ADDIS ABAB UNIVERSITY
FACULTY OF VETERINARY MEDICINE

# ASSESSMENT OF PROBLEMS/CONSTRAINTS ASSOCIATED WITH ARTIFICIAL INSEMINATION SERVICE IN ETHIOPIA

BY

DESALEGN GEBREMEDHIN GEBREEGZIABIHER

JUNE 2008
DEBRE ZEIT

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A thesis presented to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Tropical Animal Health and Production

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## Dedication

This work is dedicated to my late mother, W/ro Alefetch Abreha (Tsige-Hana) and to my beloved family.

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Above all, I would like to render my utmost praise to the Omnipotent, God, for giving me the opportunity for this postgraduate study and for giving me health, energy, and favorable situations to carryout the research work.

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## ACRONYMS

| | |
|---|---|
| A.A. | Addis Ababa |
| AAU | Addis Ababa University |
| ACA | Awasa College of Agriculture |
| AI | Artificial insemination |
| AIT | Artificial insemination technician |
| ARARI | Amhara Agricultural Research Institute |
| ARI | Agricultural Research Institute |
| BoARD | Bureau of agriculture and rural development |
| BRVL | Bahir Dar Regional Veterinary Laboratory |
| BU | Bahir Dar University |
| CCDO | Children Care & Development Organization |
| Cr | Crosses between Holstein and local |
| CR | Conception rate |
| CRF | Conception rate to first insemination |
| CSA | Central Statistics Agency |
| DCOP | Deputy Chief of Party, Land O'Lakes |
| DDE | Dairy Development Enterprise |
| EARI | Ethiopian Agricultural Research Institute |
| ESAP | Ethiopian Society of Animal Production |
| FAISTED | Field AI Service, Training, and Extension Department |
| FAnGR | Farm Animal Genetic Resource |
| FDRE | Federal Democratic Republic of Ethiopia |
| FVM | Faculty of Veterinary Medicine |
| GIS | Geographic Information System |
| HF | Holstein Friesian |
| HF*L | Crosses between HF an Local Zebu |
| HLBDF | Holeta Bull Dam Farm |
| ILRI | International Livestock Research Institute |
| IPMS | Improving Productivity &Market Success of Ethiopian Farmers |
| JCCD | Jerusalem Children's and Community Development Organization |
| Je | Jersey |

| | |
|---|---|
| Kg | Kilograms |
| Km | Kilometers |
| MoA | Ministry of Agriculture |
| MoARD | Ministry of Agriculture and Rural Development |
| Ml | Milliliter |
| MRAS | Milk Recording and Analysis Service |
| MU | Mekelle University |
| NAIC | National Artificial Insemination Center |
| NM | Natural mating |
| NSC | Number of services per conception |
| OoARD | Office of Agriculture and Rural Development |
| RDO | Research and Development Officer |
| REST | Rlief Society of Tigrai |
| SARI | South Agricultural Research Institute |
| SE | Standard error |
| Sida | Swedish International Development Agency |
| SLNPD | Semen and Liquid Nitrogen Production and Distribution |
| SNNP | South Nations, Nationalities, and Peoples |
| TARI | Tigrai Agricultural Research Institute |
| WJF | Wolaita Jersey Farm |

## ABSTRACT

Study on reproductive performance of 18 AI bulls and on the efficiency of AI operations was conducted at the National Artificial Insemination Center and in ten purposively selected areas of five regional states. This study was also conducted to assess the problems and constraints associated with artificial insemination service in Ethiopia. The 18 bulls were owned by NAIC and were in semen production. Questionnaire survey was also carried out on technical staffs that were performing their duties at the National AI Center. Evaluation of number of services per conception and conception rates to first insemination was carried out. Pregnancy diagnosis was performed on 375 cows in the selected areas. Besides, 114 straws of semen, 61 from regions, and the other 53 from NAIC were checked for semen motility to see if there were any differences in motility due to handling between the center and the regions. Thirty AI technicians and 246 farmers were used for the collection of data using questionnaire surveys. Moreover, fifty-two high-level professionals who have stakes directly or indirectly in the artificial insemination service have been used for the focus group discussions in the five regions. Mean (± E) scrotal circumference for Holstein, Jersey and crosses of Holstein with indigenous breeds at NAIC was 39.71± 0.64, 41.00 ± 1.16 and 39.00 ±1.00 respectively. The results did not differ ($p>0.05$) among the three breeds. Similarly, the outcome of semen physio-morphological analysis revealed that there was no difference ($P>0.05$) for the different semen characteristics except for the total morphological defects which differed significantly ($P<0.05$) among the three breeds. The sources, the selection procedures, and the health status of the AI bulls at NAIC were found to have serious problems. Mean (± SE) number of services per conception and conception rate to first insemination were 1.88 ± 0.07 and 27.06 ± 0.44 respectively. These results differ significantly ($P<0.001$) among the five regions. Of the total cows used during the study, 40.53% have been found to be repeat breeders. Mean (± SE) semen motility for the NAIC and for the regions were 53.2% and 51.7% respectively and there was no difference ($P>0.05$) between the NAIC and the regions. The overall results of the assessment via questionnaire surveys and focus group discussions at large have indicated that artificial insemination is not doing well in all the regions and at national level at large. It is inferred, therefore, that artificial insemination operation in Ethiopia is not a success and requires urgent measures to change the situation before it totally collapses.

# 1. INTRODUCTION

Agriculture (mainly crop and livestock production) is the mainstay of the Ethiopian economy employing approximately 85% of the total population (Lobago, 2007). Livestock production accounts for approximately 30%of the total agricultural GDP and 16%of national foreign currency earnings (Lobago, 2007).

The total cattle population for the rural sedentary areas of Ethiopia is estimated to be 43.12 million, of which 55.41% are females (CSA, 2006). Out of the total female cattle population, only 151,344 (0.35%) and 19,263 (0.04%) heads are hybrid and exotic breeds, respectively. With an average lactation length of 6 months and an average daily milk production of 1.44 liters per cow, the total milk produced during the year 2006/07 was recorded to be 2.634 billion liters (CSA, 2006). This suggests that the total number of both exotic and hybrid female cattle produced through the crossbreeding work for many decades in the country is quite insignificant indicating unsuccessful crossbreeding work. This again suggests that Ethiopia needs to work hard on improving the work of productive and reproductive performance improvements of cattle through appropriate breeding and related activities.

In spite of the presence of large and diverse animal genetic resources, the productivity (i.e., meat and milk) of livestock remains low in many developing countries including Ethiopia for various reasons such as inadequate nutrition, poor genetic potential, inadequate animal health services, and other management related problems (Lobago, 2007).

Cattle breeding is mostly uncontrolled in Ethiopia making genetic improvement difficult and an appropriate bull selection criteria have not yet been established, applied and controlled (Tegegn *et al*. 1995). Although artificial insemination, the most commonly used and valuable biotechnology, (Webb, 2003), has been in operation in Ethiopia for over 30 years, the efficiency and impact of the operation has not been well-documented (Himanen and Tegegn, 1998). Reproductive problems related to crossbreed dairy cows under farmers' conditions are immense (Bekele, 2005).

It is widely believed that the AI service in the country has not been successful to improve reproductive performance of dairy industry (Sinishaw, 2004). From the previous, little study (Dekeba *et al*., 2006) AI service is weak and even declining due to inconsistent service in the smallholder livestock production systems of the Ethiopian highlands. The problem is more aggravated by wrong selection and management of AI bulls along with poor motivations and skills of inseminators (GebreMedhin, 2005).

The objective of the research was, therefore, to assess and identify problems and constraints associated with the artificial insemination service in Ethiopia and to come up with pertinent and workable recommendations that could call upon decision makers and stakeholders to give the utmost attention to the AI service.

# 2. LITRATURE REVIEW

## 2.1. Cattle production in Ethiopia

Ethiopia has an estimated cattle population of about 41.5 million heads (EASE, 2003). Around 99.45 are indigenous breeds with very few hybrids, 0.5%, and exotic 0.1%. Cattle production together with the production of other livestock sectors has been known to be an important component of the agricultural sector. Livestock contributes much by providing meat, milk, cheese, butter, export commodities (live animals, hides and skins), draught power, manure, near-cash capital stock (EASE, 2003).

It is known that no enough selection and improvement for productivity has been performed on the indigenous cattle. Nevertheless, the indigenous cattle are known to have special merit of coping with the harsh environments of the country. On the other hand, the high performing exotic cattle cannot cope with the harsh environments of the country (MoA, 1996). Therefore, improvement on the indigenous cattle for productivity with out losing traits, which are essential for survival, has been proposed (MoA, 1996).

## 2.2. Artificial insemination

Artificial insemination (AI) has been defined as a process by which sperm is collected from the male, processed, stored, and artificially introduced into the female reproductive tract for the purpose of conception (Morrow et al., 1985; Roberts, 1985; Webb, 2003). Semen is collected from the bull, deep-frozen and stored in a container with Liquid Nitrogen at a temperature of minus 196 degrees Centigrade and made for use. Artificial insemination has become one of the most important techniques ever devised for the genetic improvement of farm animals. It has been widely used for breeding dairy cattle as the most valuable management practice available to the cattle producer and has made bulls of high genetic merit available to all (Webb, 2003; Bearden et al., 2004).

In livestock rearing, the producer makes efficient use of the generous supply of sperm available from an individual male in a manner that greatly increases genetic progress, as well as improving reproductive efficiency in many situations. Today, many bulls have been reported to produce sufficient semen to provide enough sperm for 40,000 breeding units in one year (Bearden et al., 2004). Using the long accepted standard of $10 \times 10^6$ motile sperm at the time of insemination with an average initial motility of 60% and a 33.3% loss of sperm during freezing and thawing, the number of breeding units would entail $1 \times 10^{12}$ total sperm. The author also suggested that by using sexual stimulation and more frequent collections, many sperm have been obtained from most bulls in a year without adversely affecting conception rate.

The use of AI in Ethiopia is growing but estrus detection is difficult owing to poorly expressed estrus of Zebu breeds (Mukassa-Mugerwa et al., 1989). Similarly, Tegegn et al.,1989, Bekele et al.,1991) have shown that the short duration and low intensity of estrus signs in Ethiopian Zebu cattle caused most estrus detection failures which indicates a need for the use of current advances in AI such estrus synchronization.

### 2.2.1 History of artificial insemination

The first successful AI was performed in Italy in 1780 and over 100 years later, in 1890, it was used for horse breeding (Webb, 2003). In Russia, however, the method was first taken up seriously as a means of improving farm animals (Heinonen, 1989). According to Webb (2003), the history of AI is interesting in that old Arabian documents dated around 1322 A.D. indicate that an Arab chieftain wanted to mate his prize mare to an outstanding stallion owned by an enemy. He introduced a wand of cotton into the mare's reproductive tract, and then used it to sexually excite the stallion causing him to ejaculate. The semen was introduced into the mare resulting in conception. The author further indicated that Anthony Van Leeuwenhook, inventor of the microscope, first observed human spermatozoa under magnification, which led to further research. In fact, Spallanzani has been recognized as the inventor of AI. His scientific reports of 1780 have indicated successful use of AI in dogs. In 1899, Ivanoff of Russia pioneered AI research in birds, horses, cattle and sheep, and was

apparently the first to successfully inseminate cattle artificially (Webb, 2003). Mass breeding of cows via AI was first accomplished in Russia where 19,800 cows were bred in 1931 Webb (2003). Denmark was the first European country to establish an AI cooperative association in 1936. E.J. Perry of New Jersey visited the AI facilities in Denmark and established the first United States AI cooperative in 1938 at the New Jersey State College of Agriculture.
The first artificial vagina (AV) was reportedly devised by G. Amantea, which was used to collect semen from the dog (Sorensen, 1979). In the years that followed, numerous Russian researchers developed artificial vagina for the bull, stallion, and ram. The method of semen collection using artificial vagina has been reported to be closest to the natural conditions and is assumed to yield the most normal ejaculate of all methods used. An attempt has been made to simulate the normal or best temperature, pressure, lubrication, and position to obtain the optimum response of the male (Sorensen, 1979). The AV consists of an outer rigid or semi-rigid support with an inner jacket containing controlled-temperature water and pressure and collecting funnel and container.

In Ethiopia, AI was introduced in 1938 in Asmara, the then part of Ethiopia, which was interrupted due to the Second 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 requirement. In 1967 an independent service was started in the then Arsi Region, Chilalo Awraja under the Swedish International Development Agency (Sida). Zewdie et al. (2006) has described that the technology of AI for cattle has been introduced at the farm level in the country over 35 years ago as a tool for genetic improvement. The efficiency of the service in the country, however, has remained at a very low level due to infrastructure, managerial, and financial constraints and also due to poor heat detection, improper timing of insemination and embryonic death.

Table 1. Number of artificial insemination technicians trained from 1981-2006

| Year | Number of AITs trained |
|---|---|
| Prior to 1981/82 | 20 |
| 1981/82 | 14 |
| 1985/86 | 20 |
| 1989/90 | 22 |
| 1990/91 | 20 |
| 1994/95 | 22 |
| 1995/96 | 24 |
| 1996/97 | 24 |
| 1997/98 | 30 |
| 1998/99 | 29 |
| 1999/00 | 77 |
| 2000/01 | 29 |
| 2001/02 | 57 |
| 2002/03 | 160 |
| 2003/04 | 86 |
| 2005/06 | 152 |
| **Total** | **791** |

AITs = artificial insemination technicians

Source: FAISETD, 2007

In Ethiopia, there is often complaint of the AI service, by service users for imbalance female and male ratios of calves born in which the latter exceeds in percentage, which is against the interests of most of the beneficiaries (Bekele, 2005). Breeding using AI or natural mating affected male: female calf ratio, which gives sense and can be applicable if the system works. However, the reason why natural mating gave more female progenies than males for cows mating to AI is not clearly known (Bekele, 2005).

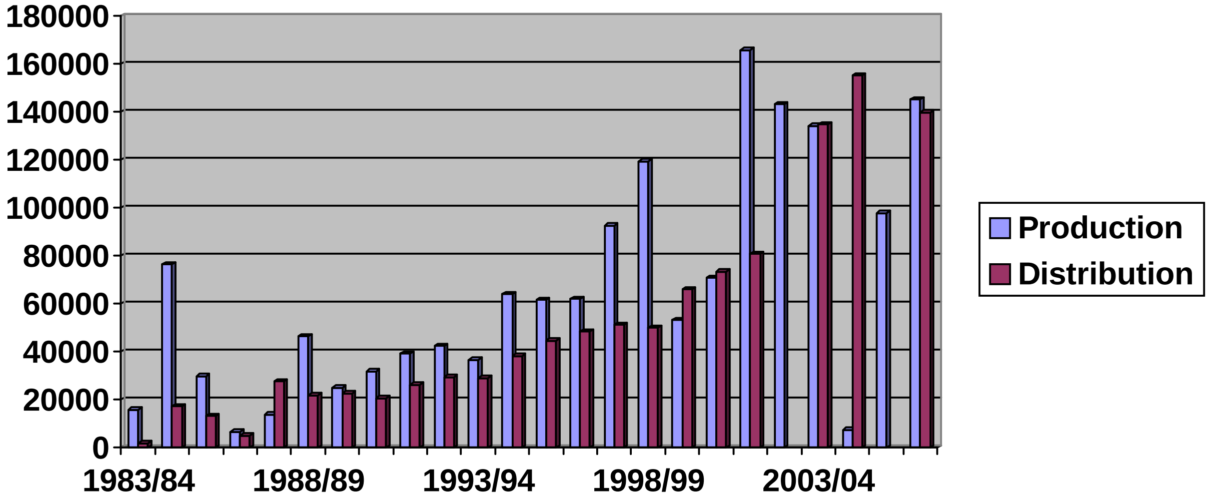


Figure 1.Semen production and distribution at NAIC during the last 15 years
Source: Semen Production and Distribution Department (2006)

2.2.2 Advantages and disadvantages of artificial insemination

The worldwide scale and importance of the artificial insemination industry in cattle breeding are beyond question (Bonadonna and Succi, 1980; Chupin and Thibier, 1995). Maximum use of superior sires has been considered as the greatest advantage of AI while natural service has been linked to limit the use of one bull, probably, to less than 100 mating per year (Webb, 2003). The author further showed that AI usage enabled one dairy sire to provide semen for more than 60,000 services in one year. Gebremedhin (2005) has listed many advantages of AI including prevention of reproductive diseases, control of inbreeding, minimizing the cost of keeping bulls for natural service and others. Besides, the availability of accurate breeding records such as breeding dates, pregnancy rates, inter-estrus intervals, and days to first service used to monitor fertility are other advantages of AI (Sinishaw, 2004).

Artificial insemination, however, has disadvantages that include poor conception rates due to poor heat detection and inefficiency of AI technicians, dissemination of reproductive diseases and poor fertility rates if AI centers are not equipped with appropriate inputs & are not well managed (GebreMedhin, 2005). Other disadvantages include high cost of production (collection and processing), storage and transport of semen (Pope, 2000), as well as budget and administrative problems and inefficiency of AITs (GebreMedhin, 2005).

Table 2. AI coverage, semen production and its application in different continents

| Region | AI Coverage (% of cattle) | Semen Production (straw/year/ country) | AI Application | |
|---|---|---|---|---|
| | | | Per Year | Per inseminator |
| Africa | <2 | 57787 | 30637 | 369 |
| Asia | 3 - 12 | 1314246 | 377215 | 543 |
| Latin America | 5 - 6 | 367006 | 308127 | 841 |
| Near East | 4.5 - 14 | 442987 | 110675 | 801 |
| Ethiopia | NA | 35545 | 20649 | 312 |

NA=Not Available

Source: Chupin and Schuh (1992), own observation at NAIC

### 2.3. Recruitment of semen producing bulls

The selection criteria of bulls for AI service must include record-based pedigree information, individual performance as regularly recorded starting from the time of birth, which should include birth weight, subsequent weight increments. Later on progeny testing and general health status should also be parts of the selection criteria (Zewde, 2007). Recruitment of bull calves for the purpose of semen production must be free from a known contagious disease (Yamane, 1995).

### 2.4. Investigation of bull fertility

Infertility or sterility has been accepted as common problem in the male as in the female (Roberts, 1985), but because of the greater hazards presented by parturition and pregnancy, acquired infertility or sterility, however, is much more frequent in the female. The degree of fertility in males may vary greatly but is more easily evaluated because of the large number of females bred by each male, especially by those males used in artificial insemination (Roberts, 1985).

Bulls selected for AI have been shown to transmit to their offspring the genetic potential for well-above-average milk or meat production (Herman et al., 1994). In addition, the progeny must be of desirable conformation, be long wearing, have quiet disposition, and be free of genetic defects. Genetic improvement of cattle using AI calls for a continual replacement of the lower-production-transmitting bulls by younger, proven bulls with superior genetic merit. Herman *et al*. (1994).

### 2.4.1. Libido

Libido is defined as sexual desire, while serving capacity is the ability to complete the act of mating (Hansen, 2006). Libido or sexual desire has been found to be affected by age, heredity, environment, and disease (Arthur et al. 1983). Although puberty occurs, for example, in bulls at nine to ten months, in all species poor feeding retards its onset. Full libido may be achieved before normal spermatogenesis and therefore, as a rule animals are not put to stud until a few months after puberty. Bulls retain normal sexual desire until five or six years of age, but beyond this point libido very gradually wanes.

In the Ethiopian NAIC, there is no limitation on how long one specific bull may be used as an AI bull (Jokinen and Bertilson, 2003). If an imported bull is considered superior, it is not taken out of the AI service even if there is a risk of inbreeding.

### 2.4.2. Copulation

Inability to perform service despite normal sexual desire is a frequent cause of bull infertility (Arthur et al., 1983). Copulation comprises several distinct conditions, some of which are not understood. Inability to copulate has been reported to be due to skeletal or visceral pain, in others to lesions of the genital organs, inability to protrude and penile deviations , while in many cases in which no lesions can be found the nervous control of copulation is believed to be defective (Arthur et al., 1983). The prognosis for the virgin bull has been suggested to be favorable, but grave for adult bull.

### 2.4.3. Penile erection and ejaculates

The penis has two-fold function: the expulsion of urine and the deposition of semen in the genital tract of the female (Roberts, 1985). Before the latter process can occur, the penis must become erect, which is accomplished by dilation of the internal and external pudendal arteries to the penis. The cavernous blood sinuses dilate with blood, the out flow of which is retarded by the increased venous pressure caused by contractions of the smooth muscles of the corpora cavernosa and the extrinsic, ischiocavernosus muscle at the base of the penis. The process of ejaculation probably starts in the epididymis and travels along the ducts deferens at the same time the walls of the accessory glands contract and force their contents into the urethra (Hafez, 1993).

Semen or sperm is the entire seminal discharge of the male during normal ejaculation. It has been known that semen consists of cellular elements, the spermatozoa produced in the somniferous tubules, seminal plasma, or the liquid portion of the semen produced by secretions of the somniferous tubules, epididymis, ducti differentia, and ampulae, seminal vesicles, prostate, and bulbo-urethral glands (Arthur et al., 1982). Failure of penile erection can, therefore, affect semen collection and it can be caused due to various reasons previously described (Arthur et al., 1982) including lack of libido, which in turn can be affected by age, heredity, environment, and disease.

2.4.4. Capacity to fertilize

Incapacity to fertilize due to seminal defects forms the largest category of bull infertility. Although incapacity to fertilize is necessarily concerned with morbid changes that may occur in the organs contributing to the seminal ejaculate, it is more directly related to the seminal micro pathology (Arthur *et al*., 1982).

2.4.5. Other considerations

According to various studies (Laing, 1970; Morrow et al., 1985; Roberts, 1985), failure to mount, failure to achieve intromission, and failure to thrust and ejaculate are other important factors that need to be considered during investigation of bull fertility.

Scrotal circumference provides a good indication of a bull's ability to produce sperm and is related to his own age at puberty (Hansen, 2006). The measurement should be taken at the largest diameter of the scrotum. Both testicles should be positioned next to each other and a flexible measuring tape should be placed snugly around the scrotum. Testicles need to be descended into the scrotum, and should be of the same size and shape. Any irregular shape or swelling may indicate abnormal structure, illness, or injury.

Table 3. Recommended scrotal circumference for *Bos taurus* bulls

| Age | Very Good | Good | Poor |
|---|---|---|---|
| 12-14 months | >34 cm | 30-34 cm | <30 cm |
| 15-20 months | >36 cm | 31-36 cm | <31 cm |
| 21-30 months | >38 cm | 32-38 cm | <32 cm |
| Over 30 months | >39 cm | 33-39 cm | <33 cm |

Source: Hansen, 2006

Table 4. Recommended scrotal circumference for *Bos indicus* bulls

| Age | Very Good | Good | Poor |
|---|---|---|---|
| 12 months | >22 cm | 18-22 cm | <18 cm |
| 13 months | >24 cm | 20-24 cm | <20 cm |
| 14 months | >26 cm | 24-26 cm | <24 cm |
| 15 months | >30 cm | 26-30 cm | <26 cm |
| 16-20 months | >31 cm | 28-31 cm | <28 cm |
| 21-24 months | >32 cm | 29-32 cm | <29 cm |
| 25-31 months | >35 cm | 31-35 cm | <31 cm |
| Over 31 months | >39 cm | 34-39 cm | <34 cm |

Source: Hansen, 2006

### 2.4.6. Bull health control

Disease prevention in bulls has been considered as essential as in breeding females (Hansen, 2006) and new bulls need to be screened by a qualified veterinarian for infectious agents prior to entering a new herd. Bulls have been recommended to be purchased only from reputable seed stock producers with adequate herd health plans; including vaccination against infectious diseases, e.g. leptospirosis and campylobacteriosis. New animals should be quarantined (30 days). Bulls are also recommended to be tested annually for brucellosis, but not be vaccinated for brucellosis. In some instances, bulls need to be vaccinated for bovine viral diarrhea

(BVD), infectious bovine rhinotracheitis (IBR), and trichomoniasis (Hansen, 2006). Based on personal observations during the study at NAIC, the status of bovine tuberculosis at the Holeta Dairy Farm, the sole source of semen producing bulls,was found to be 48%, 14%, 4%, 22%, and 10% every year since 2003. Unless it is made possible to make full control of the health of bulls selected for semen production, the disadvantages of artificial insemination in disseminating diseases will be much higher (Zewde, 2007).

The frequency of tests made and the diseases tested at NAIC are not sufficient (Agegnehu, 2007). According to the international animal health code (2001) of the Office International des Epizooties (OIE)), donor and teaser animals should be tested for the following specific diseases: Bovine Brucellosis, Bovine Tuberculosis, Bovine Viral Diarrhea, Infectious Bovine Rhinotracheitis, Campylobacter fetus/subspecies veneralis, Trichomonas fetus. Nevertheless, semen-producing bulls at NAIC are tested only for brucellosis and tuberculosis and yet not on regular basis due to many associated constraints (Agegnehu, 2007).

## 2.5. Semen collection and assessment of ejaculates

Semen collection has been considered like harvesting any other farm crop (Bearden et al., 2004) since effective harvest of semen involves obtaining the maximum number of sperm of highest possible quality in each ejaculate to make maximum use of sires. This involves proper semen collection procedures used on males that are sexually stimulated and prepared. The initial quality of semen has been determined by the male and cannot be improved even with superior handling and processing methods. However, semen quality can be lowered by improper collection and the processing techniques (Bearden et al., 2004).

Realization of the maximum benefits of AI depends upon the collection of maximal numbers of viable sperm cells at frequent intervals from genetically superior males (Cole and Cupps, 1977). The success of AI depends on the collection of a relatively large numbers of potentially fertile spermatozoa from genetically superior sires (Garner, 1991).

### 2.5.1. Facilities needed for semen collection

The routine collection of semen for AI in dairy and beef bulls is by using artificial vagina (Faulkner and Pineda, 1980). Several essential features have been considered in designing facilities for collecting semen, of which the safety of the handler and the collector have been found to be the most important in bulls in dairy farm. Safety fences, usually constructed of 7.6 cm. steel pipe with spaces large enough for a person to step through at 2.44 meters intervals, should be provided. The collection area must provide good footing to prevent slipping and injury to the male being collected. An earthen floor in the immediate collection area best provides this. Means to restrain the teaser animals to minimize lateral as well as forward movement must be provided. At the same time, easy access for semen collection must be maintained (Morrow et al., 1985; Roberts, 1985; Bearden *et al*., 2004).

Appropriate and specialized facilities, equipments, and procedures have been used during collection of semen to prevent injury to the bulls and their handlers, to maximize the physiological responsiveness of the bulls in producing semen and to enhance the quantity and the quality of the semen that can be collected (Garner, 1991). The area for semen collection has been preferred clean, relatively quite, free of distractions and any other stressful procedures. There has been a report of increase in spermatozoa motility by 50% through proper sexual stimulation of the bulls (Salisbury *et al*., 1978).

2.5.2. Procedure for collection of semen from the bull

Standard semen collection procedures normally include sexual stimulation, sexual preparation, and collection of the semen (Herman *et al*., 1994).

Sexual stimulation

Providing a stimulus situation that elicits mounting behavior in the bull is termed "Sexual Stimulation" (Herman et al., 1994). The stimulation process has been best practiced by exposing the bull to a mount animal in a collection environment and allowing to move briefly around female/teaser for a couple of minutes (Morrow *et al*., 1985).

Sexual preparation

This has been found to determine the intentional prolongation of sexual stimulation. It is achieved through a series of false mounts (allowing the bull to mount but not ejaculate) and restraint and ultimately results in an increase in the quantity and quality of sperm ejaculated.

In dairy bulls, one false mount plus two minutes of restraint plus two additional false mounts before each ejaculation will help obtain the maximum amount of good quality semen (Herman *et al*., 1994).

### 2.5.3 Methods of semen collection

Semen has been collected in a number of ways, and the methods of collection are governed by the intended purpose for future use. A sample for evaluation may need to be only a very small volume and not as clean a sample as one for use in artificial insemination (Sorensen, 1979). The following various methods have been used in collection of semen.

Recovery: follows normal copulation and can be applied in different ways. A pipette such as an inseminating catheter with an attached suction bulb may be inserted into the vagina following ejaculation and the semen is, then, siphoned into it. This semen is contaminated with the fluids of the female tract but is satisfactory for evaluation. It may also be used for artificial insemination when trying to over come some obstruction in the cervix or satisfy breeding restrictions of some pure bred societies. This method can be applied using different mechanisms and includes spooning, using a sponge, using a cup, and blotting (Sorensen, 1979).

Massage: semen has been collected from the bull, in most instances, by massage. The bull is restrained and the gloved arm and hand are lubricated before inserting through the anus into the rectum. The area of the ampulae, vesicular glands, and prostate is located under the rectum. The fingertips then are used to exert a downward pressure milking this area caudally. This stimulates and mechanically causes the sperm to be passed through the urethra by gravity to drip from the prepuce (Sorensen, 1979; Roberts, 1985).

Vagina*l* insert*:* consists of a tapered insert with a flange on the end that may be placed in the vagina prior to copulation (Sorensen, 1979).
Urethral fistula*:* the male urethra may be cannulated with a tube just under the anus with a T-type cannula allowing passage of urine through the urethra proper or collection of sperm under the anus at the time of copulation(Sorensen, 1979; Roberts 1985),. This is only useful experimentally since rather exacting surgery is involved (Morrow et al., 1985).

Figure 2. Illustration of semen collection from a bull at NAIC using artificial vagina

The electro ejaculation method of semen collection has been derived from observations of persons being electrocuted that ejaculated in response to the electrical stimulus. The semen collected by electro ejaculation is equal in quality to that collected by the artificial vagina, and processing, storage, and later use are comparable (Sorensen, 1979). The method of electro ejaculation for semen collection is preferred to the artificial vagina method under certain conditions (Bearden et al. (2004). It has been used for dairy bulls that have become crippled, have low sexual activity due to age, or for other reasons are unable to serve the artificial vagina. However, semen should not be collected and used from males that have not demonstrated normal sexual behavior or ability to ejaculate, as the cause may be genetic and transmitted to the offspring.

2.5.4 Assessment of ejaculate

Monitoring of qualitative semen characteristics has been indicated to be an important function of the AI Laboratory (Herman et al., 1994). Seasonal and even daily fluctuations in a bull's seminal characteristics are possible. Therefore, to maintain a quality AI program constant vigilance is required. An integral part of this monitoring is an accurate system for keeping records of the bull's seminal quality. Such records document the bull's history of seminal quality and provide information on which to base production – related decisions.

Physical appearance

The gross appearance of freshly collected bull semen has been described usually to be the first measure of quality made by the semen laboratory. Neat (unaltered) semen normally appears as a thick whitish to slightly yellowish fluid whose consistency is mainly determined by the number of spermatozoa it contains. Normal bull semen has very little odor (Herman et al., 1994).

The microscopic appearance of bull's semen varies between ejaculates, individual bulls, breed, and age. Normal bull semen is generally white or yellowish creamy in color (Zewdie *et al.*, 2005).

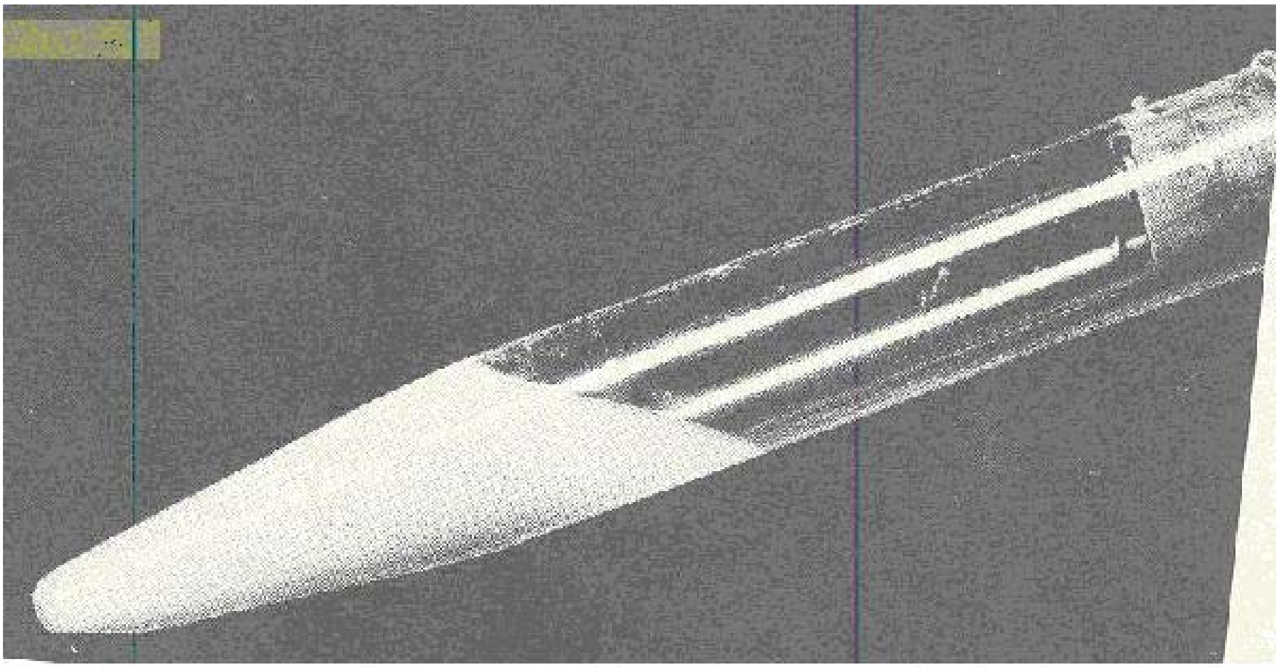

Figure 3. A Freshly collected ejaculate of good quality bull semen
Source: Herman *et al*., 1994

Volume

The volume of the ejaculate is readily measured by collecting the sample directly into a graduated vial (Garner, 1991). Alternatively, it can be done by weighing the tubes after semen collection on top-loading balance, and later converting the reading into milliliter by using a computer program. The latter has been known to reduce error associated with visual reading of the tube specially when small volume or bubbles are found by 10% (Bearden and Fuquary, 2000).The volume has been reported to decline when young bulls are used or when there is frequent ejaculation or incomplete or failure of ejaculation and in bilateral seminal vesiculities (Garner, 1991; Hafez, 1993). Furthermore, those authors have described in summary that a number of factors like season of the year, method of collection, and the sexual preparation of the bull have been known to affect semen volume.

The volume of bull's semen varies between ejaculates, individual bulls, breed, and age. However, a bull with less than 2ml of semen per ejaculate is not acceptable (Zewdie et al., 2005).

Semen volume for *Bos taurus bulls* in Brazil was reported to be 6.9ml and 8.2ml in different years (Brito et al. 2002). Crossbred bulls had higher values of semen volume while Friesian bulls had better values in the rest of the parameters and age had significant effect only on semen volume($p<0.050$) , (Sinishaw, 2005).

Differences between reports on semen volume could be attributed to differences in age, breed, nutritional status geographic locations, seasons of year of study, method of semen collection and handling of bulls during collection, procedure and frequency of collection (Caroll et al., 1963; Igboeli and Raka, 1971; Salisburyet et al., 1978; Tegegn et al., 1992a; Hafez, 1993; Blezinger, 1999; Andrabie et al., 2002).

Mass activity

The mass activity is evaluated by putting a drop of semen onto a slide without cover slip under low magnification (100X). A rapid wave motion with formation of eddies at the end of waves indicate a good quality of semen (Zewdie, et al., 2005).

Spermatozoa motility

Motility of spermatozoa has been defined as the percentage of sperm cells that are motile under their own power and progressive motility of spermatozoa has been defined as those spermatozoa that are moving or progressing from one point to another in a more or less straight line (Bearden and Fuquary, 2000). Spermatozoa are driven by a propulsive apparatus, the flagellum, which is equipped with contractile proteins strategically arranged in longitudinal organelles, the coarse fibers, and with associated sub filaments, and micro tubes, which provide the propulsive force necessary to overcome internal structural resistance and external viscous drag of extra cellular fluids (Hafez, 1993). Motility of spermatozoa at time of collection has been used commonly as a measure of the fertilizing ability of the sperm (Roberts, 1985; Bhosrekar, 1990). However, spermatozoa have been found to lose their fertilizing capacity before they lose motility, which puts motility estimation to be not necessary indicative of fertilizing capacity of the sperm (Hafez, 1993). In general, however, a definite correlation has been found between concentration, morphology, and motility of spermatozoa and the proportion of the total number of actively motile normal spermatozoa in the ejaculate has been found to show levels of fertility of the bull (Roberts, 1985).

The individual sperm motility is evaluated by taking small drops of semen onto a slide with cover slip under high magnification (200X). Sperm cells moving in a straight-line forward direction are considered in the motility measure. In order to be acceptable bull semen should have at least 70% and 40% motility respectively at the time of collection and after freezing (Zewdie et al., 2005).

Live-dead sperm evaluation (vital staining)

The percentage of live sperm has been determined by means of a differential vital stain (Herman et al., 1994). The measure of the live-dead sperm ratio may be useful in conjunction with the motility examination for a more complete analysis. A certain percentage of dead sperm may not be apparent in initial microscopic motility examinations, since these inactive sperm might be moved about merely by action of the live motile sperm. In addition, a proportion of sperm estimated to be motile may be weak and show only slow oscillatory movements. Differential live-dead staining may help reveal these differences, thus supplementing initial motility estimations and providing more conclusive results.

Sperm morphology

Previous studies have shown that the normal morphology of spermatozoa is composed of a head and a tail that is divided into a mid-piece, main-piece, and end-piece (Bearden et al., 2004). Films for microscopic examination under the oil immersion lens are made immediately after the motility estimation, but the examination can be made, subsequently, in the laboratory (Arthur, 1979). To obviate temperature shock and the assumption of spurious morphological defects, a drop of semen is mixed with two drops of Indian ink previously raised to body temperature on a warm slide. The drops are mixed and spread like a blood film. Between 200 and 300 sperms are examined and classified according to their shape and appearance. Fertile bulls show about 90 percent of the morphologically normal sperms. According to previous studies (Arthur, 1979 and Bearden et al., 2004), the following morphological abnormalities can be investigated. These include: tailless sperms and sperms with looped tail, the commonest sperm abnormalities which are detachment of the sperm head and bending of the middle piece and tail around and over the sperm head (looped tails), sperms with coiled tails (this abnormality is of two types: the coil involves the extremity of the tail, or the coil, which includes the whole of the tail & sometimes the middle piece), immature or unripe sperms (these are characterized by the presence of a droplet of protoplasm at the junction of the sperm head with the middle piece at the so-called neck), abnormalities of the sperm head and cytogenic disturbances, and other defective sperms.

Over all assessment

Evaluations routinely conducted by the AI laboratory that have been used to determine whether the semen that is collected and processed for use could be used for practical purpose are screening tests for quality and number of spermatozoa in order to eliminate any substandard ejaculates. This initial screening also avoids wasting expensive supplies, antibiotics, semen extenders, etc., because substandard samples are not processed (Herman et al., 1994). Semen that passes initial screening have been further extended, cooled, packaged into straws, and frozen. After freezing, a representative sample is normally thawed and evaluated using various laboratory tests. These post-thaw evaluations not only reflect the ability of the semen to with stand the processing conditions (process quality control) but also can give some indication of the potential fertility of the semen (fertility prediction). Assessing the progressive motility of the semen sample is probably the most common evaluation made for post-thaw viability (Herman et al., 1994).

Table 5. Summary of different findings on semen parameters conducted at NAIC

| Parameter | | Crossbred | HF | Indigenous | Source |
|---|---|---|---|---|---|
| Volume(ml) | | 7.18 | 6.77 | | Sinishaw, 2005 |
| | | | | 4.84 | Sori, 2004 |
| Mass motility(1-5) | | 3.17 | 3.18 | | Sinishaw, 2005 |
| | | | | 3.15 | Sori, 2004 |
| Individual motility (%) | | 71.67 | 71 | | Sinishaw, 2005 |
| | | | | 68.72 | Sori, 2004 |
| Concentration($10^9$/ml) | | 1.14 | 1.27 | | Sinishaw, 2005 |
| | | | | 1. 54 | Sori, 2004 |
| Live cell % | | 74.67 | 76.60 | | Sinishaw, 2005 |
| | | | | 79.73 | Sori, 2004 |
| Percent total defects | | 18.01 | 16.10 | | Sinishaw, 2005 |
| | | | | 5.30 | Sori, 2004 |
| Color (%) | Watery | | | 1.49 | Sori, 2004 |
| | | 16.6 | 0 | | Sinishaw, 2005 |
| | Milky | | | 17.92 | Sori, 2004 |
| | | 33.3 | 40 | | Sinishaw, 2005 |
| | Creamy | | | 77.61 | Sori, 2004 |
| | | 33.3 | 40 | | Sinishaw, 2005 |
| | Bloody | | | 1.49 | Sori, 2004 |
| | | 16.6 | 0 | | Sinishaw, 2005 |
| | yellowish | | | 1.49 | Sori, 2004 |
| | | 0 | 20 | | Sinishaw, 2005 |

Table 6. Ejaculation and semen characteristics in various species of domestic animals and man

| No. | Parameters | Bull | Ram | Boar | Stallion | Man |
|---|---|---|---|---|---|---|
| 1 | Time lapse for ejaculation | 1 Sec | 1 Sec | 5 – 25 min | 30 – 60 Sec | |
| 2 | Point of semen deposition | os cervix | os cervix | Cervix | os cervix | os cervix |
| 3 | Ejaculate volume (ml) | 5-15 | .8-1.2 | 150-200 | 40-100 | 2-6 |
| 4 | Composition of ejaculate | single fraction | single fraction | fractionated sperm-free sperm-rich coagulum | fractionated sperm-free sperm-rich mucus | coagulated single fraction |
| 5 | Concentration: sperm/ml x $10^6$ | 800-1200 | 2000-3000 | 200-300 | 200-500 | 50-150 |
| 6 | Total sperm/ejaculate x $10^9$ | 4-18 | 1.6-3.6 | 30-60 | 8-50 | .1-.9 |
| 7 | % motile | 75 | 95 | 70 | 70 | 65 |
| 8 | % normal | 95 | 95 | 90 | 90 | 60 |

Source: Sorensen (1979)

## 2.6. Application of Artificial Insemination

### 2.6.1. Estrus and estrus detection

Estrus has been defined as a period when the female shows characteristic sexual behavior in the presence of a mature male, such as immobility, raising the hind quarters or arching the back, pricking of the ears-features that are collectively termed lordosis in small laboratory animals; mounting and riding behavior between females is also common (Gomes, 1977; Hunter, 1980; Heinonen; 1989; Herman et al., 1994; Bearden et al., 2000; Bekana et al., 2005; GebreMedhin, 2005).

Where AI or hand mating is being used, estrus detection is the most important limiting factor for optimum reproductive performance. Insufficient and/or inaccurate estrus detection leads to delayed insemination (with in estrus and post-partum), reduced conception rates and thus extended calving intervals (Daris, 1998).

Since the fertile life of eggs in most species is relatively short and sperm may require capacitation before they are capable of fertilizing ova, insemination should precede ovulation. Ovulation is difficult to determine routinely, so inseminations are usually related to the time of on set of estrus (Gomes, 1977). Estrus in the cow is characterized by the psychic manifestation of heat. The cow may bawl frequently, is usually restless, may attempt to mount other animals, and will stand to be mounted/standing heat. The vulva is swollen and mucus is often secreted

### 2.6.2 Timing of insemination

In the cow, maximum fertility has been achieved if inseminated from mid estrus to the end of estrus (Gomes, 1977). Fertilization of the ovum has been reported to occur in the oviduct at the junction of the isthmus and ampulla (Daris, 1998). The life span of the ovum is around 12 – 18 hours and its viability decreases with time. About 8 hours after service sufficient spermatozoa have reached the isthmus of the oviduct. For fertilization to take place, capacitation of the spermatozoa is required. Capacitated sperm cells show a hyper motility and have undergone the acrosome reaction. The life span of spermatozoa is limited. If insemination takes place too early, the sperm cells will die before fertilization of the ovum can occur. Conversely, when insemination is over delayed, the ovum has lost its capacity to be fertilized (Daris, 1998).

Table 7. Optimum time of insemination in relation to estrus

| Fertility | Poor | Fair | Good/Excellent | | | Fair | Poor |
|---|---|---|---|---|---|---|---|
| Hours | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
| Standing estrus | \|← | | | →\| | | | |

Source: Daris (1998).

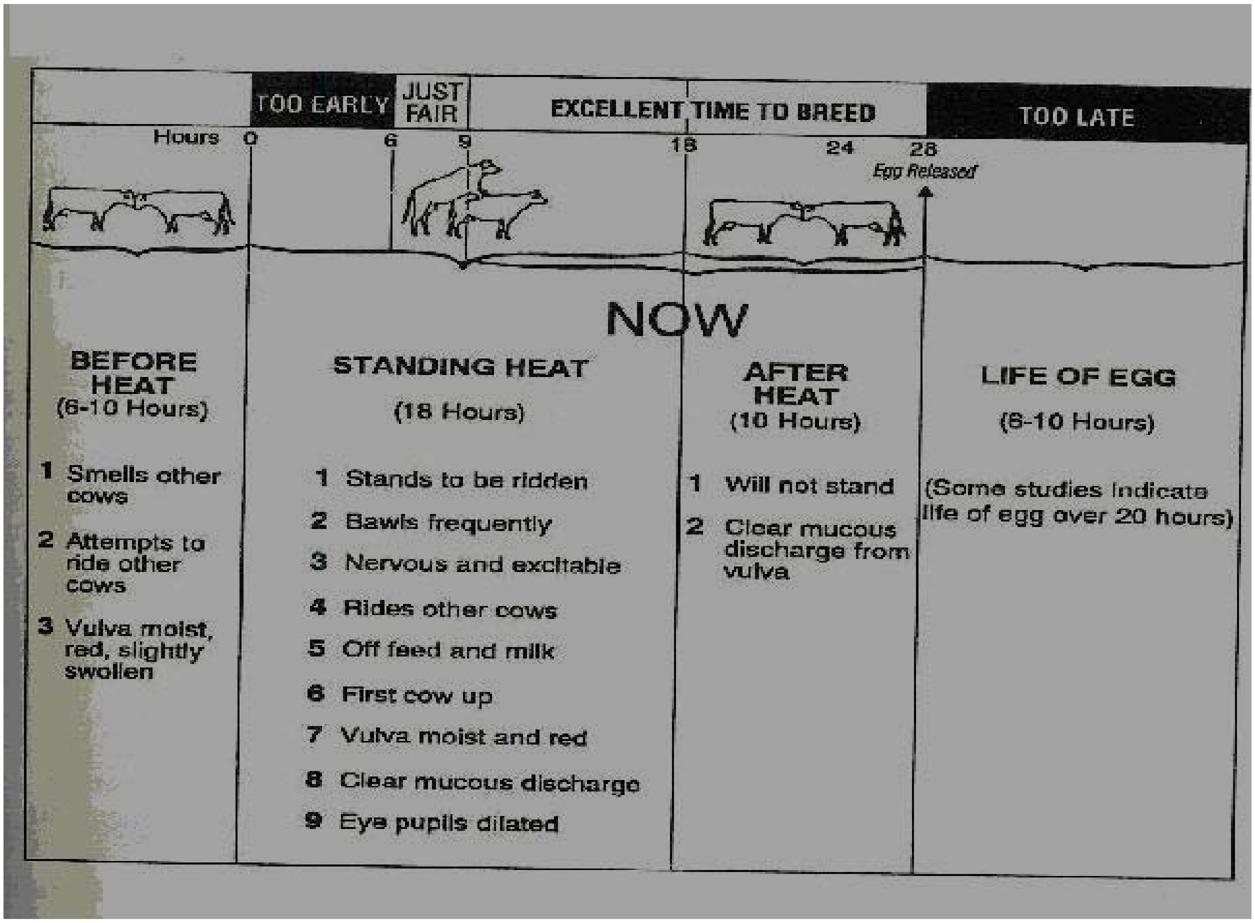


Figure 4. Timing guide for inseminating the average cow

Source: Herman et al. (1994).

2.6.3. Control of estrus

Reason for control of estrus

The estrus cycle can be regulated pharmacologically to induce or control the time of estrus and ovulation (Morrow et al., 1985; Daris, 1998; Bekana et al., 2005). The main reasons for estrus control are: induction of estrus in lactating dairy cows that are not observed in estrus by 45 days post-partum, synchronization of groups of heifers for insemination with semen of easy calving bulls, reduction of the time necessary for estrus detection, to facilitate the use of AI under extensive conditions, synchronization of donor and recipient cattle for embryo transfer and induction of ovarian activity in beef cows with lactation anoestrus.

Methods of controlling estrus

In cattle with active ovaries, the estrous cycle can be manipulated by administration of prostaglandin to induce early regression of the corpus luteum (Davis et al., 1987; Daris, 1998; Bekana et al., 2005) and by the use of progestagens that act as an artificial corpus luteum (Daris, 1998). The detection of estrus by regular surveillance or by the use of vasectomized teaser males may not be warranted or possible and, in any event, neither of these approaches in it enables insemination to be performed at the optimum time with regard to fertility (Hunter, 1980). Detection of estrus is getting more and more difficult according to the extension of the numbers of cows reared, the improvement of milking cows with a high milk production and the changes of the circumstances of feeding. Other factors include management of cows, implying the dependence on the techniques for estrus and ovulation synchronization in the reproductive management being very high (Sugawara, 2004). More logical and satisfactory way of estrus detection by far would be a situation in which the estrous cycles of animals to be bred could be controlled by a pharmacological or pseudo-physiological treatment such that the time of onset of estrus could be predicted in the great majority of animals receiving the treatment (Hunter, 1980). Furthermore, the author showed that the precise time of ovulation has been predetermined, and thus the animals can be inseminated at a fixed time without reference to the state of behavioral estrus, thereby avoiding the penalties associated with incorrectly timed insemination and the aging of gametes.

In essence, therefore, a system of estrous cycle control would attempt to detect the desired timetable of breeding rather than permitting females to impose their own reproductive rhythms on the farming system. Synchronization of estrus has been known to have many advantages including the reduction of time needed for detection of estrus (Hunter, 1980; Hailu, 2007).

Synchronization of estrus and ovulation can be conducted by the use of either, $PGF_{2\alpha}$ or GnRH or the combination of the two where the former is injected 7 days before the latter to induce a new follicular wave (Sugawara, 2004; Hailu, 2007).

Application in dairy cows

Failure to detect estrus is the main cause of sub optional fertility in dairy cows. Control of the time of luteolysis will help estrus detection. Commonly, these animals are submitted to a rectal examination in order to determine the stage of the cycle. When treated after day 6 of the cycle, insemination can be carried out at detected estrus 3-4 days after prostaglandin injection. For animals that are in pro-estrus, no treatment is required and the day of expected estrus can be predicted. In both cases, the farmer knows which animals to pay attention to. This will greatly improve the estrus detection rate.

2.6.4. Factors affecting success of artificial insemination

The site of semen deposition has been an important factor in the success of AI in cattle. In addition, the deposition of semen in the uterine body resulted in a 10% higher non-return rate than did cervical deposition (Macpherson, 1968). An increase in the conception rate has been reported when semen was deposited in the uterine horns rather than the uterine body (Senger et al. (1988). In contrast, no difference was found in the fertilization rate, conception rate or non-return rate, respectively, between uterine body and uterine horn inseminations (Hawk and Tanabe, 1986; Williams et al., 1988; and McKenna et al., 1990). In super ovulated cows, Hawk et al. (1988) used a modified insemination device requiring two technicians to deposit semen near the uterotubal junction and as compared to uterine body deposition; he found no effect upon the fertilization rate.

The major factors that determine AI efficiency are heat detection skills, fertility level of the herd, semen quality, and efficiency of inseminators (Barrett, 1974). Similarly, a successful insemination requires the acquisition of quality semen from a bull, the detection of estrus in the female, and the ability to properly place the semen in the reproductive tract of the female (Damron, 2000). Detection of estrus has been known to be one of the most difficult tasks for successful AI activities, which in turn is affected by diseases of testis, epididymis, and accessory glands in the male (Sori, 2004) and diseases of the female reproductive tract (Roberts,1985). The success of AI depends upon various factors such as the efficiency, capacity and commitment of

AI centers in procedurally and ethically producing, processing, handling and distributing semen; the commitments and efficiencies of AITs; presence of appropriate breeding policy along with proper control of indiscriminate crossbreeding; proper heat detections by farmers and other factors (GebreMedhin, 2005).

### 2.6.5. Artificial insemination and fertility rates

Fertility is measured by calving rate to first service for artificially inseminated dairy cattle (Hafez, 1980). Conception rate at first breeding provides a useful estimate of the conception rate for a herd. However, it is a measurement that combines the effects of semen quality, fertility of the cow, timing of insemination, semen handling and insemination techniques, as well as factors such as high environmental temperature and stress (Nebel, 1998).

In USA, conception rate of virgin heifers has been found relatively constant at approximately 65% to first service conception; where as the first service conception rates for lactating cows has decreased approximately 33% from 60 to 40 % (Nebel, 2002; Thirrunavukkarasu,2006 ). Number of services per conception as an indicator of reproductive efficiency has been defined as the number of services required for a successful conception (Albero, 1993; Bekele et al., 1991; HaileMariam et al., 1993; Negussie et al., 1998; Shiferaw,1999; Shiferaw et al., 2003). The number of services per conception is directly related to the conception rate in the herd (Smith and Becker, 1996). Female fertility, male fertility, environmental factors, and techniques used in AI are the four general multitude factors that determine the ultimate outcome of conception per insemination. Female fertility refers to any factor directly related to the heifer/cow that may alter her probability of becoming pregnant, including condition of the reproductive tract, nutritional status, changes in body condition from calving to insemination, age, and breed (Nebel, 2002). Male fertility cannot be controlled by the dairy producers. The mean first service conception rate for Virginia Dairy Herd Institute herds over the past 12 months in USA has been found 40 ± 13% (Nebel, 2002). There is a great reduction in fertility during the summer for lactating cows than for non-lactating heifers. High milk yield intensifies the effects of heat stress on conception and is related to increased metabolic rates and reduced thermoregulatory ability for cows with high milk yield. Techniques used in AI include accuracy of heat detection, timing of insemination, semen handling, and placement in the reproductive tract.

Fertility in cattle is affected by environmental, genetic, disease, and management factors (Mukasa-Mugerwa and Tegegn, 1989). These influence the reproductive process at ovulation, fertilization, or implantation during gestation and parturition.

In Ethiopia, Several factors have been reported to influence the number of services per conception. Breeding taking place during the dry season required more services per conception than the short and long rainy seasons (Swensson et al., 1981, HaileMariam et al., 1993; Negussie et al., 1998). Management factors such as accuracy of estrus detection, timing of insemination, insemination technique, semen quality, skill of pregnancy diagnosis have been reported to affect number of services per conception (Shiferaw, 1999; Shiferaw et al., 2003). Higher number of services per conception might also result from repeat breeding due to infectious and/or non-infectious diseases (Bekele, et al, 1991).

In postpartum cows, the mean number of services per conception as 2.4 and 2.7 for sub clinical endometritis positive cows, fourth and eighth weeks postpartum, respectively as compared to 1.7 for sub clinical endometritis negative cows showing that sub clinical endometritis has a significant effect on number of services per conception (Bacha, 2007).

Similar findings have been reported for number of services per conception as $1.74 \pm 0.43$and $1.65 \pm 0.43$ for Nharira and Lancashire, respectively in Zimbabwe (Kaziboni et al., 2004). Higher number of service per conception was found at Assela Dairy Farm and has been reported due, in most cases, to inefficiency in AI operations (Negussie, 1992). Similarly, Haile Mariam (1987) has reported a significant effect of year on the number of services per conception at Abernossa Ranch. This has been supposed to be due to the fact that incentives and bonuses which used to be given to AITs for each insemination resulting in conception was later stopped and subsequently resulting in increased number of services per conception. The role of inentivesfor inseminators is also well documented to increase reproductive efficiency (Mc Dowell 1972; Abate, 2006).

Table 8. Relationship between conception rate and services per conception and between breeding per conception and level of fertility

| Conception rate (%) | Service/conception | Level(breeding per conception | Interpretation(Level of fertility |
|---|---|---|---|
| 95-100 | 1.0 | Under 1.8 | Excellent |
| 87-94 | 1.1 | 1.8 to 2.0 | Adequate |
| 80-86 | 1.2 | 2.0 to 2.3 | Slight problem |
| 75-79 | 1.3 | 2.3 to 2.8 | Moderate problem |
| 69-74 | 1.4 | Over 2.8 | Sever problem. |
| 64-68 | 1.5 | | |
| 61-63 | 1.6 | | |
| 54.3 | 1.8 | | |
| 52.6 | 1.9 | | |
| 47.8 | 2.1 | | |

Adapted from Smith and Becker, 1996; Nebel, 1998.

### 2.8 Breeding policy and conservation of farm animal genetic resources

At present, there is no legal framework in Ethiopia to regulate crossbreeding or to regulate the importation and distribution of exotic genetic materials (ESAP, 2007). In an increasingly globalized market, the absence of breeding policies and regulations, as well as the absence of gene bank for animal genetic resource conservation, could put indigenous breeds at risk and endanger the future generations of livestock in Ethiopia and the rest of the world.

Lack of appropriate livestock policies have been identified as one of the increasing key factors causing threats to Farm Animals Genetic Resource (FAnGR) in the developing world (Gibson *et al*., 2006). The following were identified as some of the primary justifications for conserving FAnGR:

- Prevent genetic erosion of populations that retain value for current use;
- Maintain sufficient genetic diversity to meet the needs of current and future utilization

- Provide options for adaptation to changing environmental conditions;
- Support sustainable animal production systems for food security;
- Provide genetic resources for cross-breeding and development of new genotypes;
- Provide options to meet the demands of new markets for livestock products and services;
- Preserve cultural and historical values;
- Sustain the bequest value of livestock; and
- Fulfill the rights of an existing genetic resource to continue to exist.

# 3. MATERIALS AND METHODS

## 3.1 Study area

The research was conducted at the National artificial Insemination Center and in ten purposively selected areas of five regions, viz., Addis Ababa, Southern Nations Nationalities and Peoples Region, Oromia, Tigrai and Amhara (Figure 5). All the study areas were purposively selected because it was believed that these areas are the ones where an AI service is widely exercised and constitute wide range of agro- ecology. The background information of the study areas is presented in Table 9.

The National Artificial Insemination Center is the only place where semen is produced for use allover the country and is responsible for the coordination of AI operations in the country. It is directly accountable to the office of the State Minister for Agriculture in the Ministry of Agriculture and Rural Development of Ethiopia. During the initial periods of the research work, the Center had 38 bulls of Holstein Friesian, Jersey, indigenous and crosses of Holstein Friesian with indigenous breeds. However, only 18 of them were used for semen collection due to various problems. Few weeks after the start of this research, 9 bulls from the ones used for semen production and 25 bulls from the total 38 bulls available in the Center were slaughtered due to tuberculosis. The Center tested bulls only for brucellosis and tuberculosis and yet not on regular basis due to different problems. The source of AI bulls was Holstein Friesian cattle reared at the Holeta Bull Dam Farm.

The Center uses 0.25ml capacity mini straws for filling semen and 30 million spermatozoa per straw is the standard used by the center. Any semen with concentration of less than 500 million spermatozoa per ml at the time of collection was automatically rejected.

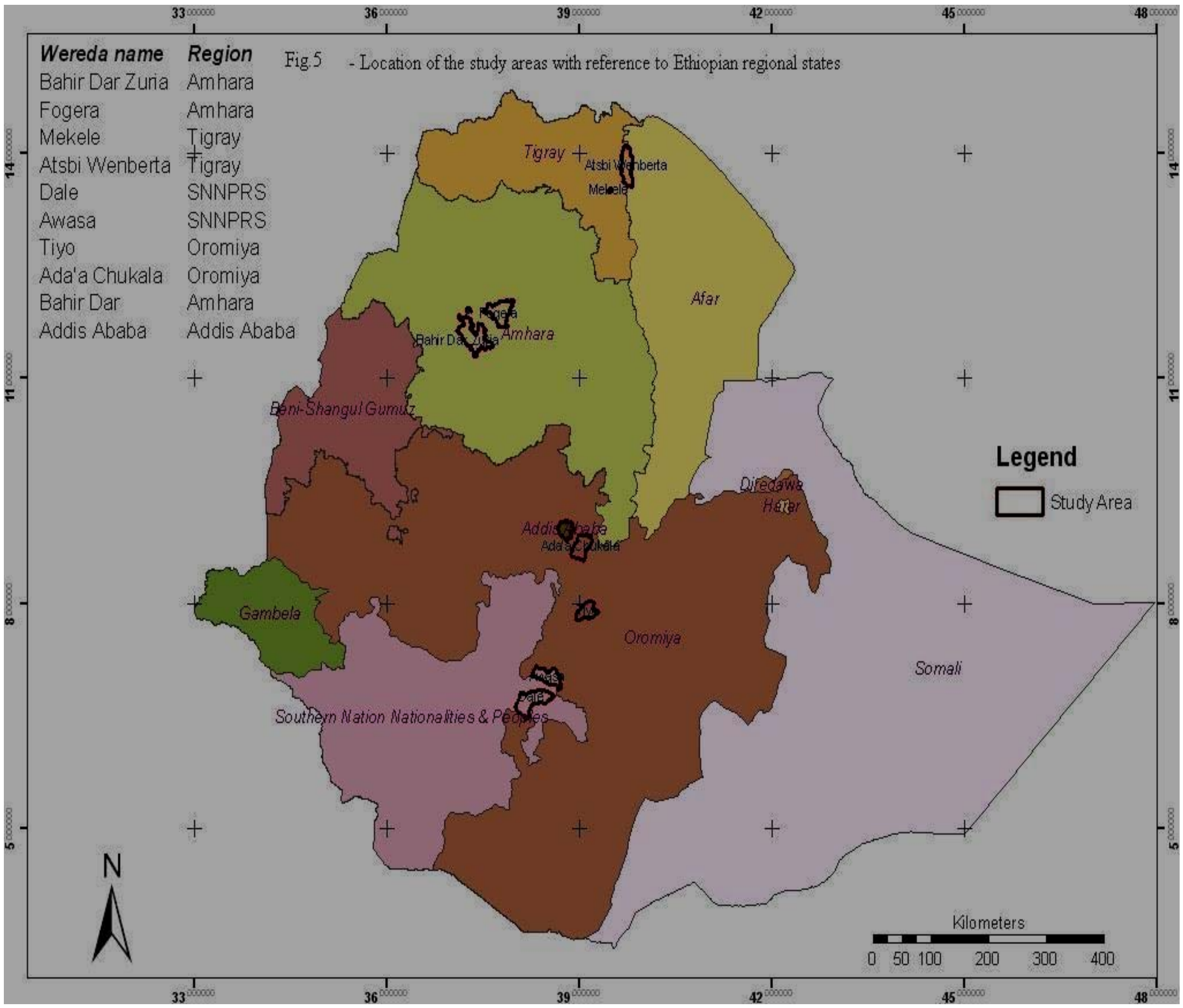


Figure 5. Illustration of the study areas

Table 9. Background information on the study areas

| Region | Zone | Woreda | DA/C (km) | Human Population | Cattle Population | Altitude (masl) | Average Temperature | | AAR (mm) | Production system |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Maximum | Minimum | | |
| A.A[1] | All | All | - | 3706439 | 67366 | 2300-3000 | 24.6 | 9 | 1200 | Urban dairying |
| SNNP[2] | Sidama | Dale | 315/40 | 428648 | 215924 | 1000-2500 | 19[a] | | 1170 | MCLPS |
| SNNP[2] | Awasa | All | 275 | 498534 | 261365 | 1750 | 20[a] | | 955 | Urban dairying |
| Oromia[3] | Arsi | Tiyo | 175 | 128297 | 98966 | 3815[b] | NA | NA | | MCLPS |
| Oromia[4] | East Shoa | Ada'a | 47 | 217887 | 104364 | 1540-3100 | 28 | | 476 | MCLPS |
| Tigrai[5] | Eastern | Atsbiw | 853/70 | 120120 | 52482 | 1800-3100 | 15[a] | | 500-600 | MCLPS |
| Tigrai[6] | Mekelle | All | 783 | 500000 | 19161 | 1800-2400 | 23 | 7 | 400-900 | Urban dairying |
| Amhara[7] | W. Gond | Fogera | 619/55 | 246541 | 195728 | 1174-2737 | 20 | 14 | 1090- 1400 | Mixed |
| Amhara[8] | E. Gojam | BDZ | 565 | 102096 | 460700 | 2300 | 32 | 10 | 820- 1250 | MCLPS |
| Amhara[9] | Bahir Dar | All | 564 | NA | 50176 | 1860 | 27 | 13 | 1490 | Urban dairying |

DA/C= distance from Addis Ababa/Regional capital; km=kilometer; mas=meters above sea level; AAR=annual average rainfall; NA= not available; [a] mean annual temperature; BDZ=Bihr Dar Zuria; W. Gond=West Gondar; [b] highest altitude;

MCLPS= Mixed crop livestock production system.

Sources: 1=Addis Ababa Regional Bureau of Agriculture (unpublished), 2= Yigrem (2007), 4=Ada'a Woreda Agricultural Office ((unpublished), 5= Atsbiw Woreda Office of Agriculture Rural Development (unpublished); 6=Mekele Zonal Bureau of Agriculture (unpublished), 7= Fogera Woreda Bureau of Agriculture (unpublished ), 8=Bahidar Zuria Woreda Bureau of Agriculture (unpublished), 9=Aynalem (2007).

Physical and retrospective evaluations of semen producing bulls at NAIC, physio-morphological assessment of semen in laboratory were conducted. Eighteen bulls were checked for locomatory and other physical situations at standing status, during sexual stimulation and during mounting. Scrotal measurement for all the 18 bulls was done using a flexible scrotal circumference tape.

Semen was collected from each bull involved in the study once a week per bull for three consecutive weeks. The collection of semen was done using artificial vagina. Semen characteristics were assessed in the semen laboratory of the Centre. Stage- heated microscope with a magnification of 100x for mass activity, 200x for sperm motility, and 1000x for morphology were used.

### 3.2 Study population

Bulls and AI personnel in the National Artificial Insemination Center, cattle owners and their dairy cattle in the five regions, animal health and production professionals in federal, regional, zonal and Woreda agriculture and rural development offices and also professionals in NGO's., research centers and academic institutions were represented in the study population.

### 3.3 Study design

A cross-sectional type of study supported by questionnaire survey, and observation was carried out from August 2007 to March 2008 in the National Artificial Insemination Center and the five regions included in this study.

### 3.4 Sample size determination and sampling procedures

Sample sizes were determined by the following formula (Thrusfield, 2005)

$$\text{Total cows } (n) = Z_{\alpha}^{2} \times \frac{p\,(1-p)}{d^{2}}$$

Where:

P (expected prevalence) = 0.5

d (desired absolute precision) = 0.05

$Z\alpha$ = 1.96.

Based on this formula, the total number of cows to be sampled was 384. However, the study was conducted on 375 cows (98%). In the case of farmers, the value used for d (absolute precision was 0.02 and hence the total sample size required was 246 and this size was fulfilled in this study.

In addition, all the bulls, which were in use for semen production during the study (18), all animal science professionals (17) in the Center, and 30 artificial insemination technicians, were included in the study purposely. Furthermore, a total of 52 animal health and production professionals were included in the focus group discussion the number of people in each group ranging from 9 to 14.

In the sampling procedure, the five major regions, which are major users of AI service in the country, were purposively selected to conduct the study. Moreover, the specific study areas (Zones and Woredas) were also purposively selected considering the same reason. Stratified sampling was used to determine the total number of farmers and cows for each region while systematic random sampling method was used to select cows and farmers within region. Table 10 depicts the summary of the number of cows, farmers and number of participants for focus group discussion in each study area.

Table 10. Distribution of farmers, cows, AITs, and FGD participants in the five regions

| Region | Woreda | Sample size | | AITs | | Focus group discussion | |
|---|---|---|---|---|---|---|---|
| | | Cows | Farmers | Number of groups | Number of participants | Number of groups | Number of participants |
| Addis Ababa | Addis Ababa | 87 | 83 | 6 | 6 | 1 | 9 |
| SNNPR | Dale | 69 | 34 | 1 | 2 | 1 | 10 |
| | Awassa | 15 | 10 | 1 | 5 | | |
| Oromia | Tiyo | 54 | 24 | 1 | 2 | 1 | 9 |
| | Ada'a | 16 | 17 | 1 | 1 | | |
| Tigrai | Atsbi | 15 | 16 | 1 | 4 | 1 | 10 |
| | Mekelle | 55 | 22 | 1 | 5 | | |
| Amhara | Fogera | 36 | 12 | 1 | 3 | 1 | 14 |
| | Bahir Dar Zuria | _ | 14 | 1 | 1 | | |
| | Bahir Dar | 28 | 14 | 1 | 1 | | |
| Total | | 375 | 246 | 15 | 30 | 5 | 52 |

AITs= artificial insemination technicians; FGD= focus group discussion

### 3.5. Data collection

3.5.1. Semen quality analysis and evaluation of bulls

Physical and retrospective evaluations of semen producing bulls at NAIC, physio-morphological assessment of semen in laboratory were conducted. Eighteen bulls were checked for locomatory and other physical situations at standing status, during sexual stimulation and during mounting. Scrotal measurement for all the 18 bulls was done using a flexible scrotal circumference tape.

Three consecutive semen collections were done in the National Artificial Insemination to determine semen quality of bulls used at the Center. The collection of semen was done using artificial vagina. Semen characteristics were assessed in the semen laboratory of the Centre.

Stage- heated microscope with a magnification of 100x for mass activity, 200x for sperm motility, and 1000x for morphology were used. The values for semen parameters were recorded every week while semen was collected. The parameters included were semen color, volume, mass activity, individual motility, live-dead percentage, and morphological abnormalities of the semen collected from AI bulls. The details of the procedures are indicated in Annex 10. Semen analysis was done in accordance with the procedures provided by (Cole and Cupps, 1977; Salisbury et al., 1978; Sorensen, 1979; Faulkner and Pineda, 1980; Morrow et al., 1985; Roberts, 1985; Garner, 1991; Herman et al., 1994; Bearden et al., 2004).

Bulls used in the NAIC were also checked for fitness of locomatory organs, scrotal circumference, and libido. Bulls were evaluated as very good, good, adequate, and poor for locomatory organs and libido. The following criteria were used to categorize the status of locomatory organs and libido (Arthur, et al., 1983; Zewdie et al, 2005; Hansen, 2006).

Locomatory organs

Very good: having no any defect with the locomatory and can move easily and freely

Good: having some type of problems with hoof, untrimmed nail

Poor: having major hoof problem and hence problems in moving and mounting.

Libido

Very good: showing sexual desire in less than 5 minutes

Good: showing sexual desire in 5 minutes

Adequate: showing sexual desire in 5 to 10 minutes

Poor: showing sexual desire in 10 to 30 minutes

Evaluation of spermatozoa motility for each region was done for comparisons between that of the regions and the Center to check if there were major changes in spermatozoa motility between NAIC and the regions due to handling differences. It was initially planed to perform the motility check in each region. But because of lack of stage- heated microscopes in the regions, it was done by transporting sample semen back from each study area to the semen laboratory at NAIC using a three-litter capacity with periodically controlling and filling liquid nitrogen by making maximum care for the semen. A total of 93 straws of semen from 16 bulls in which 49 were from regions and the other 44 from NAIC were analyzed for semen motility. Moreover, 17 straws of new batch semen of which eight were from region 5 and 9 from NAIC were analyzed for motility to check why semen motility from region 5 was so low.

### 3.5.2 Pregnancy diagnosis and assessment of services per conception

Pregnancy diagnoses by rectal palpations were conducted to assess the number of services per conception and conception rates to first insemination in each study area.

### 3.5.3. Questionnaire survey

Structured questionnaires were prepared to interview farmers, AI technicians, animal health, and production professionals to collect data on the status of AI services and constraints associated with the service. The details of the questionnaire formats for farmers, AI technicians and animal health and production professionals are presented in Annex 4, 5, and 6. During the interview process, every respondent included in the study was briefed about the objective of the study before starting presenting the actual questions. Then the questions were presented to the respondents. Farmers were being convinced to come for the meetings at their respective houses few days before the actual dates.

### 3.5.4. Focus group discussion

A total of five groups were organized one in each region. Each group was made of 9 to 14 professionals originating from development, academic and research institutions in the regions. The points of discussion and the list of participants are presented in Annex 7 and 3. Before the start of the discussion, participants of each group were briefed about the objective of the study and invited to participate in the discussion.

### 3.6. Data management and statistical analysis

All data were entered in to Ms-Excel after the completion of data collection work from the study areas. Then the analysis work was done using SPSS (release 11.05, 2002). The data was summarized using descriptive statistics (means, standard errors and percentages) and mean comparison was done by one way ANOVA while rank comparison was made by Mann-Whitney U test.

## 4. RESULTS

### 4.1. Morphological characteristics of semen and bull evaluation

The outcome of the assessment of locomatory organs and libido are presented in Tables 11. Most of the bulls were under the category of very good libido (77.8%) and good locomatory organs. Four bulls (22.2%) had hoof problem affecting their locomotion.

Table 11. Summary of libido and locomatory organs evaluations of bulls at NAIC

| Parameter | Bull breeds | Attributes | Count | Proportion (%) |
|---|---|---|---|---|
| Locomatory | Holstein Friesian (HF) (n=10) | Very good | 0 | 0 |
| | | Good | 9 | 90 |
| | | Hoof problem | 1 | 10 |
| | Jersey(n=5) | Very good | 0 | 0 |
| | | Good | 4 | 80 |
| | | Hoof problem | 1 | 20 |
| | Cross(HF*Local) (n=3) | Very good | 0 | 0 |
| | | Good | 1 | 33.3 |
| | | Hoof problem | 2 | 66.7 |
| Libido | Holstein Friesian (HF) (n=10) | Very good | 10 | 100 |
| | | Good | 0 | 0 |
| | | Adequate | 0 | 0 |
| | | Poor | 0 | 0 |
| | Jersey(n=5) | Very good | 4 | 80 |
| | | Good | 1 | 20 |
| | | Adequate | 0 | 0 |
| | | Poor | 0 | 0 |
| | Cross(HF*Local) (n=3) | Very good | 1 | 33.3 |
| | | Good | 2 | 66.7 |
| | | Adequate | 0 | 0 |
| | | Poor | 0 | 0 |

The results of one-way ANOVA on the scrotal circumference of bulls in the NAIC showed that there was no statistically significant difference in mean scrotal circumference ($p>0.05$). However, the highest value for scrotal circumference was observed in Jersey cattle (41cm) followed by

Holstein-Friesian (39.71cm) and crosses of Holstein-Friesian (39cm) and indigenous cattle (39cm). The result of assessment of scrotal circumference is presented below in Table12.

Table 12. One- way analysis of variance to assess scrotal circumferences of semen producing bulls at NAIC

| Parameter | Bull breeds | Mean(SE) | 95%CI | P-value |
|---|---|---|---|---|
| Scrotal circumference | Holstein Friesian(n=7) | 39.71(0.64) | 38.14-41.29 | |
| | Jersey (n=3) | 41.00(1.16) | 36.03-45.97 | 0.44 |
| | HF*L crossbred Bulls (n=2) | 39.00(1.00) | 26.29-51.71 | |

The result of one- way ANOVA on the semen characteristics of bulls used for semen collection at NAIC is presented in Table 13. Only total morphological defects showed significant difference between the breeds of bulls ($p<0.05$). The highest proportion of defects was observed in Jersey bulls (18.8%) followed by crossbred (13.33%) and Holstein bulls (8.5%).

Table 13. Results of one-way ANOVA to assess semen characteristics of bulls at NAIC

| Parameters | Holstein-Friesian | | Jersey | | Crosses of HF and Locals | |
|---|---|---|---|---|---|---|
| | Mean (SE) | 95% CI | Mean (SE) | 95% CI | Mean (SE) | 95% CI |
| Volume(Ml) | 8.87(0.90) | 6.84-10.90 | 5.68(0.37) | 4.67-6.70 | 8.00(1.85) | 0.03-15.97 |
| Concentration ($10^9$) | 1.40(0.97) | 1.18-1.62 | 1.24(0.09) | 0.98-1.50 | 1.23(0.38) | -0.42-2.89 |
| Mass activity (1-5)a | 3.45(0.21) | 2.97-3.93 | 3.38(0.12) | 3.05-3.70 | 2.80(0.49) | 0.67-4.92 |
| Live cell percentage | 75.90(1.20) | 73.19-78.61 | 74.40(1.81) | 69.39-79.41 | 76.33(2.85) | 64.08-88.59 |
| Fresh individual motility | 73.97(3.06 | 67.04-80.90 | 75.60(0.87) | 73.18-78.02 | 74.33(1.86) | 66.35-82.32 |
| Individual motility at dispatch | 54.50(3.83) | 45.83-63.17 | 59.00(5.10 | 44.84-73.16 | 43.33(3.33) | 28.99-57.68 |
| Major morphological defects | 2.27(0.93) | 0.16-4.38 | 6.58(3.08) | -1.98-15.14 | 3.33(1.33) | -2.40-9.07 |
| Total morphological defects | 8.50(1.85) | 4.32-12.69 | 18.80(2.85) | 10.89-26.72 | 13.33(4.67) | -6.74-33.41 |

[a] 1=very poor, 2=poor, 3=good, 4=very good, 5= excellent

With regard to the color of semen, most of the collected semen had milky (41.2%) and creamy color (37.3%). There were also some bulls with bloody (7.8%), watery (3.9%), and yellow (9.8%) colors. The results indicated that 14.29 percent of the semen colors for the Holstein bulls were bloody while 22.22 percent for that of the crosses were watery. The detail results are indicated on the Table15.

Table 14. Proportion of semen colors for semen produced during the study period at NAIC

| Parameter | Bull breeds | Attributes | Count | Proportion (%) |
|---|---|---|---|---|
| Semen colors | Holstein Friesian (HF) | Milky | 12 | 42.86 |
| | (n=30 straws) | Creamy | 9 | 27.78 |
| | | Bloody | 4 | 14.29 |
| | | Watery | 0 | 0 |
| | | Yellow | 5 | 17.86 |
| | Jersey(n=12 straws) | Milky | 8 | 66.67 |
| | | Creamy | 4 | 33.33 |
| | | Bloody | 0 | 0 |
| | | Watery | 0 | 0 |
| | | Yellow | 0 | 0 |
| | Cross(HF*Local) | Milky | 1 | 11.11 |
| | (n=9 straws) | Creamy | 6 | 66.67 |
| | | Bloody | 0 | 0 |
| | | Watery | 2 | 22.22 |
| | | Yellow | 0 | 0 |
| | Overall averages(n=49 straws) | Milky | 21 | 41.17 |
| | | Creamy | 19 | 37.25 |
| | | Bloody | 4 | 7.84 |
| | | Watery | 2 | 3.92 |
| | | Yellow | 5 | 9.80 |

## 4.2. AI organization and efficiency of AI service

Eighty two percent of the NAIC technical staff confirmed that there are no appropriate collaborations and communications between the NAIC, regional agriculture bureaus and other stakeholders at all. Similarly, participants of the focus group discussions in all study regions unanimously supported the above idea. Again, 88.2% of the NAIC staff said that the AI service is not doing appropriately at national level and that there is no structured and procedural way of recruiting semen-producing bulls by the center. About 88.2% of the NAIC personnel indicated that there is no structured and procedural way of selecting AI bulls and selection is being done from only one farm and 70.6% revealed that bull selection and management at NAIC is not being done according to recommended procedures and all agreed that the Center is not regularly and appropriately checking bulls for reproductive diseases. Eighty eight %of the respondents confirmed that there is no policy that guides the distribution of semen in the country.

Results of the focus group discussions have revealed that there are no functionally effective responsible bodies at the respective regional and wereda levels to coordinate the AI services and no proper mechanisms of controlling indiscriminate inseminating/breeding. Moreover, it was found with full consensuses that there are problems associated with the AI service as regards to properly carrying out responsibilities by the NAIC, the regional, and the wereda agriculture bureaus.

The evaluation of the technical know-how of AI technicians showed that most of them were in the category of good (56.7%) and very good (26.7%). The remaining were evaluated as poor (10%) and excellent (10%). Regarding their motivations, 86.67% of the respondents were totally unmotivated while the remaining had some motivation (13.33). Nearly all (96.7%) of the AI technicians responded that they never got on job trainings and other incentives at all. About three fourth (73.3%) of the AI technicians were not giving service on the weekend while others did so on personal agreements (26.3%). Most of the AI technicians complained that liquid nitrogen is not readily available (86.7%) and the rest 13.3% had no problem in getting liquid nitrogen. More than three fourth of the AI technicians (76.7%) believed that there is a risk of indiscriminate insemination while the others either did not have any idea about the problem (13.3%) or believed it can be controlled. Seventy percent of the AITs confirmed that they started their careers as AITs within the last ten years while the more experienced ones had abandoned and/or changed their jobs. Ninety-three percent said that they do not believe that NAIC is doing its responsibilities properly. Eighty seven percent of the AITs revealed that farmers are willing to pay more fees for the services provided they get reliable and quality services. On the other hand, 80 percent of them revealed that they do no get necessary supports by the respective wereda and regional bureaus of agriculture to perform their duties appropriately. Similarly, 83 % said that AI service delivery is not consistent in their respective areas.

Ninety seven percent of the AITs revealed that they are not satisfied and neither are they happy with their jobs as AITs because of the very little attention given to it by all responsible bodies.

Ninety three percent, of the farmers who participated in the Questionnaire surveys bitterly revealed that, they do not get reliable and consistent AI service at all and 81% of them explained the reasons for that as absence of service on weekends & holidays, shortage of AITs and shortage of inputs. In relation to this, 64% of them said that they pass the estrus with out breeding the cow while 34% said that they us bull/ natural mating at times where they do not get the AI service. The study has clearly confirmed that 93.1% of all the farmers participated in the study areas showed dissatisfaction with the overall AI service. In many places, it was observed that farmers trek their cows for more than 28km round trip to fetch for AI service (with or without success). This is happening in many areas and the reason is AITs are unable to get facilities and services like motor bicycles, fuel, etc. The results of the questionnaire surveys indicated that 91.5% of farmers participated in the study confirmed their willingness to pay more fees for the service provided they get reliable, efficient, and effective services. Moreover, 90% of the AIT's who took part in the study confirmed that the AI service is not doing well in their respective areas due to many impeding situations (6.7% responded "AI is doing well" and 3.3% of them abstained from giving any judgment).

In Bahir Dar, where artificial insemination service was being delivered by a private AIT only, farmers were supposed to pay not less than 30 Birr per single insemination and yet the average

NSC in this place is much higher (5). Nevertheless, in the same place with the same AIT, the NSC for Jerusalem Children's and Community Development Organization was found to be as low as 1.3.

Ninety percent of the farmers said that they usually have herd health problems, which directly and indirectly have impacts on the efficiency of the AI service. The diseases said to be of major importance in order of prevalence were mastitis with 39%, tuberculosis with 24%, problems associated with calving with 17%, and others. In relation to this, 76 percent of the farmers said that they do not have easy access to animal health services while 21 percent said they more or less get the service.

According to the responses of the respondents in the questionnaire survey and focus group discussion, the necessity of a national body responsible to coordinate AI service was emphasized by 94.1% of the NAIC personnel (94.1%) unanimously by AI technicians and the focus group discussion groups. Most of the respondents in the questionnaire survey (82.4%), all the respondents in the AI technician group and all the groups in focus group discussion agreed that there is no appropriate collaboration and regular communication between AI and stakeholders. Lack of breeding policy, absence of herd recording system, inefficient management at national level and lack of clearly defined share of responsibilities among stakeholders were the constraints mentioned by 70.6% of the AI personnel at NAIC and all the groups in the focus group discussion. Lack of ownership and follow-up, inadequate manpower and lack of commitment, lack of attention and incentives to AIT's, limitation of inputs and facilities and structural problems were also mentioned by 29.4% of the NAIC personnel, all of the AI technicians and all the groups in the focus group discussion.

Regarding the possible solutions, institution of a national breeding policy and strategy, restructuring the service at all levels and create awareness, diversifying the service and establishment of a system of monitoring and evaluation, and encouraging the private involvement in the sector were emphasized by 52.94% of the NAIC personnel, all of the AI technicians and all the groups involved in the focus group discussion. Establishment of means for strong stakeholder participations, establishment of ownership to the sector, integration of AI service with health and feeds packages, re-establishment of incentive mechanisms to AITs and coordination of efforts to alleviate the technical management problems of the NAIC were also mentioned by 11.76% of the NAIC personnel, all the AI technicians and all the groups in the focus group discussion.

### 4.3 Assessment of efficiency of AI operations

The results of one-way ANOVA showed that semen motility at NAIC (53.2%, n=44) and in the regions after dispatch (51.7%, n=49) was not significantly different (p>0.05). The result indicated that there was no significant difference (p>0.05) in semen motility among the regions as well. The result is presented on Table 15.

However, a Special case was observed whereby the average value of motility for semen obtained from region 2(SNNP) was as low as 20%. Similarly, the average motility for semen obtained from region 5 was as low as 32.5%. Nine straws of semen for the same bulls as that of region 5 were taken and checked for motility from NAIC for assessing the reasons why the motility in region 5 was so low and it revealed that the average motility was as low as 38%.

Table 15. One-Way analysis of variance to asses and see effect of handling of semen between NAIC & regions on semen motility

| Parameter | Region | n | Mean (SE) | 95%CI | P-value |
|---|---|---|---|---|---|
| Semen motility | 1 | 22 | 51.59(1.49) | 48.50-54.68 | |
| | 2 | 6 | 50.00(3.65) | 40.61-59.39 | |
| | 3 | 15 | 51.67(1.74) | 47.94-55.39 | 0.77 |
| | 4 | 6 | 54.17(2.01) | 49.01-59.33 | |
| | Overall regions | 49 | 51.73(0.97) | 49.78-53.69 | |
| | NAIC | 44 | 53.18(1.01) | 51.05-55.31 | 0.32 |

n=number straws used for the analysis of semen motility

The results of One- way analysis of variance on the number of services per conception (NSC) and conception rates to first insemination (CRF) in the different study areas are presented in Tables 16 & 17 respectively. There was significant different among the study regions in NSC ($p<0.001$). The least NSC was observed in Amhara (1.55) followed by Addis Ababa (1.70) and Oromia (1.78). Highest value for NSC was recorded for Tigrai (2.47). These values of number of services per conception did not take in to account 152 cows (40.53% of the total sampled cows) which were found to be repeat breeders. There was also significant variation between the regions in conception rate after first service (CRF). The highest CRF was observed in Addis Ababa (40.23 %) and the least was found in Tigrai (7.14%).

Table 16. Results of One-way ANOVA to asses NSC by region

| Parameter | Region | N | $N^1$ | Mean(SE) | 95% CI | P-value |
|---|---|---|---|---|---|---|
| NSC | Addis Ababa | 64 | 109 | 1.70 (0.14) | 1.42-1.98 | |
| | SNNPR | 44 | 84 | 1.91(0.19) | 1.53-2.29 | |
| | Oromia | 46 | 82 | 1.78 (0.06) | 1.03-1.28 | 0.000 |
| | Tigrai | 47 | 116 | 2.47 (0.12) | 2.04-2.51 | |
| | Amhara | 22 | 34 | 1.55 (0.17) | 1.19-1.90 | |
| | Total | 223 | 425 | 1.88 (0.07) | 1.60-1.87) | |

N= total number of pregnancies

$N^{1=}$ total number of inseminations

Table 17. Results of One-way ANOVA to asses CRF by region

| Parameter | Region | N | $N^1$ | Mean(SE) | 95% CI | P-value |
|---|---|---|---|---|---|---|
| CRF (%) | Addis Ababa | 87 | 35 | 40.23 (0.50) | 20.84-22.84 | |
| | SNNPR | 84 | 28 | 33.33 (0.13) | 17.44-17.96 | |
| | Oromia | 70 | 24 | 34.29 (0.37) | 18.45-19.94 | 0.000 |
| | Tigrai | 70 | 5 | 7.14 (0.85) | 2.00-5.40 | |
| | Amhara | 64 | 13 | 20.31(1.25) | 13.75-18.75 | |
| | Total | 375 | 105 | 27.06(0.44) | 15.22-16.94 | |

N= total number of first inseminations

$N^{1}$= total number of pregnancies to first services

## 5. Discussions

In this study, it was found that the bulls in NAIC originated from one farm and standard guidelines were not used during selection. This situation is supported by the reports given by Agegnehu *et al*. (2008) and this was not because of lack of guidelines and standards rather failure to follow the already set guidelines (Yemane, 1995). Agegnehu (2007) and Zewde (2007) indicated that AI bulls need be carefully recruited and the frequency of tests for performance and diseases at NAIC were not sufficient. According to the international animal health code (2001) of the Office International des Epizooties (OIE)) as cited by Agegnehu (2007), donor and teaser animals should be tested for bovine brucellosis, bovine tuberculosis, bovine viral diarrhea, infectious bovine rhinotracheitis, Campylobacter fetus, and trichomoniasis. However, it was found the NAIC does not follow this procedure. It is believed, therefore, that this negligence could be the reason for the high prevalence of tuberculosis within the semen producing bulls in the center.

Regarding the evaluation of locomatory situations of the semen producing bulls at NAIC, it was found that 4 bulls out of 14 (22.2%) had hoof problems. Since hoof problem is believed to affect fertility, this higher proportion of hoof problem within the semen producing bulls is a serious problem that needs immediate attention to change the situation. The result of the evaluation of libido of the bulls indicated that 83.3% of the bulls were found within the "very good" category and the rest 16.7% within the "good" category. Nevertheless, no bulls fall within the "Poor" categories. Therefore, the results are in this regard are encouraging but endeavors should be made to upgrade the libido status of those found within the "good" category to higher ones. Different reasons for low libido have been given by Arthur et al (1982) which include age, heredity, environment and disease or defects of the penis in which case the penis fails to make contact with the vulva either because of insufficient protrusion or because it is deviated ventrally or laterally.

The mean value of the scrotal circumferences for the three breeds of bulls at NAIC ranged from 39.71 to 41cm. It was found that the results did not differ (P>0.05) between the three breeds. As regards to the overall evaluation of semen characteristics, results indicated that there were no significant differences between the three breeds for all the semen traits except for the total morphological defects. The highest total morphological defect rate was observed in Jersey bulls (18.80%) followed by crosses (13.33%) and Friesian bulls (8.50). However, the rate of total morphological defects in this study (8.50% for Friesian and 13.33% for crosses) is lower than the reports of Sinshaw (2005) (16.10% for Friesian, and 18.01% for crosses).

The volume of semen did not differ (p>0.05) among the three breeds. These results did not coincide with that of Sinishaw (2005) and Sori (2004) where 6.77% by Sinishaw for Friesian breeds and 4.4 % by Sori for indigenous breeds were found. The absence of significant difference among the breeds could be due to similar management at the Center level. According to Zewdie *et al*. (2005), the volume of bull's semen varies between ejaculates, individual bulls, breed, and age. Other reasons, which could contribute, to differences in semen volume include nutritional status, geographic locations, season of years of study, method of semen collection and handling of bulls during collection and procedure and frequency of collection (Caroll *et al*., 1963; Igboeli and Raka, 1971; Salisbury *et al*., 1978; Tegegn *et al*., 1992a; Hafez, 1993; Blezinger, 1999; Andrabie *et al*., 2002). Sorensen (1979), Sinishaw (2005), and Sori (2004) reported similar findings for the other parameters (semen motility, semen concentration, live cell percent, and morphological defects).

The results of the assessment of semen colors for all the three breeds of bulls in percentages was found to be 41.2, 37.3, 7.8, 3.9, and 9.8 for milky, creamy, bloody, watery and yellowish, respectively. The proportion of milky and creamy colors do not differ much from the findings of Sinishaw (2005), while they differ significantly from that of Sori (2004) (77.61% and 1.49% respectively) .The other color proportions differ much from those of Sori (2004) (17.92% watery,1.49% bloody, and none for watery) and Sinishaw (2005) (none for watery, and bloody, 20%yellowish). The presence of semen with abnormal colors indicates problems associated with the process of spermatogenesis and pathologies accessory reproductive organs and the reproductive passageways. The normal color of bull semen ranges from thick whitish to slightly yellowish fluid whose consistency is mainly determined by the number of spermatozoa it contains (Herman *et al*., 1994).

The out come of the assessment of AI technicians regarding their technical knowledge was 10%, 26.7 %, 53.3%, and 10%, respectively for excellent, very good, good, and poor. This result and the finding that most of the technicians do not get on job trainings shows that there is some deficit indicating a need for upgrading the capacity of technicians through giving proper trainings particularly for those who were under the category of the poor technical expertise.

The study has found an alarming result with motivations of the AI technicians in which 86.67% of them have indicated that they are not motivated to work as AI technicians due to associated problems and constraints. This is fully supported by the reports of the Field AI Service and Extension Department (2007) that indicated a very high turn over of AI technicians all over the country. The situation is closely associated to the discontinuation of in-service trainings and incentive mechanisms during the past years.

Again, it was revealed that all responsible bodies from federal to wereda levels, particularly the NAIC, are not giving proper attention to the AI service indicating that decision makers need to work hard to change the current situation of the AI operation at national level.

It was found that 94.1% of NAIC personnel, 100% of AI technicians, and the full consensus of the focus group discussions supported the necessity of a national responsible body to coordinate the AI service. This result agrees with the reasons identified as problems of AI by Chupin and Schuh (1992)**,** GebreMedhin (2005), Belaineh *et al*. (2006). Semen Production and Distribution Department (2006), FAISETD (2007) and Zewdie *et al.* (2006).

Again, out come of the study revealed that there is no appropriate collaboration and communications among stakeholders in which the NAIC failed to do which consequently contributed to the unsuccessfulness of the service.

As far as the constraints associated with the AI service at national level/regional levels is concerned, 70.65% of NAIC personnel and all the groups in the focus group discussions indicated that lack of breeding policy and herd recording scheme, inefficient management at national level and lack of clearly defined share of responsibilities among stakeholders were identified as the most important constraints. Similarly, 29.4% of the NAIC personnel, 100% of the AI technicians and all the groups in the focus group discussions indicated low attention/lack of ownership and follow-up, inadequate manpower and lack of commitment, lack of attention and incentives to AI technicians, limitation of inputs and facilities, and structural problems as other major reasons. These findings are in agreement with the suggestions of Tegegn *et al*. (1989), Mukassa-Mugerwa *et al*. (1989), Garner (1991), Jokinen and Bertilson (2003), Bearden *et al*. (2004), Bekele (2005), Gebremedhin (2005), Belaineh *et al*. (2006), Gibson *et al*. (2006), ESAP (2007) and Zewde (2007). This indicates that the NAIC is not functioning well and is consistently losing the confidence of stakeholders in the country.

There was no difference in semen motility among the regions and between the regions and the NAIC due to difference in handling. Hence, this justifies that there is no significant effect on semen motility due to handling differences. However, the low motility observed in four straws of semen obtained from region 2(SNNP) was as low as 20% on the average. The reason for this condition was believed to be that the semen was produced from 50% bulls and distributed with out demand to the region and was kept for many years with out being utilized. Similarly, the mean semen motilities for sample semen obtained from region 5 was as low as 32.5% and that of sample semen from the same bulls taken from NAIC was as low as 38%. Even though statistically significant differences ($p<0.05$) between the two was found the value for both was lower than the recommended lower values, 40% (Zewdie et al., 2005). The reason was hypothesized to be either of or a combination of two facts. The first assumption was that the center shifted from using Laiciphos to Andromed as semen extenders during the production of this particular batch. The other possible reason assumed to cause the difference was also the shifting of the long-experienced laboratory technicians by new ones during that time.

The overall mean number of services per conception was found to be 1.88 as the national average. This result is lower than the reports of Abate (2006) (2.48) but within the range reported by Bacha (2007) (1.7-2.7) and higher than the finding of Kaziboni *et al*. (2004) (1.65-1.74). The values of number of services per conception in the current study did not take in to account 152 cows (40.53% of the total sampled cows) which were found to be repeat breeders. The very high repeat breeding condition in the country is believed to be a serious problem. The problem of repeat breeders was also mentioned by farmers and hence needs to be seriously addressed. High numbers of services per conception are the results of problems associated with poor semen quality, poor semen handling practices and poor insemination practices (Macpherson, 1968; McDowell, 1972; Negussie, 1992). Other reasons were such as discontinuation of incentives to AI technicians, season of breeding, management factors in relation to estrus detection, timing of insemination and skill of pregnancy diagnosis were also indicated by other reports (Haile-Mariam, 1987; Swensson *et al*., 1981; Denbarga, 2005; Haile-Mariam *et al*., 1993; Negussie *et al*., 1998; Damron, 2000 and Shiferaw *et al*., 2003).

The difference in the number of services per conception among the five regions was significant. It was understood during the study that the NSC could have dramatically increased than the actual/obtained result if it was possible to include in the study all the cows/heifers, which were continuously being sold due to repeat breeding in many farms.

The conception rates to first inseminations in general were poor ranging from 7.14 to 40.23%. The differences for these parameters among regions were also highly significant. This is also an indicator of very low level of fertility or reproductive efficiency, which could be due to AI inefficiency among other reasons. The umber of services per conception is an indicator of reproductive efficiency/ conception rates (Albero, 1993; Bekele *et al*., 1991; Haile-Mariam *et al*., 1993; Negussie *et al*., 1998; Shiferaw *et al*., 2003).

## 6. CONCLUSION AND RECOMMENDATIONS

According to the results of this study, AI service in Ethiopia has been given little or no emphasis at the federal, regional or wereda levels during the last years though it is an important and the most widely practiced animal biotechnology all over the world. Hence, it can generally be concluded that the AI service in Ethiopia is on the verge of total collapse unless urgent corrective measures are taken. The most important constraints associated with AI in Ethiopia include loss structural linkage between AI Center and service giving units, absence of collaboration and regular communication between NAIC and stakeholders, lack of breeding policy and herd recording system, inadequate resource in terms of inputs and facilities, and absence of incentives and rewards to motivate AI technicians. The values for semen volume, concentration, live-dead percentage, fresh individual motility, and thaw motility, were within the recommended values whereas the values for morphological defects among the jersey and crossbred bulls and mass activity were not encouraging. The locomatory organs and libido of AI bulls were in general good but needs to be checked regularly and improved for some of them particularly the status of hoof problems with in the bulls. The repeat breeding situation was a very alarming finding. Similarly, the conception rates were found to be very low and discouraging at large. The source of AI bulls particularly the HF bulls is only one farm that is highly tuberculosis-infected farm amongst others, which is an obvious hazard to the AI operation in the country.

Based on the above conclusions the following are recommended:

- One national body responsible to coordinate and monitor AI service, herd recording and also livestock breeding programs needs to be established and be very well organized in human and material resources;
- Mechanisms should be devised to increase the involvement of stakeholders in the activities of AI in the country. Professional associations should critically work in close collaborations with the Ministry of Agriculture and Rural Development in formulating policies and implementation strategies;
- Selection of bulls for AI should strictly follow the standard guidelines and procedures set for the purpose and also the national livestock development policies of the country;
- The private sector should be encouraged to be involved in the AI service sector but with strict control by an active breeding policy;
- Establishment of a functional breeding policy and strategy should be given at most priority and each stakeholder and professional should work hard towards its implementation;
- Import semen of the desired quality for the immediate use in accordance with the rules and regulations for the import of genetic materials to be followed by creating reliable source of semen producing bulls through reestablishing the Milk recording Scheme of the center in a more strengthened status;

- The AI service provision should be restructured in such a way that it responds well to the breed improvement programs of the country. It should be well organized with clearly defined duties and responsibilities of stakeholders;
- Endeavors should be made to improve the current status of conception rates at large by improving the efficiency of AI and heard health;
- Establishment of cattle collection centers in selected areas in the different regional states to practice natural mating using proven bulls could be considered as an alternative to the AI;
- Further study should be conducted on assessment of the fertility levels of herds at national level.

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## 8. Annexes

Annex 1. Participants of questionnaire filling at NAIC

| SNo | Name | Department | Responsibility |
|---|---|---|---|
| 1 | Demere Fikremariam | SLNPD | Team Leader |
| 2 | Mohamed Alie | FAITED | Team Leader |
| 3 | Dr.Bula Agegnehu | SLNPD | Expert |
| 4 | Alemu Asnakew | MRAS | Expert |
| 5 | Dr. Netsanet Deneke | SLNPD | Team Leader |
| 6 | Gashaw Feleke | MRAS | Expert |
| 7 | Ashebir Abebe | SLNPD | Expert |
| 8 | Dr. Deneke H/Mariam | FAITED | Expert |
| 9 | Asya Mussa | SLNPD | Lab Technician |
| 10 | Zewdu Achamyeleh | MRAS | Expert |
| 11 | Gashaw G/Wold | SLNPD | Lab Technician |
| 12 | Hadera Gebru | FAITED | Department Head |
| 13 | Berhanu Yalew | FAITED | Team Leader |
| 14 | Keberu Belaineh | FAITED | Team Leader |
| 15 | Afework Worana | SLNPD | Lab Technician |
| 16 | Mesfin Tadesse | FAITED | Expert |
| 17 | Dr. Addis Desyalkegn | FAITED | Expert |

Annex 2. AITs who participated in the questionnaire filling

| SNo | Name | Region | Zone | Wereda |
|---|---|---|---|---|
| 1 | Shewarega Kagnew | Addis Ababa | Nefas Silk Lafto | na |
| 2 | Assefa Kidanemariam | Addis Ababa | Akaki Kality | na |
| 3 | Eyasu Ali | Addis Ababa | Bole | na |
| 4 | Hailu Mekonen | Addis Ababa | Yeka | na |
| 5 | Teklai W/Gebriel | Addis Ababa | Gulele | na |
| 6 | Zerai G/Medhin | Addis Ababa | Kolfe Keraneo | na |
| 7 | Tesema Godana | SNNP | Sidama | Dale |
| 8 | Befekadu Tafesse | SNNP | Sidama | Dale |
| 9 | Berhanu Mentre | SNNP | Awasa | na |
| 10 | Chemesa Fola | SNNP | Awasa | na |
| 11 | Dawit Amero | SNNP | Awasa | na |
| 12 | Wendimu Musse | SNNP | Awasa | na |
| 13 | Getahun shediso | SNNP | Awasa | na |
| 14 | Wube Feyisa | Oromia | Arsi | Tiyo |
| 15 | Dawit Temesgen | Oromia | Arsi | Tiyo |
| 16 | Tilahun Kopesa | Oromia | East Shoa | Ada'a |
| 17 | Melaku Hawas | Tigrai | Eastern Zone | Atsbi Wenberta |
| 18 | G/Kiros G/egziabiher | Tigrai | Eastern Zone | Atsbi Wenberta |
| 19 | Selamawit Gidey | Tigrai | Eastern Zone | Atsbi Wenberta |
| 20 | Alemat Hagos | Tigrai | Eastern Zone | Atsbi Wenberta |
| 21 | Melaku Asfaw | Tigrai | Mekelle | na |
| 22 | Hayelom Etai | Tigrai | Mekelle | na |
| 23 | Lemlem Tuemai | Tigrai | Mekelle | na |
| 24 | T/Ezgi Huluf | Tigrai | Mekelle | na |
| 25 | Etai G/Tsion | Tigrai | Mekelle | na |
| 26 | Zewdu Adera | Amhara | South Gondar | Fogera |
| 27 | Alemayehu Senbetu | Amhara | South Gondar | Fogera |
| 28 | Guadie Marew | Amhara | South Gondar | Fogera |
| 29 | Dejen Fenta | Amhara | West Gojam | BahirDar Zuria |
| 30 | G/Yohannes Zewdie | Amhara | West Gojam | na |

na= non-applicable

Annex 3. Participants of Focus group Discussions

| SNo | Name | Region | Institution | Responsibility |
|---|---|---|---|---|
| 1 | Hizikias Ketema | Addis Ababa | MoARD | Team Leader |
| 2 | Dr. Emiru Zewdie | Addis Ababa | ESAP | Executive Comm. Member |
| 3 | Dr. Tesfaye Kumsa | Addis Ababa | Private | Ex- Livestock Director, EARO |
| 4 | Wegayehu Mazengiya | Addis Ababa | OoARD | Animal Product & Market Agen |
| 5 | Abebe Jiru | Addis Ababa | OoARD | Livestock Forage Agent |
| 6 | Dejene Tadesse | Addis Ababa | OoARD | Animal Husbandry& Nu. Sup. |
| 7 | Eshetu G/Micael | Addis Ababa | OoARD | Livestock & Forage |
| 8 | Nigat Tessema | Addis Ababa | OoARD | Livestock |
| 9 | Berhanu Abitew | SNNP | S/Z/Agr. Desk | Head |
| 10 | Mulugeta Tesfaye | SNNP | BoARD | Animal Prod.expert |
| 11 | Dukale Lamisso | SNNP | Private | Livestock Consultant |
| 12 | Gizachew Amaha | SNNP | BoARD | Forage Pro.& R.M. Team Leader |
| 13 | Takele Taye | SNNP | ACA | Lecturer |
| 14 | Dr.Gebeyehu Ganga | SNNP | SARI | Livestock Director |
| 15 | Ketema Yilma | SNNP | ILRI/IPMS | Research & Dev't Officer |
| 16 | Sintayehu Yigrem | SNNP | ACA | Lecturer |
| 17 | Mulugeta Yigzaw | SNNP | BoARD | Livestock Desk Head |
| 18 | Tilahun Amejo | SNNP | Zone Agri office | Expert, Animal Husbandry |
| 19 | Dr. Azage Tegegn | ILRI/IPMS | ILRI/IPMS | Senior Animal Scientist |
| 20 | Dr. Kelay Belihu | Oromia | AAU/FVM | Associate Dean for Research& and Graduate Programs |
| 21 | Dr. Fekadu Regassa | Oromia | AAU/FVM | Lecturer |
| 22 | Mohamed Adem | Oromia | Wer. Agri office | Team leader |
| 23 | Berhanu Yalew | Oromia | NAIC/FVM | Post graduate student |
| 24 | Col. Girma Moges | Oromia | Ada'a Dairy Co | Manager |
| 25 | Medhin W/aregay | Oromia | Ada'a Dairy Co | Manager |
| 26 | Aweke Tsega | Oromia | AAU/FVM | Post graduate student |

Annex 3. Participants of Focus group Discussions **CONT…**

| SNo | Name | Region | Institution | Responsibility |
|---|---|---|---|---|
| 27 | Tsehay Reda | Land O'Lakes | Land O'Lakes | DCOP |
| 28 | Desalegn Abebaw | Oromia | AAU/FVM | Post graduate student |
| 29 | Mulugeta Neguse | Tigrai | Zone Agri.office | Head |
| 30 | Prof. S.K.Khar | Tigrai | MU | Prof.of gynae.&obstetrics |
| 31 | Dr.Etsay Kebede | Tigrai | MU | Department Head |
| 32 | Zelealem Tesfay | Tigrai | TARI | Director, An.Sc. research |
| 33 | Dr.Tesfay Belay | Tigrai | TARI | Director, Crops research |
| 34 | G/egziabiher Hagos | Tigrai | BoARD | A/Head , BoARD |
| 35 | Dr.Mulugeta Berhane | Tigrai | REST | Head, Environment & Agri. |
| 36 | Tesfamariam Assefa | Tigrai | BoARD | Animal production |
| 37 | Dr. G/Yohannes Berhane | Tigrai | IPMS/ILRI | Livestock expert |
| 38 | Girmay Murutse W/Mic | Tigrai | MU | RDO |
| 39 | Getachew Delele | Amhara | Zone BoARD | An prod |
| 40 | Ayalew Assefa | Amhara | Wer. Agri office | An prod |
| 41 | Belete Anteneh | Amhara | BoARD | Expert |
| 42 | G/Yohannes Zewdie | Amhara | Reg. AI Sub C. | AIT/ Machine Operator |
| 43 | Andargachew Gashaw | Amhara | Wer. Agri office | Expert |
| 44 | Dr.Mohamed Ali | Amhara | BoARD, AI Sub C | Repr. & Vet expert |
| 45 | Getnet Mekuria | Amhara | ARARI | Researcher |
| 46 | Dr. Mussie H/Mariam | Amhara | BU | Head, An Sc Department |
| 47 | Seid Abderkadir | Amhara | Private AIT | Private AIT |
| 48 | Mulu Moges | Amhara | BoARD | Livestock Expert |
| 49 | Degitu Alemu | Amhara | BoARD | Livestock Expert |
| 50 | Dr. Darsema Gulima | Amhara | BRVL | A/Head |
| 51 | Endris Segid | Amhara | JCCDO | Agriculture Officer |
| 52 | Tilahun gebey | Amhara | IPMS/ILRI | RDO |

Annex 4. Questionnaire used to collect information from dairy farmers

Address: Region_____, Zone ___, Woreda ___, Keble ___ Farmer ID _____

Q1. As a user of AI, do you get the service regularly and without interruptions? 1. yes 2. no

Q2. If your answer is to the above question is no, what is the reason for this?

1.because the service is not available on weekends & holidays

2.because there is shortage of AITs

3.because there is shortage of inputs

4.all of the above 5. others

Q3. How do you communicate with AI technicians?

1. AITs visit us daily 2. we call AITs when we need them 3. we take our cows to the AI station

Q4. Do you get AI service on weekends and holidays?

1. yes 2. no

Q5. If your answer to the above question is no, what do you do?

1. pass the date with out breeding the cow 2. use NM

Q6. Do you let male animals go along with the herd?

1. yes 2. no

Q7. If your cows do not conceive with repeated t inseminations, then what do you do?

1. use AI again and again b. use NM

Q8. Do you have any say in the selection of the type of semen you use?

1. yes 2. no

Q9. In relation to the above question, what factors would you use to choose the type of semen given the chance?

1. milk production 2. breed type

3. 1&2 4. others

Q10. Are you aware of the problems of inbreeding?

1. yes 2. no

Q11. If your answer is yes, give examples

Q12. Have you faced any animal health problem so far in your dairy herd? 1. yes 2. no

Q13. If your answer is yes, what problems

1. Mastitis 2. Tuberculosis 3. Problems associated with calving 4. 1&2 5. 1&3 6. All of the above 7. Others

Q14. Do you have easy access to animal health? 1. yes 2.no

Q15. Are you satisfied with the over all AI service? 1. yes 2. no

Q16. If you can be provided with reliable and regular service, would you mind raising the service charge? 1. yes 2. no

Q17. Do you have any problem in using AI service? 1. yes 2. no

Q18. If your answer is yes, what problems?

Q19. How do you evaluate the AI technician in giving you the service?

1. Cooperative 2. Non-cooperative

Q20. What are the signs of estrus you use in order to report your cows for AI service?

Q21. When should your cow, which came in heat in the afternoon, be inseminated?

Q22. When should your cow, which came in heat in the morning, be inseminated?

Q23. In relation to the above answer, what do you do if the AIT comes too late for insemination?

1. Get the service any way 2. Reject the service and wait for another 21 days 3. Use NM 4. Do not know

Name ………………………

Date ……………………….

Annex 5. Questionnaire used to collect information from AITs

Address: Region________, Zone_______, Woreda_________,

Kebelie____, AIT ID ____

Please answer the following questions precisely:

Q1. When did you start your career as AIT?

1. 1968-1978 2.1979-1988 3. 1989- 1998 4. 1999-2008

Q2. Where did you attend your training as AIT?

1. Assela 2. NAIC 3. Region

Q3. For how long did you attend your training as AIT?

1. 6 months 2. 3 months 3. 9 months 4. 2 months

Q4. How do you evaluate the quality of training?

1. V.good 2. good 3. poor

Q5. What is the method of service delivery?

1. stationed 2. daily run 3. on call basis

Q6. Do you get on- the- job trainings and other incentives?

1. yes 2. no

Q7. Is there any other technician in your area?

1. yes 2. no

Q8. If your answer to the above question is no, what happens in case you are not available due to some reasons?

1. service discontinues 2. farmers use NM

Q9. Where do you get semen?

1. regional BoARD 2. wereda BoARD 3. from NAIC directly

Q10. In relation to the above question, do you face any problem while obtaining semen

1. yes 2. no

Q11. Do you provide services on weekends and on holidays?

1.yes 2. no

Q12. If your answer to the above question is no, why not?

Q13. How do you judge the overall availability of inputs including liquid nitrogen and other consumables?

1. good 2. poor

Q14 Do you think the NAIC is carrying out its responsibilities properly?

1. yes 2. no 3. I do not know

Q15. Who does decide the type of semen/bull to be used by you for inseminating?

1. myself 2. regional/wereda BoARD 3. NAIC

Q16. Do you think there is a proper mechanism of controlling indiscriminate insemination?

1. yes 2. no 3. I don 't know

Q17. Do farmers report on time for inseminations?

1. yes 2. no

Q18. Are farmers willing to pay more for the services provided they get reliable and quality services?

1. yes 2. no 3.don't know

Q19. How do you judge the quality of semen you are getting?

1.good 2. poor, 3. do not know

Q20. Do you perform other duties/responsibilities?

1.yes 2. no

Q21. If your answer to the above question is yes, then does this type of work affect your work in AI? 1. yes 2. no

Q22. Do you get the necessary support by the BoARD and wereda agriculture office to the AI service?

1. yes 2.no

Q23. Do you generally believe that AI is doing well in your area?

1.yes 2.no 3. I do not know

Q24. What is the average number of cows you are covering per day?

1. 1-10 2. 11-20 3.21-30 4.31-40

Q25. What radius in kilometers do you cover daily to deliver the service?

1. 1-20 2. 21-30 3.31-40 4. >40

Q26. In relation to the above answer, is the distance being covered convenient for proper application of the service?

1. Yes 2. no

Q27. Which transportation system do you use?

1. stationed 2. on foot 3. motorbike 4. car

Q28. Is AI service delivery consistent in your area?

1. Yes 2. no

Q29. What do you think are the major problems associated with the AI service in your area?

Q30. Are you satisfied and happy with your job?

1.yes 2.no

Q31. What are the major signs of estrus?

Q32. Which sign is the most obvious and of practical importance?

Q33. When do you inseminate a cow, which came in heat early in the morning?

Q34. Do you have any idea on how to improve the AI service in the future?

Annex 6. Questionnaire used to collect information from NAIC technical staff
(Animal Production and animal Health only)

Q1. Is there a responsible body at national level to coordinate the AI service? 1.yes 2. no 3. I do not know

Q2. Do you think it is essential to have a nationally responsible organization to technically coordinate the service?
1. yes 2. no 3. I do not know

Q3. If your answer to the above is yes, why?

Q4. If your answer to the above is no, why not?

Q5. Is there a national breeding policy that guides the AI service in general and the distribution of semen in particular in the country?
1. yes 2. no, 3. I do not know

Q6. Is there appropriate collaboration and communication among the NAIC, regional BoARD and other stakeholders with regard to the AI service?
1.yes 2. no 3. I do not know

Q7. Is there any major problem hindering the AI service at national level?
1. yes, 2. no 3. do not know.

Q8. What is the possible reason for the above question?

Q9. Do you think that AI service is doing properly at national level at present?
1. yes 2. no 3. do not know

Q10. If your answer to the above question is yes, why?

Q11. If your answer to question 9 is no, why not?

Q12. What are the sources of AI bulls at present and how are they obtained?

Q13. Do you think that bull selection and management at NAIC is being done according to recommended procedures?
1. yes 2. no, 3. I do not know

Q14. If your answer to the above question is yes, please justify

Q15. If your answer to question 13 is no, please justify

Q16. Do you believe that semen production and processing at NAIC is according to recommended procedures to prove quality and at the maximum precaution to prevent the disseminations of reproductive diseases?

1. yes 2. no 3. do not know

Q17. If your answer to question 16 is yes, give reason

Q18. If your answer to question 16 is no, give reason

Q19. Do you believe that there is an appropriate mechanism of controlling indiscriminate inseminations?

1. yes 2. no 3. I do not know

Q20. How many times do you collect semen per week per bull (for Semen lab staff only)

1.once 2. twice 3.three times

Q21. Do you regularly and appropriately check bulls for reproductive diseases?

Q22. If your answer to the above question is no, why not?

Q23. Do you exercise andrological examinations regularly?

1. yes 2. no 3. I do not know

Q24. What do you think are the major problems/constraints hindering the activities of the center?

Q25. Do you have any idea of improving the work of AI service in the future?

Annex 7. Issues presented for focus group discussion

(The issues listed below, 1-14, are in relation to the assumed and responsibilities following them)

Q1. Is there a functional and effective responsible body at regional level
1.yes 2.no 3. unknown

Q2. Is there a functional and effective responsible body at wereda level
Is it necessary to have a national responsible body to coordinate the AI services?

Q3. Is it necessary to have a national responsible body to coordinate the AI services?
1.yes 2.no 3. unknown

Q4. Is there any control mechanism employed in your region to evaluate semen for quality in terms of health, reproduction, etc?
1.yes 2.no 3. unknown

Q5. Is the semen obtained from NAIC believed to be of the desired quality?
1.yes 2.no 3. unknown

Q6. Is it important to have a national breeding policy in place soon to assist the AI service?
1.yes 2.no 3. unknown

Q7. Is there a strong collaboration between the NAIC and your regional or wereda BoARD and other stakeholders?
1.yes 2.no 3. unknown

Q8. Is there a proper mechanism of controlling indiscriminate inseminating?
1.yes 2.no 3. unknown

Q9. Are there any problems regarding the AI service as regards to the NAIC?
1.yes 2.no 3. unknown

Q10. Are there any problems regarding the AI service with regard to the BoARD in your region?1.yes 2.no 3. unknown

Q11. Is AI doing well in your area in general terms?
1.yes 2.no 3. unknown

Q12. Is the AI service a success at national level in general and in your area in particular?
1.yes 2.no 3. unknown

Q13. What are the major problems associated with AI in your area in particular and in the country in general?

Q14. Is there any idea on how to improve AI service in the future?

Annex 8. Major duties & Responsibilities of the major stakeholders of the AI service

A. National Artificial Insemination Center

- Coordinate & lead the overall AI operations & maintain a uniform strategies for implementation at national level
- Prepare policies & strategies on livestock improvement and work for their implementations following their approvals by the government
- Produce & secure semen of high quality standards. Regulate their distributions & utilization procedures all over the country to control indiscriminate cross breeding. Maintain uniform recording systems on the AI operations
- Appropriate utilization of the full participation of stakeholders with clear share of responsibilities amongst the parties
- Appropriate recruitment of semen producing bulls/record based progeny testing, work on establishing milk recording/herd registration schemes in collaboration with regions
- Appropriate record keeping on farms used as sources of AI bulls including in regions
- Work very closely with regions, render technical and professional supports to them
- Train AI technicians, provide regular in-service trainings /refreshment trainings and incentive mechanisms to them
- Provide maximum care to protect the dissemination of contagious diseases that can be transmitted through semen/artificial insemination
- Monitoring evaluation of the over all AI service operation in the country

B. Regional Bureaus of Agriculture and Rural Development

- Provide full supports to the AI service in general
- Work in close collaborations with NAIC and other stakeholders so as to optimize the service delivery & outputs; maintain appropriate implementation strategies
- Play its role in securing semen & LN2 at all times for the AITs
- Make sure that appropriate budget for the service & for the AITs is maintained; make sure that the service is given due attention in their respective regions
- Make sure that trainings to AITs and service beneficiaries are regularly delivered
- Maintain career structure and incentives to AITs
- Make sure that the field AI service goes smoothly & take timely corrective measures when problems occur
- Suggest on bull recruitment & follow-ups
- Assure the maintenance of appropriate record keeping
- Overall monitoring & evaluation of the AI operations in their respective regions

C.Wereda Bureaus of Agriculture and Rural Development

- Has role in securing semen & LN2 at all times for the AITs
- Has role in fulfilling logistics for field operation
- Has role in maintaining appropriate budget for the service & for the AITs
- Make sure that the field AI service goes smoothly & take timely corrective measures when problems occur
- Has role in the preparation & implementation of career structure and incentives mechanisms to the AITs
- Has role in the process of AITs training
- Appropriate bridging b/n the AITs & BoARD
- Has role in farmers' training & related issues
- Has role in maintaining records/necessary information on the AI service and communicating with relevant stakeholders …

Annex 9. Evaluation of bulls used for semen collection at NAIC

| Bn | Bd | Br | Or | Source | Sp | Se | Ls | Testicular measurements | | | | | | Mo | Service behavior(1-4;1=very good | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | T.length | | T.width | | Sc | Sy | | | | |
| | | | | | | | | RT | LT | RT | LT | | | | Libido | EI. | Mounting |
| 10-005 | 9/9/2000 | HF | HLBDF | HLBDF | 2 | 55 | 3 | 13 | 13 | 6 | 6 | 40 | 1 | 2 | 1 | 2 | 2 |
| 10-141 | 162/2003 | HF | HLBDF | HLBDF | 2 | 25 | 2 | 14 | 14 | 7 | 7 | 40 | 1 | 2 | 1 | 2 | 1 |
| 10-144 | 30/6/2002 | HF | HLBDF | HLBDF | 2 | 25 | 2 | 14 | 14 | 8 | 8 | 43 | 1 | 2 | 1 | 3 | 2 |
| 10-154 | 15/4/2003 | HF | HLBDF | HLBDF | 2 | 25 | 2 | 14 | 14 | 7 | 7 | 40 | 1 | 2 | 1 | 2 | 1 |
| 10-164 | 9/5/2004 | HF | HLBDF | HLBDF | 2 | 17 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 1 |
| 10-165 | 23/2/2004 | HF | HLBDF | HLBDF | 2 | 17 | 2 | 10 | 10 | 7 | 6 | 38 | 1 | 2 | 1 | 2 | 2 |
| 10-168 | 24/11/2004 | HF | HLBDF | HLBDF | 2 | 4 | 2 | 12 | 12 | 7 | 7 | 38 | 1 | 2 | 1 | 2 | 1 |
| 10-170 | 26/9/2004 | HF | HLBDF | HLBDF | 2 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 1 |
| 10-171 | 13/12/2004 | HF | HLBDF | HLBDF | 2 | 4 | 2 | 12 | 12 | 7 | 7 | 39 | 1 | 2 | 1 | 2 | 1 |

Bn= bull number, Bd= birth date, Br= breed, HF=Holstein Friesian, Or =origin, HLBDF= Holeta bull Dam Farm, S= source, Sp= selection procedure(2= farm's own information), Se= service period in months, Ls= locomatory status( 1=very good, 2= good, 3= poor), RT= right testicle, LT left testicle, Sc= scrotal circumference, Sy= symmetry (1-3; 1=Symmetrical,2=minor deviation), Mo= movability of testicles(1-3; 1= very good, 2= good,3= ), Li= libido, EI= erection and intromission.

Annex 9- Evaluation of bulls used for semen collection at NAIC **Cont…**

| Bn | Bd | Br | Or | Source | Sp | Se | Ls | Testicular measurements | | | | | | Mo | Service behavior(1-4;1=very good | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | T.length | | T.width | | Sc | Symmetry | | Libido | Erection & Intromission. | Mounting |
| | | | | | | | | RT | LT | RT | LT | | | | | | |
| 10-172 | 26/12/2000 | HF | HLBDF | HLBDF | 2 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 1 |
| 11-132 | 27/3/2000 | JE | WJF | WJF | 2 | 54 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 1 |
| 11-133 | 5/5/2000 | JE | WJF | WJF | 2 | 54 | 2 | 11 | 12 | 7 | 6 | 41 | 1 | 2 | 1 | 1 | 1 |
| 11-134 | 1/9/2000 | JE | WJF | WJF | 2 | 53 | 2 | 13 | 13 | 8 | 7 | 43 | 1 | 2 | 1 | 1 | 1 |
| 11-157 | 4/9/2003 | JE | HLBDF | HLBDF | 2 | 25 | 2 | 12 | 12 | 7 | 7 | 39 | 1 | 2 | 2 | 1 | 1 |
| 11-167 | 2/10/2003 | JE | HLBDF | HLBDF | 2 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 2 |
| 50-138 | 12/8/2003 | HF*L | HLBDF | HLBDF | 2 | 28 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 2 |
| 75-002 | 15/6/2000 | HF*L | HLBDF | HLBDF | 2 | 53 | 3 | 11 | 11 | 7 | 77 | 38 | 1 | 2 | 2 | 2 | 2 |
| 75-114 | 5/5/2002 | HF*L | ILRI | ILRI | 2 | 28 | 2 | 12 | 12 | 7 | 7 | 40 | 1 | 2 | 2 | 1 | 1 |

Annex 10. Semen evaluation at NAIC

| Bull No | Volume (ml) | Color | Concent. (density) | Mass activity | Individual sperm motility | | | | | Morphology | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | fresh | Prefreez (4°c) | Post freez (-140°c) | 24 hrs (-196°c) | At dispatch | live cell% | Major defects % | Total defects % |
| 10-005 | 16 | 1 | 1.2 | 2 | 47 | Nd | Nd | Nd | 40 | 71 | 1.6 | 17 |
| 10-141 | 8.7 | 1 | 1.3 | 4 | 80 | 80 | 60 | 60 | 70 | 76 | 2 | 12 |
| 10-144 | 8 | 1 | 1.3 | 3.9 | 76 | 75 | 65 | 63 | 50 | 75 | 6 | 18 |
| 10-154 | 9.5 | 1 | 0.9 | 2.8 | 75 | Nd | Nd | Nd | 50 | 71 | 9 | 10 |
| 10-164 | 8.3 | 5 | 1.4 | 4 | 80 | 77 | 60 | 60 | 60 | 73 | 1 | 4 |
| 10-165 | 8.5 | 3 | 1.3 | 3.8 | 75 | 70 | 60 | 60 | 40 | 76 | 2 | 7 |
| 10-168 | 10.3 | 2 | 1.5 | 3.7 | 75 | Nd | 60 | 60 | 45 | 80 | 0.1 | 3 |
| 10-170 | 6.7 | 2 | 1.9 | 3 | 75 | 75 | 57 | 57 | 50 | 80 | 1 | 6 |
| 10-171 | 6 | 2 | 1.9 | 4 | 78 | 78 | 55 | 55 | 50 | 82 | 0.009 | 0.03 |
| 10-172 | 6.7 | 2 | 1.3 | 3.3 | 78 | 78 | 60 | 60 | 70 | 75 | 0 | 8 |
| 11-132 | 6 | 2 | 1.6 | 3.4 | 75 | Nd | Nd | Nd | 65 | 72 | 3 | 24 |
| 11-133 | 5 | 2 | 1.2 | 3.7 | 78 | 78 | 57 | 57 | 50 | 73 | 1 | 23 |
| 11-134 | 4.7 | 1 | 1.2 | 3.5 | 77 | 77 | 57 | 53 | 50 | 77 | 2.9 | 20 |
| 11-157 | 6.7 | 1 | 1.1 | 3 | 75 | 75 | 48 | 47 | 40 | 70 | 8 | 8 |
| 11-167 | 6 | 1 | 1.1 | 3.3 | 73 | 70 | 50 | 50 | 40 | 80 | 18 | 19 |
| 50-138 | 4.3 | 2 | 1.8 | 3.7 | 78 | 78 | 57 | 57 | 50 | 74 | 6 | 6 |
| 75-002 | 9.7 | 4 | 0.5 | 2 | 73 | Nd | Nd | Nd | 40 | 73 | 2 | 12 |
| 75-114 | 10 | 2 | 1.4 | 2.7 | 72 | 72 | 53 | 50 | 40 | 82 | 2 | 22 |

Colors= 1=milky; 2=creamy; 3=bloody; 4= watery; 5=yellow
Nd= not done

Annex 11.  Format used during Pregnancy diagnosis works

Region _______wereda ________kebele ________

| SNo | Cow ID | Breed | # of services | Last date of Insem. | Bull used (bull ID) | PD result (+ / - ) | Remarks |
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Annex 12. Semen motility evaluation

| S.No | Region | Bull No(ID) | Sperm motility (%) |
|---|---|---|---|
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Annex 13. Evaluation of AI technicians

| S.No. | Code of AIT | Service years | Capacity in record keeping | Knowledge of signs of estrus | Knowledge in timing of insemination | Motivation |
|---|---|---|---|---|---|---|
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Annex 14. Codes used for the classification of study areas

| Region | | Zone | | Wereda | | Remarks |
|---|---|---|---|---|---|---|
| Name | Code | Name | Code | Name | Code | |
| Addis Ababa | 1 | Nefas Silk Lafto | 11 | | | All weredas considered |
| | | Akaki Kality | 12 | | | |
| | | Bole | 13 | | | |
| | | Yeka | 14 | | | |
| | | Gulele | 15 | | | |
| | | Colfe Keranio | 16 | | | |
| SNNP | 2 | Sidama | 21 | Dale | 211 | |
| | | Awasa | 22 | | | All weredas considered |
| Oromia | 3 | Arsi | 31 | Tiyo | 311 | |
| | | East Shoa | 32 | Ada'a | 312 | |
| Tigrai | 4 | Eastern | 41 | Atsbi-Wenberta | 411 | |
| | | Mekelle | 42 | | | All weredas considered |
| Amahara | 5 | South Gondar | 51 | Fogera | 511 | |
| | | West Gojam | 52 | Bahir Dar Zuria | | |
| | | Bahir Dar | 53 | Bahir Dar | | All weredas considered |

Annex 15. Assessment of bulls at NAIC

Source:

| | |
|---|---|
| Holeta dairy farm | 1 |
| Welaita dairy farm | 2 |
| ILRI | 3 |

Locomatory situations:

| | |
|---|---|
| Very good | 1 |
| Good | 2 |
| Poor(Hoof problem) | 3 |

Libido:

| | |
|---|---|
| Very good | 1 |
| Good | 2 |
| Adequate | 3 |
| Poor | 4 |

Erection & intromission:

| | |
|---|---|
| Very good | 1 |
| Good | 2 |
| Adequate | 3 |
| Poor | 4 |

Mounting:

| | |
|---|---|
| Very good | 1 |
| Good | 2 |
| Adequate | 3 |
| Poor | 4 |

Annex 16. Assessment of semen quality evaluation

Color:

| | |
|---|---|
| Milky | 1 |
| Creamy | 2 |
| Bloody | 3 |
| Watery | 4 |
| Yellowish | 5 |

Mass activity:

Scores were given based on:

| | |
|---|---|
| Very poor | 1 |
| Poor | 2 |
| Good | 3 |
| Very good | 4 |
| Excellent | 5 |

Evaluation of live and dead sperms& morphology of spermatozoa:

A. Live and dead sperm evaluation using Eosin-Nigrosin staining

1. From solution of Eosin 5% and Nigrosin 10%, 3and 5 drops respectively are taken and mixed in a small glass test tube maintained in a water bath at 34$^{o}$c
2. Two drops of mixed stain and a small drop of semen are taken on a pre-warmed slide and mixed gently

3. Two smears are prepared and allowed to dry in the air
4. Random fields (diagonally)are counted over the slides to obtain a representative figure
5. A maximum of 333 sperms are counted to find out the percentage of live sperm using the following formula:
   Number of live sperms counted ×3/10 = % live sperms; it should be noted that if a part of the sperm, for example the nucleus, is stained or takes the stain, then it is counted as dead.

B. Morphology of spermatozoa

Wet smear method (using formal saline):

1. Semen is diluted at 1:10-1:15 rate(high concentration) and semen of low concentration at 1:1-1:2 rate with formal saline solution kept in small tube(sugar tube) maintained at 34 $^{o}$c in water bath
2. A small drop of the diluted semen is placed on a clean slide and it is covered with a cover slip.
3. The different fields are studied under oil immersion microscope and individual sperm defects are recorded (for major and minor sperm defects)
4. A minimum of 200-500 sperms are counted from different fields and types of sperm abnormalities are recorded. Samples having more than 20% of total abnormalities are discarded.

Some of the common sperm defects

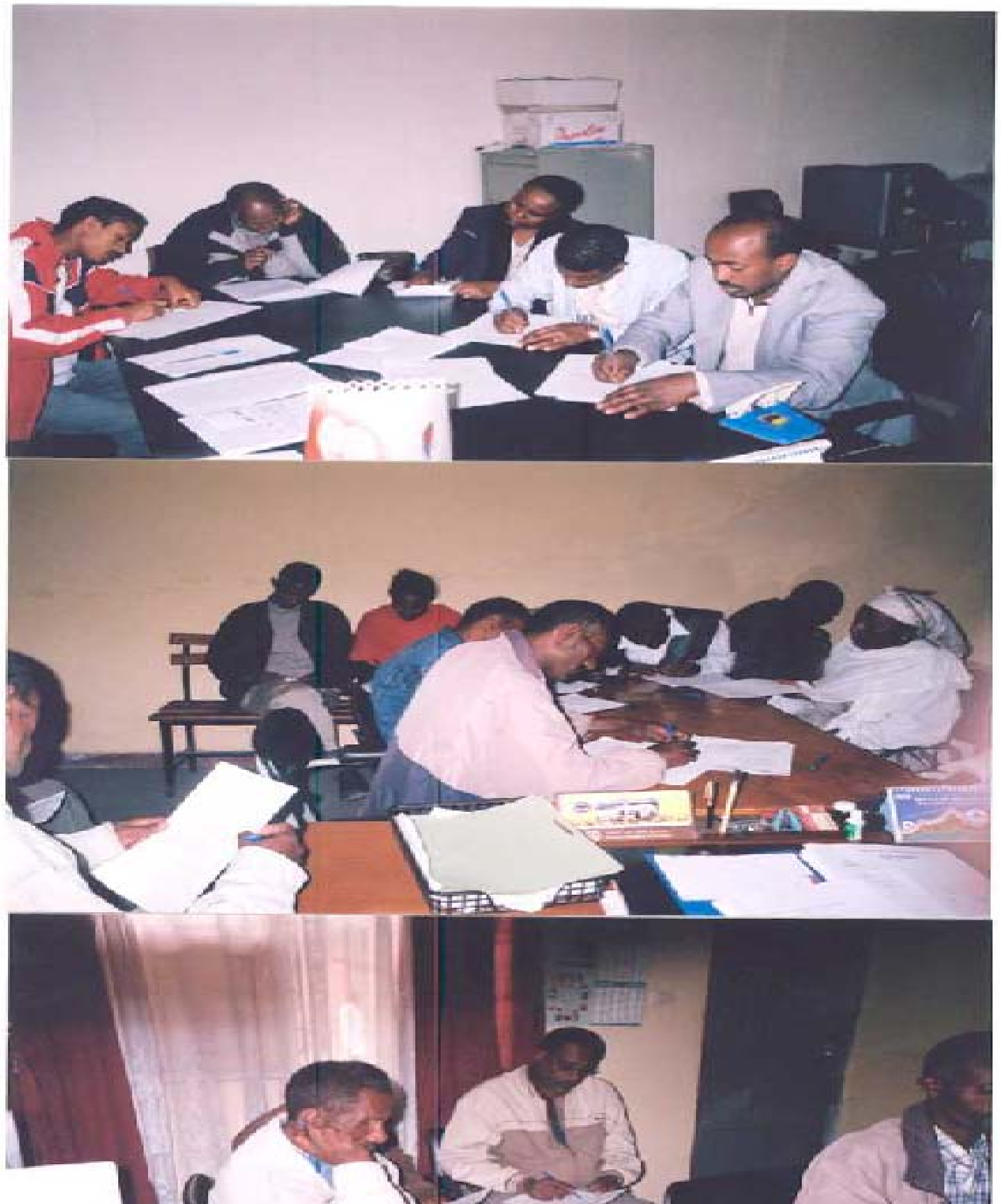
| S No | Major sperm defects | Minor sperm defects |
|---|---|---|
| 1 | Double forms | Proximal droplet |
| 2 | Pear-shaped head | Bent tail |
| 3 | Abnormal contour | Terminally coiled tail |
| 4 | Small abnormal head | Abaxial implantation |
| 5 | Detached abnormal head | Detached normal head |
| 6 | Acrosome defect | Small normal head |
| 7 | Middle piece defect, tail stump | Giant broad head |
| 8 | Strongly folded tail stump | Distal droplet |
| 9 | Hairpin | |
| 10 | Corkscrew defect | |
| 11 | Narrow at the base | |
| 12 | Diadem effect | |

Annex 17. Different photos taken during the study

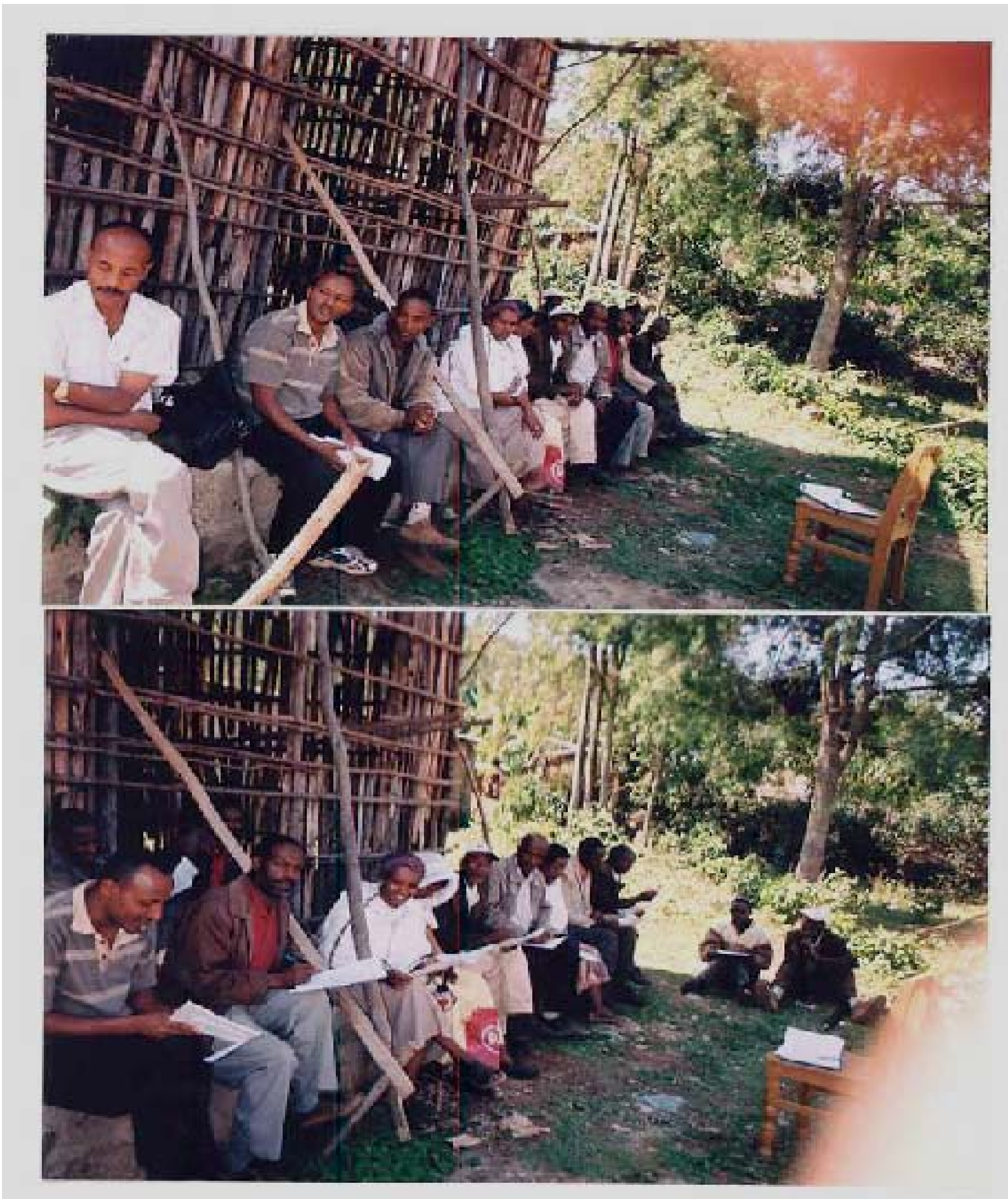
Bulls preparation for semen collection at NAIC

Semen analysis in progress at NAIC semen Laboratory

Partial view of Pregnancy diagnosis in progress

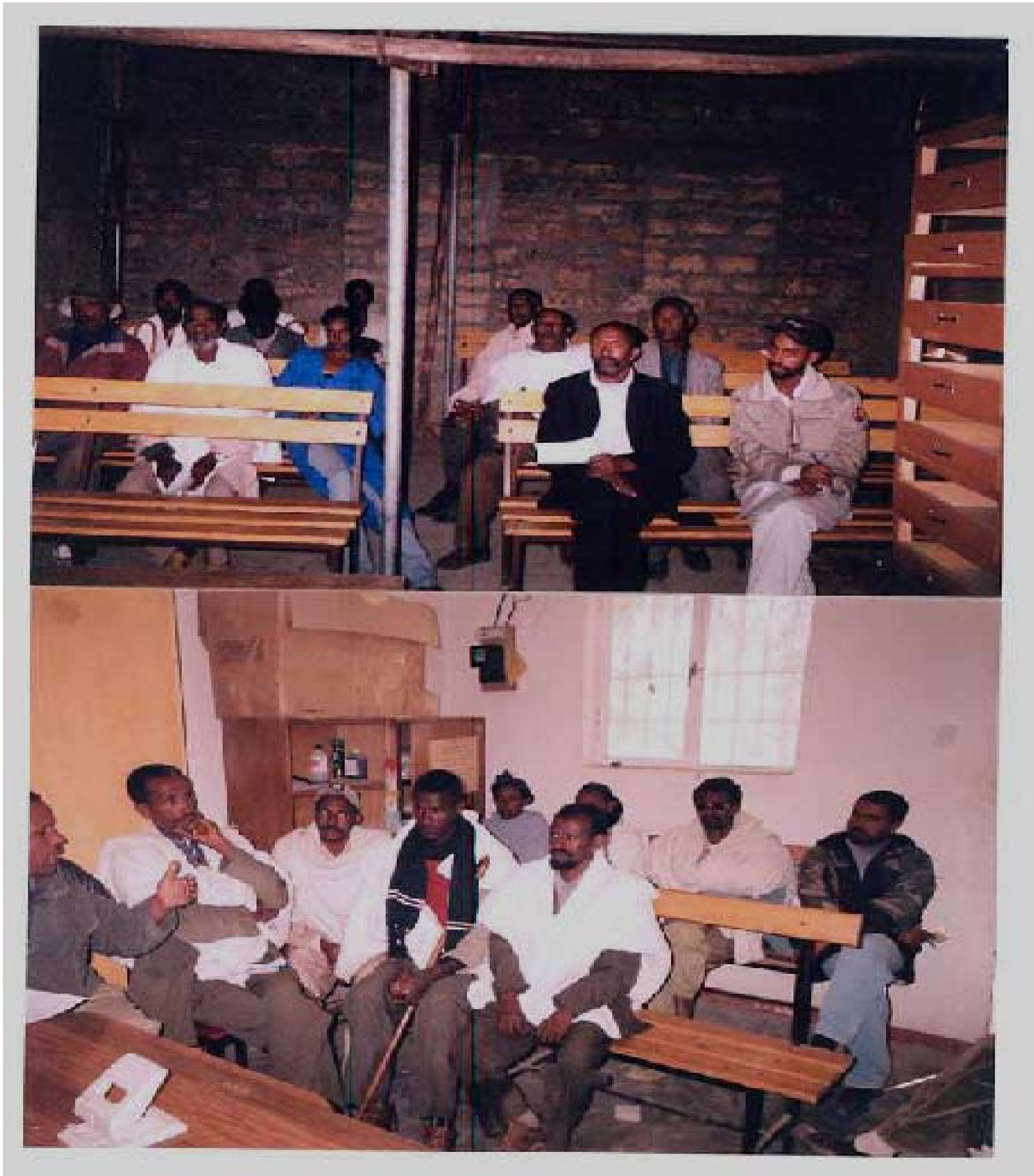


Partial view of questionnaire filling in progress in Addis Ababa Region



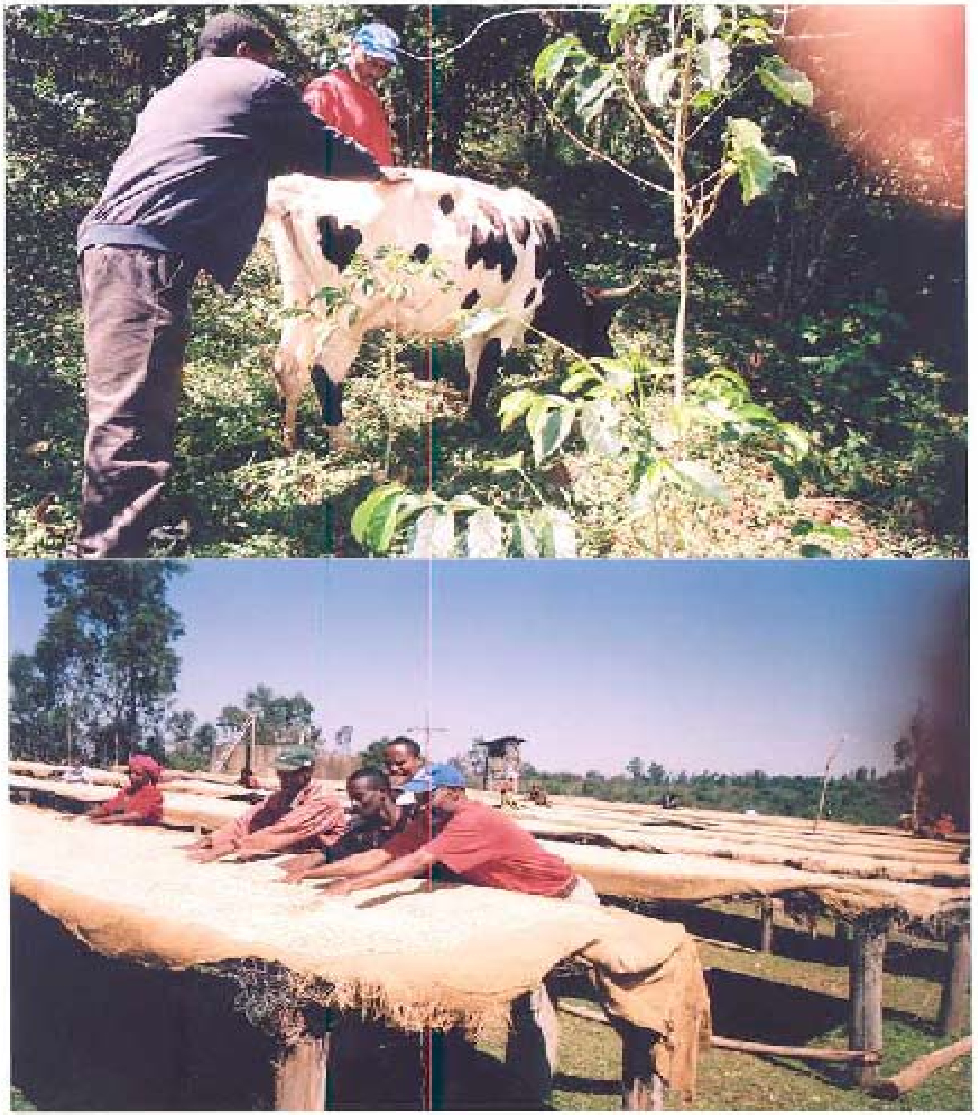
Partial view of questionnaire filling in progress in SNNPR

Partial view of questionnaire filling in progress in Oromia Region

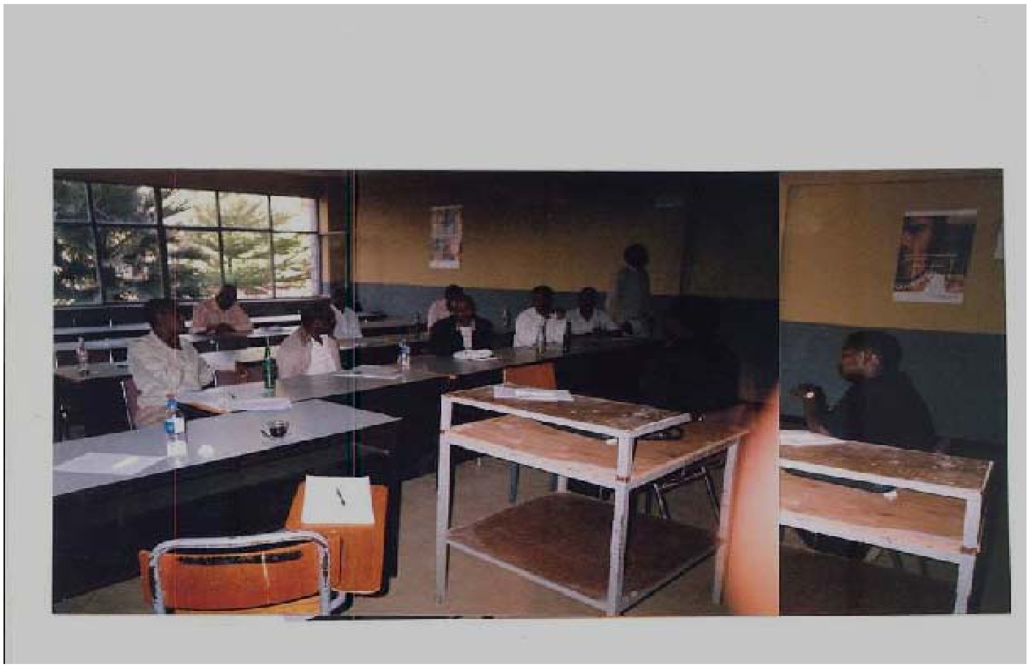


Questionnaire filling in progress in Tigrai Region

Partial view of questionnaire filling in progress in Amhara region



A farmer involved both in Dairying and in coffee production, in Dale wereda



Partial view of focus group discussion session in SNNPR

Partial view of focus group discussion session in Oromia Region

Partial view of focus group discussion in Amhara Region

## 9. CURRICULUM VITAE

A. Personal Details

| | |
|---|---|
| Name: | Desalegn G/Medhin |
| Date of Birth: | July 4, 1963 |
| Place of Birth: | Mekelle, Ethiopia |
| Sex: | Male |
| Marital Status: | Married |
| Language: | Tigrigna, Amharic, English |
| Contact Address: | Mob. - 091-112 8937 |
| | Office - 011-439 3234 |
| | P. O. Box No. 29493, Addis Ababa/Ethiopia |
| | E-mail desalegn_gm@yahoo.com |

B. Educational Background

| | |
|---|---|
| 1. Elementary School | Meserete Elementary School, Mekelle, Sep.1971-June1976 |
| 2. Junior Secondary School | Mekelle Junior Secondary School, Sep.1976-June1978 |
| 3. High School | Atse-Yohannes Comp. Sec. School, Mekelle Sep.1979 – June 1983 |
| 4. University | Alemaya University<br>BSc in Animal Sciences<br>Sep. 1983 – July 1987<br>Addis Ababa University, Faculty of Veterinary Medicine<br>MSc in Animal Health and Production<br>Sep.2006- July 2008 |

C. Skills

Using computer

Livestock-related project preparation

Livestock-related consultancy works

Clean driving license (3rd grade)

Good football coaching experience with grade one coaching certificate

Able to cop under pressure

D. Training

| | |
|---|---|
| 1. Livestock Data Collection and Management | International Livestock Research Institute(ILRI), Debre Zeit Station<br>Jan. 25 – Feb. 3, 1995 |
| 2. Computer | Ministry of Agriculture, MIS & Data Processing Dep't (1998) |

MS – Dos

MS – Windows

MS – Word

MS – Excel

MS – Access

| | |
|---|---|
| 3. Management Information Systems | Ethiopian Management Institute, Debre Zeit<br>Oct. 19 – 30, 1998 |
| 4. Study Tour | National Dairy Development Board, Anand, India<br>Jan. 31 – Feb. 16, 1999 |

| | |
|---|---|
| 5. Artificial Insemination and Dairy Cattle Management | National AI Center (by guest lecturers from Israel), Oct. 4 – 15, 1999 |
| 6. Udder Health, Hygiene and Milk Quality | Swedish University of Agricultural Sciences (SLU), Sweden<br>March 8 – May 17, 2000 |
| 7. Leadership Skills | Ethiopian Management Institute, Debre Zeit<br>Sep. 17 – 21, 2001 |
| 8. Dairy Production and Processing Technology | Delivered by the Government of the State of Israel (MASHAV) at Holeta Agricultural Research Center<br>November 4 – 14, 2002 |
| 9. General Management | Ethiopian Management Institute, Debre Zeit<br>Oct. 20 – 31, 2003 |
| 10. Research Methods | International Livestock Research Institute (ILRI)<br>June 3-5, July 7-8, 2008 |

E. Work Experience

| | |
|---|---|
| 1. Unit Head, Adamitulu, and Abernosa Cattle Breeding & Improvement Ranch (Ministry of Agriculture) | Sep. 1987 – Aug. 1989 |
| 2. Manager, Adamitulu and Abernosa Cattle Breeding & Improvement Ranch | Sep. 1989 – Oct. 1991 |

| | |
|---|---|
| 3. Member of a team in the re-establishment of Agricultural Bureau and Agricultural Offices and performing related activities in Tigrai Region | Mekelle<br>Oct. 1991 – Feb. 1992 |
| 4. Expert, National AI Center | July 1992 – May 1998 |
| 5. Head, Milk Recording & Analysis Service (National AI Center) | June 1998-August 2006 |

F. Consultancy and Project Planning

| | |
|---|---|
| 1. Served as a member of a team to assess and Produce a project on restrengthening of the Agarfa & Ardaita Dairy Farms | Ministry of Agriculture<br>April 1999 |
| 2. Modern Dairy Farms Establishment Projects in Addis Ababa (two projects) | Feb. 1998 and Aug. 2001 |
| 3. Dairy Cattle Breeding & Improvement (project and action plan on integrated urban, peri-urban, and rural dairy development programme in Tigrai Region) | Relief Society of Tigrai (REST) Mekelle, 2001 |
| 4. Assessment of the causes and the impact of wild fire on the social and physical environment in Kucha wereda, Gamogofa Zone (one of a team of three Professionals) | Ethiopian Rural Self Help Association (ERSHA) Addis Ababa, April 2002 |

5. Member of a team (one of three members) in the evaluation of six Technical, Vocational, Education and Training (TVET) Colleges for recognition as 10 + 3 training colleges — Ministry of Education, July 18 – August 9, 2004

6. National Consultant: — FAO Representative in Ethiopia, Division CP/ETH/060/BEL, Order number FAO/ADM/44/06, Aug.16, 2006-Sep.14, 2006

G. Teaching Experience

Actively participated in the training of:

- Development agents — Tigrai Regional Bureau of Agriculture, Mekelle, Mar. – June 1992
- Artificial Insemination technicians — National AI Center in different years since 1994
- Farmers — In different years form 1994 - 2002 (in different regions).

H. Publications

Productivity and Reproductively performance of some of the milk recorded herds (Co-authored). National AI Center, June 1994.

Production and Reproduction performances comparison for the 5 milk recorded dairy farms(1993/1994 fiscal year). National AI Center, July 1994

GebreMedhin D. (2005): Leadership Skills (training manual in Amharic). National Artificial Insemination Center, Addis Ababa, Ethiopia. Nov. 2004

GebreMedhin D. (2005): LP – System and its application for the preservation of raw milk with special emphasis to the Ethiopian situation (manual). Ethiopian Science and Technology Commission, Addis Ababa, Ethiopia. Oct. 2005.

GebreMedhin D. (2005): All in One: A Practical Guide to Dairy Farming (123 pages). Agri-Service Ethiopia Printing Press, Addis Ababa, Ethiopia. June 2005.

I. Professional Association Membership

- Member of the Ethiopian Society of Animal Production (ESAP) — Since 1992
- Served as an Executive Committee member (ESAP) — Aug. 2001 – Aug. 2003
- Served as executive committee member (ESAP) for a second term — Aug. 2003 – Aug. 2005
- Member of Ethiopian Veterinary Association (EVA) — Since June 2007

J. Others

| | | |
|---|---|---|
| 1 | Grade one Coaching Certificate (Football) | Sports Commission,<br>Feb. 22 – Mar. 14, 1982 |
| 2 | Grade 3 driving license | Mar. 1992 |
| 3 | Grade 1 riding license (motorbike) | Mar. 1992 |

**10. Signed declaration sheet**

I, the undersigned declare that this thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

**Name** **DESALEGN GEBREMEDHIN GEBREEGZIABIHER**

**Signature** ______________________________

**Date** **July 14, 2008**