | 20 | 23.3 | 7.6 | 26.4 | 10 |
| 31 | 18 | 24.0 | 16.8 | 27.1 | 0 |
| 34 | 18 | 23.3 | 6.2 | 27.8 | 15 |
| 37 | 18 | 25.7 | 19.6 | 28.7 | 0 |
| 40 | 15 | 26.0 | 18.6 | 28.6 | 0 |
| 43 | 15 | 26.5 | 17.4 | 28.9 | 0 |
| 46 | 15 | 26.6 | 16.6 | 28.9 | 0 |
| 49 | 14 | 27.0 | 10.0 | 28.3 | 5 |
| 52 | 14 | 27.1 | 24.0 | 27.8 | 0 |
| 55 | 14 | 26.8 | 25.1 | 28.4 | 0 |
| 58 | 14 | 27.0 | 24.6 | 28.5 | 0 |

Where N= number of cows, EM= embryonic mortality, ng/ml=monogram per milliliter

## APPENDIX II

Survey questionnaire

I. General Information

Zone. ------------, Woreda. ---------------, Kebele Name. ------------, Respondent name --------------- Agro ecology---------- (1.Dega, 2.mid land, 3.lowlands), Altitude ------------m.asl, Geographic coordinates: Latitude ---------to ----------N and Longitude. ----------to ------------E.

Part I. SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS

| Characteristics | Answer | Characteristics | Answer |
|---|---|---|---|
| Age in years | | Education level in grade | |
| Sex (1=Male, 2=Female) | | | |
| Marital status (1=Single, 2=Married, 3=Divorced, 4=Widowed, 5=Polygamy | | Level of education (1=Illiterate, 2= 1 to 6, 3= 7 to 8, 4= 9 to 12 , 5=Above 12 | |
| Family size<br>• Number of male<br>• Number of female | | Major farming system 1=Crop, 2=Livestock, 3=Mixed with crop dominate, 4=Mixed with livestock dominate | |

Part II. Dairy cattle management

1. Land use pattern of the respondent

| Land use | Total Area in *timad* | Land ownership | | |
|---|---|---|---|---|
| | | Owned | Rented | Exchanged |
| Total farm size | | | | |
| Cultivated land | | | | |
| Grazing land | | | | |
| Others -----------, -------- | | | | |

2. Livestock ownership of the respondent (2005/06 E.C)

| Type | composition | No | Purpose of keeping *code |
|---|---|---|---|
| Cattle | Cows | | |
| | Oxen | | |
| | Bulls | | |
| | Heifers | | |
| | Calves | | |
| Sheep | | | |
| Goat | | | |
| Chicken | | | |
| Equine | | | |
| Bee colony | | | |

*1=Milk, 2=source of income, 3= traction, 4=manure, 5=others ------------------

3. Feed source for dairy cattle

| Source of feed | 1=Yes, 2=No | Season 1=Yes, 2=No | |
|---|---|---|---|
| | | Wet | Dry |
| Pasture land | | | |
| Crop residue | | | |
| Supplementary feed | | | |
| Improved forage | | | |
| Cut and carry system | | | |

4. How do you keep animals? 1= Separately according to the cattle type 2= Together with all native and crossbred, 3= Together with household members within one house, 4= others---

5. What are the sources of water to your animals?

| Source of water | 1=Yes, 2=No | Wet season (1=Yes, 2=No) | Dry Season (1=Yes, 2=No) |
|---|---|---|---|
| River | | | |
| Pond | | | |
| Streams | | | |
| Others------------ | | | |

6. How frequently do you provide water for dairy cattle during both seasons?

| Watering frequency | Season (1=Yes, 2=No) | |
|---|---|---|
| | Dry season | wet season |
| Once a day | | |
| Twice a day | | |
| Every other day once | | |
| Other schedule ---------------- | | |

II. **Dairy cattle production and reproduction**

7. Milk production

| Cow | Cattle type* | Daily milk yield (litter) | | | lactation Length (months) |
|---|---|---|---|---|---|
| | | Beginning of lactation | Mid of Lactation | Late Lactation | |
| Cow 1 | | | | | |
| Cow 2 | | | | | |
| Cow 3 | | | | | |

*1=Native, 2= Holstein cross, 3=Jersey Cross

8. What is the average daily milk yield of a cow (litre)? Local cows --------------- Crossbred --------
9. What is the average lactation length of a cow (months)? --------------- Crossbred --------
10. What is the average age at first service for heifers (months)? Local.-------, Crossbreds ------
11. What is the average age at first effective service for male (months)? Local -----, Crossbreds
12. What is the average age at first calving (months)? Native-------------, Crossbred --------------
13. Do you record the reproductive performances ( birth date, calving date, mating date, estrus date) of your breeding cattle?----- 1=Yes, 2=No,

**Part IV Breeding practice in dairy cattle**

14. Methods of bull service and farmers' preference

| Methods of bull service | 1=Yes, 2=No | Preference (1, 2.) |
|---|---|---|
| Natural bull service | | |
| Artificial insemination (AI) | | |
| Both natural and AI | | |

15. Do you have your own breeding bull? ------------ 1.=Yes, 2= No
16. If no, what is your source of bull? --------1= Neighbor freely, 2= Neighbor with payment, 3=Gov't AI station, 4=Other sources -----------------------------------, ----------------------------
17. If yes, which type of breeding bull do you have 1= Native, 2= crossbred
18. If no, from where do you get breeding bull? 1= Neighbors, 2, Relatives, 3= Others (---------)
19. Have you detected estrus in cow/heifers? 1= yes, 2= no
20. If you see your cow is in heat in the morning at what time, do you take your cow for bull or AI service? 1. After noon of that day, 2. Morning of that day, 3. After noon of the next day, 4. Morning of the next day, 4. At the time of AIT available, 5. Immediately use bull, 6. Others ----
21. If you see your cow in heat in the afternoon at what time do you take your cow for bull or AI service? 1. After noon of that day, 2. Morning of that day, 3. After noon of the next day, 4. Morning of the next day, 5. At the time of AIT available, 5.Immediately use bull, 6. Others—
22. If you are using AI service, how do you communicate with AI technicians? 1. I take my cow to AI station, 2. I call up AI technicians when needed, 3. They visit us usually, 4. 1 and 2
23. Do you have a problem of getting AI service when your cow is ready for mating? 1. Yes, 2. No

24. If yes, what is the cause of not getting AI service on time? 1.Unavailability of AI service on time, 2. The AI service is located at distant, 3.High payment for AI service 5. AI technician shortage

25. Trait preference and selection criteria of farmer for dairy cows selection dairy cattle

| No | Criteria/traits | Rank ($1^{st}$, $2^{nd}$, $3^{rd}$, …) | Additional note |
|---|---|---|---|
| 1 | Milk yield | | |
| 2 | Breeding ability | | |
| 3 | High growth rate | | |
| 4 | Feeding behavior | | |
| 5 | Good temperament | | |
| 6 | Coat color | | |
| 7 | Disease resistance | | |

**Part V. Perception of farmers and constraints of estrus synchronization**

26. Have you participated in the estrous synchronization program? -------1= Yes 2= No

27. If yes, are you satisfied with estrus synchronization? - 1=satisfied, 2=no satisfied

28. If no satisfied, what major problems they are mentioning about the estrus synchronization? ------ ---------------------------------------------------------------, -----------------------------------------------

29. Do you think that people living in and near your village are happy with estrus synchronization? ------1=Yes, 2=No, 3=Yes, to some extent

30. Are you satisfied with the overall AI service? ---- 1=Yes, 2= No, 3= to some extent

31. If no, what major problems they are mentioning about the artificial insemination? ----------------- ------------------------------------------------------------------------------------------------------------