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Review on Major Factors That Influence the Succuss of Artificial Insemination in Ethiopia

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Abstract: Artificial insemination (AI) is the first and oldest biotechnological technology for livestock genetic improvement and it involves inserting sperm into the female's reproductive canal without using natural mating. It is one of a group of technologies known as assisted reproduction technologies (ART), in which babies are produced by enabling the meeting of male and female gametes. Ethiopia has Africa's largest livestock population and a huge potential for dairy production expansion due to the country's favourable climate, which encourages the use of upgraded, high-yielding animal breeds and provides a disease-free environment for livestock development. Over the last four decades, development and research programs have introduced genetic enhancement of indigenous cattle through crossbreeding employing AI technology. However, due to factors such as the AI delivery system, heat detection and time of insemination, intrinsic factors associated with the cow, early embryonic losses, management issues, semen quality, insemination techniques and lack of awareness, AI technology was not successful in improving cattle reproductive efficiency. As a result, in order to build a successful technology, the above-mentioned aspects must be resolved to the optimum stage of the technology requirement.

Key words: AI・Ethiopia・Insemination Techniques・Semen Quality

INTRODUCTION

Ethiopia is thought to have Africa's most important cattle population, with the livestock sector contributing a significant percentage of the country's income. It has one of the world's greatest livestock populations, with 59.5 million cattle, placing it first in Africa and sixth globally [1]. However, due to their low potential and lack of technical understanding on the part of dairy owners, their contribution to final production has shown low productivity [2]. Because of Ethiopia's favourable climate, which encourages the use of upgraded, high-yielding animal breeds and provides a largely disease-free environment for livestock development, the country has a lot of potential for dairy production development. Despite the fact that the country handles Africa's largest livestock population, animal productivity is extremely low due to a variety of factors including inadequate nutrition, poor genetic potential, insufficient animal health services and other management-related issues [3, 4]. In Ethiopia, livestock production is critical to human health and poverty reduction. Cattle production serves multiple purposes, as cattle supply milk, meat, fertilizer, fuel, draft power and economic benefits through the sale of milk and milk products [5]. Given the great potential for smallholder income and employment production from high-value dairy products, the dairy sector's development can considerably contribute to the country's food security and nutrition [3].

Over the last four decades, Ethiopian development and research efforts have promoted genetic enhancement through crossbreeding. The event projects included the distribution of crossbred heifers, the supply of AI services and the installation of bull service stations [6]. AI cross breeding is one of the most straightforward, cost-effective and time-tested breeding procedures for producing the highest genetically potential and productive animals [2]. AI is the primary and oldest biotechnological tool used for livestock genetic improvement and it's the manual placement of semen

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within the female reproductive tract by means other than natural mating and it's one of the group of technologies commonly referred to as assisted reproduction technologies (ART), whereby offspring are produced by facilitating sperm implantation [7, 8]. AI has become one of the most essential approaches for improving animal genetics ever discovered. It has been widely employed for cattle breeding because it is the most valuable management approach available to cattle producers and it has made high genetic quality bulls available to anybody [9]. The number of calves born during a herd from AI sires is one of the economic benefits of AI implementation. The advantages are twofold: an immediate increase in sale value and the long-term advantages of introducing superior genetics into a herd [10].

To this date in Ethiopia, the majority of data used to evaluate breeding efforts has come from government ranches or research stations. Furthermore, few field studies have been conducted to determine the efficacy of (AI) services [6]. It is widely assumed that the AI service in the country has failed to improve dairy reproductive performance [11].

One of Ethiopia's key livestock development goals, according to Heinonen [12], has been to increase milk and meat production by boosting the genetic merit of indigenous cattle. Improvements in livestock resources have been accomplished, according to Meles and Heinonen [13], by the adoption of an effective and dependable AI service, in conjunction with correct feeding, health care and management of cattle. As a result, to cope with successful AI service, skilled manpower, facilities, follow-up and links with those involved in animal care and breeding were required, while a scarcity resulted in the service's failure [14]. Although Ethiopia is known for its large number of livestock, the country may benefit less from livestock products in terms of development, as many authors have stated at various times. As a result, the application of assisted reproductive biotechnology such as AI to boost the productivity of indigenous cattle is not well practiced to the full potential of the technology. As a result, the goal of this review is to re-document the aspects that determine AI applicability and value capabilities, as well as to remind readers of the many AI delivery systems available.

Factors Affecting the Efficiency of AI: According to Haugan et al. [15], the success of AI (AI) in cattle is determined by the sort of intrinsic and extrinsic elements that have a negative impact. Establishing correction measures require a thorough grasp of the impact of such factors on the probability of success while performing AI. According to Mekonnen *et al*. [16], most cattle production systems have low reproductive efficiency, with most cows failing to become pregnant due to a variety of factors including management, nutrition, reproductive diseases, semen quality and other factors, so extension must ensure that farmers receive adequate information on the input required to make the most of crossbreeding.

The AI Delivery System: Ethiopia's AI delivery system is poor due to a number of factors. Inefficient management, a lack of integration of AI services with livestock health and feed packages, a lack of appropriate collaboration among stakeholders, poor inseminator motivation and skills, a lack of readily available inputs such as nitrogen and a lack of proper recording systems are among these factors [17].

Factors Related to Heat Detection: In comparison to other criteria, the accuracy of heat (oestrous detection) is one of the most important factors that determine the success of an AI program. Since the number is the smallest interval between two successive oestrus cycles, heat detection in cows is administered by experienced herd persons/inseminators who can recognize those animals that may be in heat stand while being mounted/ridden by other female cows or vasectomized bulls [18, 19]. Oestrous behaviour and, as a result, the oestrus to ovulation interval are crucial for determining the ideal time to artificially inseminate calves, albeit this does not appear to be well described for zebu breeds [20, 21].AI performed 12 hours after the onset of standing heat may result in a decreased fertilization rate and increased embryo deterioration [21, 22]. Several authors have claimed that the period of standing estrus in zebu cattle is less than in taurine cattle. Zebu cows have a shorter, less intense oestrous cycle (10.7-11.6 hours) that occurs later in relation to the oestrogen stimulus. The duration of oestrus and the length of the oestrous cycle in zebu heifers are shorter than in cows, similar to taurine cattle [23]. Many factors influence the expression of oestrus, including heredity, postpartum days, lactation number, milk output and health. Nutrition, season, housing, herd size and other environmental factors all play a role in oestrous expression [24]. The best period for insemination relative to ovulation (insemination–ovulation interval (IOI)) is determined by the fertile lifespan of spermatozoa and the viable lifespan of the oocyte within the female genital canal [24]. Successful fertilization is highly dependent on the time interval between insemination and ovulation, meaning that if insemination occurs too early, the sperm will have aged and will be unable to fertilize the ovum by the time ovulation occurs and if insemination occurs too late, the egg will have aged and fertilization and formation of a viable embryo will be unlikely. There are indications that there is a great deal of heterogeneity in the timing of insemination in relation to ovulation in practice [25]. A cow first seen in oestrus in the morning is frequently inseminated in the afternoon of the same day, but a cow first spotted in oestrus in the afternoon is inseminated early the next day [19]. Because ova remain viable for around 12-18 hours after ovulation, insemination must occur at the precise period of the cow's estrous cycle for conception to occur [26, 27].

Intrinsic Factors Related to the Cow

Reproductive Health: Cows with uterine infection during the first postpartum period had a reduced chance of conceiving in subsequent breeding's. Even moderate uterine infections have been shown to have a negative impact on conception rates [28]. The condition of the cow's reproductive system, particularly the uterine environment, is critical to AI's success. Normal uterine involution, early return of ovulation, high oestrous detection efficiency and high conception rates per service are all required for good reproductive efficiency [29, 30]. Normal uterine involution, early return of ovulation, high oestrous detection efficiency and high conception rates per service are all required for good reproductive efficiency [30]. Calving and post-calving reproductive problems have a significant impact on conception rates. As a result, the key to increasing conception rates is to focus on preventing problems rather than treating them once they have occurred. According to some research, cows with metabolic problems, such as milk fever, have a higher frequency of reproductive disorders and lower conception rates [19, 31].

Early Embryonic Loses: Poor fertilization and embryo survival cause reproductive failure in inseminated cattle [17]. Reduced conception rates could be attributed to early embryonic mortality, which adds to nursing dairy cows' reproductive inefficiency. Fertility is recognized to be a function of both conception rate and pregnancy loss at any point during pregnancy [19, 32]. On the other hand, the total result of fertilization, early embryonic, late embryonic and foetal development and each of these processes in establishing pregnancy might even be altered, is the conception rate to first service [33]. On the other hand, the combined effect of fertilization, early embryonic, late embryonic and foetal development, as well as each of these processes in establishing pregnancy, might change the conception rate to first service. Fertilization failure, early embryonic loss, late embryonic/fetal loss and late abortion account for 20 to 45 percent, 8 to 17.5 percent and 1 to 4% of all pregnancy failures, respectively [34]. Rectal palpation by a non-professional at an early stage of conception could result in the loss of an early pregnancy. Transrectal ultrasonography allows for an earlier pregnancy diagnosis than palpation per rectum, provides instantaneous information to confirm pregnancy as well as measure embryo/foetal viability and minimizes the incidence of false positive and false negative diagnoses when compared to palpation per rectum [17].

Factors Related to Management

Nutrition: Several elements associated to management have a part in a successful pregnancy, the most significant of which is n utritional management. Seasonal changes that affect feed availability, high environmental temperatures and other environmental factors [35] cause stress and thus the challenge of high disease risk in cross breed cows contributes to a high number of services per conception, late age initially calving and first service and longer calving intervals, which are all areas of reproductive loathing in cross breed cows [36]. Anzar *et al*., for example, consider energy status to be a crucial dietary component that influences reproductive performance [37]. Also, overall caloric intake can affect fertility, both at the oocyte and embryo level, implying that it is critical to distinguish between optimal follicle growth and embryo survival conditions. The quality of the follicle, oocyte and embryo is affected by nutrition [38, 39].

Housing Condition: The distribution of heat over a 24-hour period can also be affected by housing characteristics. Any housing design that allows cattle to interact throughout the day provides more opportunities for mounting and standing behaviour to be expressed, making it easier to recognize an oestrous cow. Cattle kept in tie-stall or stanchion barns, in particular, must be clothed in order for this behaviour to be manifested. In a study conducted on high-producing Holstein cows, O'Connor [28] investigated how the slippery footing surface affects oestrous expression. Mounting activity is more common when cows are on soil rather than concrete, according to the findings. When five oestrous cows were given the option of spending time on soil or concrete in the presence of a tied cow that was either anoestrous or not in heat, the test cow spent an average of 70% of her time on the ground [28] and 73 percent of her time on concrete [40]. When a tied estrous cow was on dirt rather than concrete, the test oestrous cow mounted more frequently [28].

Factors Related to Semen Quality: According to Saacke [41], success must be measured in terms of pregnancy rate to the first AI, taking into account the financial investment in semen and other inputs. In addition, an honest first-service pregnancy rate response frequently indicates favourable second-service conditions.

Semen quality is another important criterion to consider when determining the pregnancy rate at first service (primarily captivated to choose bulls). Semen quality is one of the junctures to a successful pregnancy in most breeding procedures, regardless of whether oestrous synchronization is used or not. The character of male subfertility is proving to be as complicated as that of female subfertility. The need of semen handling and placement to understand the threshold or above threshold number of sperms to the ovum is also addressed by Saacke [41] in order to maximize both 14 fertilization rate and embryo quality. In vivo and in vitro, spermatozoa become extremely sensitive to any type of stress in their surroundings. According to Lemma [42], determining the post-thaw quality of spermatozoa is critical for the AI business to obtain information on the fertilizing capacity of cryopreserved sperm. Fertility is linked to many tests of sperm motility, morphology, acrosomal status, faulty sperm organelles and DNA and metabolism.

Factors Associated with Insemination Techniques: According to Arthur [19], the highly trained inseminator has made one of the most significant contributions to the successful application of AI in breeding. The ability of the inseminator to transfer the semen to the appropriate spot within the reproductive tract at the appropriate stage of oestrous, among other things, determines the efficacy of cow insemination. However, there has been a trend to use standard insemination techniques while ignoring inseminator-related factors, which can have a significant impact on fertility. Although expert inseminators examine the reproductive tracts of a variety of cows on a daily basis, the majority are not educated to look for the uterus and ovaries. This is a significant practical restriction to AI's progress [43]. Animals in genuine heat should inseminate with frozen semen that has been thawed at 37°C for 30 seconds [18, 44]. Professional technicians are more successful at insemination than novice technicians, implying that choosing an expert inseminator is a critical component of the AI program's success and that regular practice at insemination is essential to ensure high conception rates. The location of semen deposition has been a significant factor in the success of AI in cattle [45]. Deposition of semen within the uterine body resulted in a tenth higher non-return rate than cervical deposition and when semen was placed within the uterine horns rather than the uterine body, an increase in the conception rate was recorded. Cows are only inseminated into the uterine body's short portion [46]. The various AI technicians caused a wide range of pregnancy rates. When a cow was inseminated by the poorest inseminator instead of the only inseminator, the likelihood of conception reduced by 0.25.All cows were inseminated bi-corneally (half of the seminal dose, 4-5 cm deep into each uterine horn) by two of the 13 AI technicians, while the remaining 11 AI technicians used uterine body insemination. In line with prior reports [47, 48], technicians doing deep AI produced better outcomes. This difference in conception rates could be a significant practical barrier for AI success as well as herd fertility. It's apparent that some AI technicians have a harder time inseminating cows than others. Deep cornual AI necessitates more inseminator training, favouring results [49, 50]. Because cattle can perform intrauterine insemination, just a small amount of sperm is needed to achieve acceptable pregnancy rates. Typically, 6-7 million sperm survive freezing out of the 20-30 million sperm required for each insemination dose; this is typically considered the minimal dose compatible with satisfactory fertility [19]. Hygiene, thawing procedures and maintaining a consistent temperature between thawing and insemination have all played a role in achieving conception [40].

People Awareness: Although the AI approach has been approved by a sizable percentage of livestock owners, certain conditions have a significant impact on others' adoption. Infrastructural facilities, farmer understanding of AI and its benefits, lack of farmer engagement, lack of communication and a lack of incentives for farmers and AI workers in rural areas are among these concerns. Efforts to improve AI's efficiency should be founded on a thorough understanding of the most common causes of failure. The majority of the time, the limitations of adopting AI services was attributed to a lack of understanding, owning a bull, a lack of infrastructure and a low conception rate [51]. However, people's lack of understanding today is due to poor management of their animals for the success of technology, such as heat detection, contacting the inseminator at the appropriate moment and keeping their animal in proper physical condition.

Future Perspective of AI in Ethiopia: Artificial Intelligence (AI) technology for cattle was launched at the farm level in Ethiopia over 40 years ago as a tool for genetic improvement. However, due to a variety of factors, including a problem with the AI delivery system, heat detection and insemination time, intrinsic factors relating to the cow/heifer, early embryonic loss, management issues, semen quality, insemination technique and other awareness, the efficiency of the service in the country has remained low. AI boosts animal genetic potential by increasing reproductive efficiency, which allows animals to be used as a food source. This is frequently due to the fact that protein derived from animals is one of the most important nutrient requirements. AI is commonly used in conjunction with other emerging biotechnologies such as cryopreservation, embryo transfer and genetic conservation to improve the reproductive efficiency of animals for livestock production. As a future plan, Ethiopia must re-establish/modify AI technology and other assisted reproductive technology to appreciate the stuff required to balance with the country's population and AI technology should be scaled up to other species, except for dairy cattle, to increase meat products and secure their cost, which has over-increased for the strain.

CONCLUSION AND RECOMMENDATION

Artificial insemination (AI) is one among the assisted reproductive technologies that help for genetic improvement for the aim of accelerating the stock and productivity of the animals both in terms of quantity and quality. It is the primary and oldest biotechnology tool used for genetic improvement of animals but still it is not successfully well established in our country as long because the country practicing for several years ago. This is often thanks to many factors like: AI delivery system, heat detection and time of insemination, intrinsic factors associated with the cow, early embryonic loses, problem of management, semen quality, insemination techniques and other people awareness.

Therefore, supported the above conclusion the subsequent recommendations were forwarded for the successfulness of AI in Ethiopia:

- All the above factors should be considered always before the appliance of the technology (AI).
- Capacity building like training should tend for all participant of AI technology including the owner of the animal and attendants.
- Both government and non-government organization should give attention for livestock sector and that they need to evaluate the chain of AI from the source of semen up to the location of AI/community.
- All the input required for this technology like nitrogen and other infrastructure should be provided in on the brink of every area where the technology applied.
- Every AI technician should be honest and liable for their profession also as for his or her community.

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