Global Journal of
Reproductive Medicine
ISSN: 2575-8594

Review article
Volume 6 Issue 5 - July 2019
DOI: 10.19080/GJORM.2019.06.555700

Glob J Reprod Med


# A Review on Artificial Insemination of Cattle in Ethiopia

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**Submission:** June 10, 2019; **Published:** August 14, 2019

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**Abstract**

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. The first successful AI was performed in Italy in 1780 and over 100 years later, in 1890, it was used for horse breeding. In Ethiopia, AI was introduced in 1938 in Asmara, then part of Ethiopia, which was interrupted due to the Second World War and restarted in 1952.

AI has many advantages including prevention of reproductive diseases, control of inbreeding, minimizing the cost of keeping bulls for natural service and others, however, it has disadvantages such as 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.

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 and later on progeny testing and general health status should also be parts of the selection criteria. Appropriate and specialized facilities, equipment's, 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.

Standard semen collection procedures normally include sexual stimulation and sexual preparation. Semen has been collected in a number of ways like recovery, massage, vaginal insert and electro ejaculation and the methods of collection are governed by the intended purpose for future use. In the cow, maximum fertility has been achieved if inseminated from mid estrus to the end of estrus. Fertility rate 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. Generally, AI service in Ethiopia has been given little or no emphasis though it is an important and the most widely practiced animal biotechnology all over the world.

**Keywords:** AI; cow; Ethiopia; semen

## Introduction

The total cattle population for the rural sedentary areas of Ethiopia is estimated to be 43.12million, of which 55.41% are females. 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. 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 [1].

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 [2].Cattle breeding are mostly uncontrolled in Ethiopia making genetic improvement difficult and an appropriate bull selection criterion have not yet been established, applied and controlled [3]

Although, artificial insemination, the most commonly used and valuable biotechnology, [4]. has been in operation in Ethiopia for over 30 years, the efficiency and impact of the operation has not been well-documented [5]. Reproductive problems related to crossbreed dairy cows under farmers' conditions are immense

[6]. It is widely believed that the AI service in the country has not been successful to improve reproductive performance of dairy industry [7]. The problem is more aggravated by wrong selection and management of AI bulls along with poor motivations and skills of inseminators [8].

A successful breeding program requires an effective and sustainable method of transferring genetic materials from one population to another. This can be performed through either natural service (NS) or reproductive technologies including artificial insemination (AI), embryo transfer, invitro maturation and fertilization and cloning. However, AI is the most practical reproductive technology to be used in developing countries [1]. Therefore, the objective of this paper is to review the available literatures and provide integrated information on history of AI, advantages and disadvantages of AI, recruitment of semen producing bulls, Semen collection and assessment of ejaculates, and application of AI of cattle.

## Artificial Insemination of Cattle in Ethiopia

### Cattle production in Ethiopia

Ethiopia has an estimated cattle population of about 41.5 million heads. 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 [9]. It is known that not 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. Therefore, improvement on the indigenous cattle for productivity without losing traits, which are essential for survival, has been proposed [10].

### 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 [4]. 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 [11].

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. Using the long-accepted standard of 10 x 106 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 x 1012 total sperm.

By using sexual stimulation and more frequent collections, many sperm have been obtained from most bulls in a year without adversely affecting conception rate [11]. The use of AI in Ethiopia is growing but estrus detection is difficult owing to poorly expressed estrus of Zebu breeds. The short duration and low intensity of estrus signs in Ethiopian Zebu cattle caused most estrus detection failures which indicate a need for the use of current advances in AI such as estrus synchronization [12].

**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 [13]. In Russia, however, the method was first taken up seriously as a means of improving farm animals [14]. According to the history of AI is interesting in that old Arabian documents dated around 1322 A.D [4]. 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. 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 horses, cattle and sheep, and was apparently the first to successfully inseminate cattle artificially. Mass breeding of cows via AI was first accomplished in Russia where 19,800 cows were bred in 1931 [2]. Denmark was the first European country to establish an AI cooperative association in 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 [15]. 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. 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, then part of Ethiopia, which was interrupted due to the Second World

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War and restarted in 1952 [16]. 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 Arsi Region, Chilalo Awraja under the Swedish International Development Agency (SIDA). [17]. 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.

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. 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

**Advantages and disadvantages of artificial insemination:** The worldwide scale and importance of the artificial insemination industry in cattle breeding are beyond question [18]. 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 [4]. The author further showed that AI usage enabled one dairy sire to provide semen for more than 60,000 services in one year 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 [19]. 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 [7].

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. Other disadvantages include high cost of production (collection and processing), storage and transport of semen as well as budget and administrative problems and inefficiency of AITs

## 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, and general health status should also be parts of the selection criteria [20]. Recruitment of bull Calves for the purpose of semen production must be free from a known contagious disease. Bulls selected for AI have been shown to transmit to their offspring the genetic potential for well-above-average milk or meat production. 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 [21].

**Bull health control:** Disease prevention in bulls has been considered as essential as in breeding females 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. 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 [22]. 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 [20].

The frequency of tests made, and the diseases tested at NAIC are not sufficient [23]. 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 [23].

## Semen collection and assessment of ejaculates

Semen collection has been considered like harvesting any other farm crop since effective harvest of semen involves obtaining the maximum number of sperms 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 [11]. 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. The success of AI depends on the collection of a relatively large numbers of potentially fertile spermatozoa from genetically superior sires [24].

**Facilities needed for semen collection:** The routine collection of semen for AI in dairy and beef bulls is by using artificial vagina. 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


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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 [11].

Appropriate and specialized facilities, equipment's, 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. The area for semen collection has been preferred clean, relatively quiet 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 [24].

**Procedure for collection of semen from the bull:** Standard semen collection procedures normally include sexual stimulation and sexual preparation [21].

a) Sexual stimulation: Providing a stimulus situation that elicits mounting behavior in the bull is termed "Sexual Stimulation" .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 [21].

b) 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 [25].

c) 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. The following various methods have been used in collection of semen [26].

**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 overcome 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 [26].

a) 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 [26].

b) Vaginal insert: Consists of a tapered insert with a flange on the end that may be placed in the vagina prior to copulation [11].

c) 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. The method of electro ejaculation for semen collection is preferred to the artificial vagina method under certain conditions. 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 [11].

**Assessment of ejaculate:** Monitoring of qualitative semen characteristics has been indicated to be an important function of the AI Laboratory. 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 [25].

a) 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 [25]. 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

b) Volume: The volume of the ejaculate is readily measured by collecting the sample directly into a graduated vial [24]. 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% [27]. The volume has been reported to decline when young bulls are used or when there is frequent ejaculation or


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incomplete or failure of ejaculation and in bilateral seminal vesiculities [28].

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 [29]. Semen volume for Bostaurus bulls in Brazil was reported to be 6.9ml and 8.2ml in different years [30]. 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 [7]. Differences between reports on semen volume could be attributed to differences in age, breed, nutritional status, geographic locations and seasons of year of study, method of semen collection and handling of bulls during collection, procedure and frequency of collection [31].

c) 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 [27].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 [28].

Motility of spermatozoa at time of collection has been used commonly as a measure of the fertilizing ability of the sperm [26].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 [28]. 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 [26].

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 [29].

d) Live-dead sperm evaluation (vital staining): The percentage of live sperm has been determined by means of a differential vital stain. 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 [21].

e) Sperm morphology: 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 [11].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 [32]. 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.

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 [11].

f) Overall assessments: 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 [21].

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 withstand the processing conditions (process quality control) but also can give some indication of the potential fertility of the semen (fertility prediction). Assessing the progressive


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motility of the semen sample is probably the most common evaluation made for post-thaw viability [21].

## Application of artificial insemination

**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 (Where AI or hand mating is being used, estrus detection is the most important limiting factor [19]. Insufficient and/or inaccurate estrus detection leads to delayed insemination. 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 onset of estrus. 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 [21].

**Timing of insemination:** In the cow, maximum fertility has been achieved if inseminated from mid estrus to the end of estrus. Fertilization of the ovum has been reported to occur in the oviduct at the junction of the isthmus and ampulla. The life span of the ovum is around 12 – 18 hours and its viability decrease 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 [33].

**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. An increase in the conception rate has been reported when semen was deposited in the uterine horns rather than the uterine body [34]. In contrast, no difference was found in the fertilization rate, conception rate or non-return in uterine body and uterine horn inseminations [35].

The major factors that determine AI efficiency are heat detection skills, fertility level of the herd, semen quality, and efficiency of inseminators. 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 [36]. 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 [37]. and diseases of the female reproductive tract [26].

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 [19].

**Artificial insemination and fertility rates:** Fertility is measured by calving rate to first service for artificially inseminated dairy cattle [38]. 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 [39].

In USA, conception rate of virgin heifers has been found relatively constant at approximately 65% to first service conception; whereas the first service conception rates for lactating cows has decreased approximately 33% from 60 to 40 % [40]. Number of services per conception as an indicator of reproductive efficiency has been defined as the number of services required for a successful conception [41, 42]. The number of services per conception is directly related to the conception rate in the herd. 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. The mean first service conception rate for Virginia Dairy Herd Institute herds over the past 12 months in USA has been found 40 ± 13% [40]. 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. These influence the reproductive process at ovulation, fertilization, or implantation during gestation and parturition [12].

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 [41]. 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 [42]. Higher number of services per conception might also result from repeat


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breeding due to infectious and/or noninfectious diseases [43]. 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 [44].

## Conclusion and Recommendations

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 of 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, Based on the above conclusions the following points are recommended:

1. 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

2. 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;

3. 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;

4. 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.

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How to cite this article: Zekarias Mengistu. A Review on Artificial Insemination of Cattle in Ethiopia. Glob J Reprod Med. 2019; 6(5): 5556700. DOI: 10.19080/GJORM.2019.06.5556700

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**How to cite this article:** Zekarias Mengistu. A Review on Artificial Insemination of Cattle in Ethiopia. Glob J Reprod Med. 2019; 6(5): 5556700. DOI: 10.19080/GJORM.2019.06.5556700