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Review Article

Current Status of Dairy Cattle Artificial Insemination and Constraints in Ethiopia (A review)

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Abstract: Artificial insemination is the manual placement of semen in the reproductive tract of the female by a method other than natural mating which is one of a group of technologies commonly known as "assisted reproduction technologies" whereby offspring are generated by facilitating the meeting of gametes (spermatozoa and oocytes). Artificial insemination is by far the most common method of breeding of intensively kept dairy cattle. In relation to the status, there is a big gap in biotechnology use in general between developed and developing countries, with Artificial insemination being the biotechnology most widely applied in developing countries as compared to other biotechnologies. In developed countries, advances in Artificial insemination have already had a major impact on livestock improvement programmers. Similarly, most developing countries express the wish to increase the utilization of Artificial insemination even though in many cases clear plans for incorporating this technology into animal genetic resource management are lacking. Artificial insemination speeds up genetic progress, reduces the risk of disease transmission and expands the number of animals that can be bred from a superior parent. In Ethiopia, even though this service has been in operation for over 30 years with different levels of intensification, its efficiency has remained at a very low level due to infrastructural, managerial and financial constraints and also due to poor heat detection, improper timing of insemination and embryonic death.

Keywords: Artificial insemination, spermatozoa and oocytes, Dairy Cattle.

1. INTRODUCTION

Ethiopia, livestock production accounts for approximately 35 to 49% of the total agricultural GDP and 16 to 17% of national foreign currency earnings (Fitaweke Metaferia *et al.*, 2011). Livestock production is one of the fastest growing agricultural subsectors in developing countries; where it accounts for more than a third of agricultural GDP. It is projected soon to overtake crop production as the most important agricultural subsector in terms of added value (FAO, 2006). From the total cattle population 98.95% are local breeds and the remaining are hybrid and exotic breeds. With an average lactation length of 6 months and an average daily milk production of 1.67 liters per cow, the total milk produced during the year 2015/16 was recorded to be 3.06 billion liters (CSA, 2016). This suggests that the total number of both exotic and hybrid female cattle produced through the cross-breeding work for many decades in the country is quite insignificant indicating unsuccessful cross breeding 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 (CSA, 2016).

Ethiopia, one of the developing countries, has 16% of the world's dairy livestock but produces less than 4% of global milk production with an average cow producing only 454 liters per year compared to 5630 liters for top producing cows in the European Union (EU). This is in spite of the fact that livestock products account for 25-35% of agricultural production in Africa (USDA, 2006). This low level of milk production in Ethiopia can be attributed to a number of constraints that include low quality dairy breeds, limitation imposed by harsh environmental conditions such as high ambient temperatures, high incidence of diseases and parasites and poor nutrition (Gefu, 1989). An equally important factor is the generally low-level application of modern technology in the management of dairy cattle, particularly among the small holder dairy farms. Artificial Insemination (AI) is one of such technologies that can solve these constraints if the necessary

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conditions are put in place to spur poor rural farmers to adopt the technology.

The conception rate in the field of AI programs in developing countries is very low, and therefore the desired effect in terms of animal improvement has not been achieved. AI will become more effective only when farmers will have access to considerably better technical and organizational facilities (Verma *et al.*, 2012). In Ethiopia, even though AI is the most commonly used and valuable biotechnology that has been in operation for over 30 years in the country, the efficiency and impact of the operation has not been well-documented (Webb, 2003)

OBJECTIVE OF THE REVIEW

- To Review the status of cattle Artificial insemination and constraints in Ethiopia

2. LITERATURE REVIEW

2.1 The Need for Artificial Insemination

Rozeboom (2007) suggested that among all the fundamental systems of animal breeding exercise such as random mating, in-breeding, line breeding and out breeding, artificial insemination (AI) has proved to be the best and efficient method. According to Butswat and Choji (1995), AI is a vital tool for the rapid improvement of livestock allowing for maximum use of best sires on numerous dams and that it is one of the animal production techniques which can augment production and returns from livestock at a faster rate through cross-breeding programme. AI also credited for providing the impetus for many other developments which have had a profound impact on reproductive biotechnology. Heat detection efficiency (rate) is defined as the percentage of eligible cows that are actually seen or detected in heat. Several methods of calculating the efficiency with which heat is detected are available **(AHDB, 2018).**

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		
	Awassa	15	10	1	5	1	10
Oromia	Tiyo	54	24	1	2		
	Ada'a	16	17	1	1	1	9
Tigrai	Atsbi	15	16	1	4		
	Mekelle	55	22	1	5	1	10
Amhara	Fogera	36	12	1	3		
	Bahir Dar Zuria	–	14	1	1	1	14
	Bahir Dar	28	14	1	1		
Total		375	246	15	30	5	52

AITs= artificial insemination technicians; FGD= focus group discussion

source:-GebreMedhin D. 2005)

Compared with natural mating, AI has been used for genetic improvement by utilizing proven sires, decreasing risk of venereal disease transmission, maintaining accurate breeding records necessary for good herd management, economic service, culling dangerous males on the farm, avoiding injury during mating, avoiding utilizing semen of incapacitated bulls (Rodring, 2000).

2.1.1 Reducing Transmission of Diseases through Sexual Contact

Exposure of sires to infectious genital diseases is prevented by use of AI which reduces the danger of spreading such diseases (Webb, 1992). In other way, if only males known to be free from disease are selected for semen collection, artificial insemination can play an important part in controlling diseases spread through sexual contact.

2.1.2 Improving Animals' Productivity

AI plays an important role in enhancing animal productivity, especially milk yields, in developing countries that have a well-defined breeding strategy and a sound technical base to absorb and adapt the technology to meet their needs (BBC, 2015). Daughters of AI sires produce significantly more milk than those of herd bulls' sires and the income from this extra milk may cover the extra costs resulting from extended calving intervals because of low heat detection. A study indicated that daughters of AI sires were producing almost 900 kg of extra milk per lactation than daughters of natural service bulls (Valergakis *et al.*, 2007). Another report from USA showed a difference of more than 1000 kg of milk per lactation on farms using AI (Smith *et al.*, 2005; Zwald, 2003). This means that farming using AI can be more profitable apart from covering the extra costs even with calving interval of 13.5-14 months (Valergakis *et al.*, 2007).

For countries to increase their dairy cow productivity, they have to maintain successful AI systems with an effective technology transfer mechanism, effectively integrated international assistance into their national germplasm improvement programmes, building and maintaining infrastructure, complement with improvements in animal nutrition and veterinary services, and adequate economic incentives to market dairy products. However, many developing countries lack one or more of these requirements (Heifer International, 2014).

2.1.3 Harvesting of Individual Sires with Traits of Superior Quality

The greatest advantage of AI is that it makes possible maximum use of superior sires (Webb, 2007) in which desirable characteristics of a bull or other male livestock animal can be passed on more quickly and to more progeny than if that animal is mated with females in a natural fashion (Milad, 2011). AI usage enabled one dairy sire to provide semen for more than 60,000 services (Webb, 1992). In another record, progress in semen collection and dilution and cryopreservation techniques enabled a single bull to be used simultaneously in several countries for up to 100,000 inseminations a year (Gibson and Smith, 1989).

2.2 Constraints of Artificial Insemination

2.2.1 Cost of AI Compared to Natural Service

Despite the well-known advantages of artificial insemination, a large number of dairy farmers all over the world still use natural service (NS) bulls to breed their cows. The main arguments allegedly justifying their choice are higher AI costs compared to those of keeping herd bulls and additional costs resulting from extended calving intervals because of low heat detection rates when AI is used.AI costs include; labor, equipment, liquid nitrogen, semen and three ratios of "services per conception" (Valergakis *et al.*, 2007). The availability of economically priced liquid nitrogen for the cryopreservation of semen is also a particular constraint to utilize AI as a whole (FAO International Technical Conference, 2010).

2.2 2. Impact of AI in Genetic Diversity

Even though AI is highly effective in improving animals' productivity, there is also a concern that it's inappropriate or unplanned use can lead to increased rates of genetic erosion and breed extinction (Pilling *et al.*, 2007).

2.2 3. Difficulty of Heat Detection

Among different factors that can affect conception rate per AI service, accuracy of heat (estrus) detection is the major one that determines AI program since ova remains viable for only about 12-18 hours after ovulation (Rodriguez- Martinez, 2000). A successful AI program must include efficient and accurate heat detection and timely AI relative to ovulation. The failure to detect heat is the most common and costly problem of AI programs and the major limiting factor of reproductive performance on many dairies (Nebel and Jobst, 1998; Dalton, 2011). The difference in the response of dairy cattle owners in the different study areas may be attributed to the difference in their locationfrom National Artificial Insemination center (NAIC) or local AI centre, awareness of farmers about the useof AI, knowledge of oestrus signs and proper heat detection, proper time of insemination, knowledge and skill of AITs about handling of semen during transportation, skill and time of insemination (Engidawork, 2018).

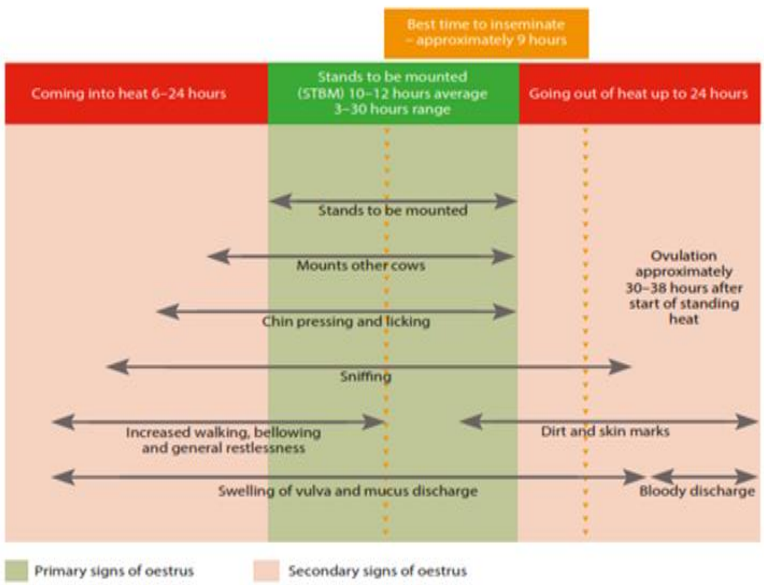


Figure 1. Changes in cow behaviour and signs of heat relative to heat onset, time of ovulation and optimum insemination time (adapted from Teagasc beef manual, 2012)

Many biological events occur within the limited window of opportunity (Figure 1), including: the transport time required for viable sperm from the site of deposition to the site of fertilization, the functional viable lifespan of sperm and ova and the timing of ovulation in relation to AI (Dalton, 2011).

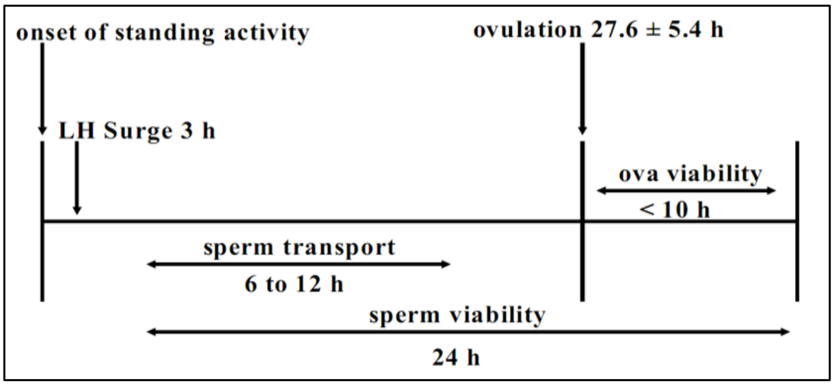


Figure 1: Biological events contributing to the optimization of AI (Dalton, 2011).

2.3. Current Status of AI in Ethiopia

The country has made great effort to improve the productivity of local breeds through AI program to crossbreed locally adapted cattle breeds with improved exotic dairy breed ones. This program has been addressing major parts of the country including Amhara and SNNPR regions. Nevertheless, the success of such programs has not been satisfactory due to numerous factors, including substandard nutrition, poor husbandry practice and infrastructure status Thus, dairy producers have challenging complaint about a poor reproductive performance in animals using AI (Lemma and Kebede 2011). As a result, dairy production is at its lowest stage compared to other countries (Azage, 2000; Lobago, 2006).

It was again discontinued due to unaffordable expenses of importing semen, liquid nitrogen and other related inputs requirement (Zewdie *et al.*, 2006). In 1984, National Artificial Insemination Center (NAIC) has been established to coordinate the overall AI operation throughout the country (NAIC, 1995; GebreMedhin, 2005). As a result of this, urban dairying is flourishing in many small towns and big cities with different level of intensification from less than 1% to over 40% growth (Kelay, 2002).

Even though it is the most commonly used and valuable biotechnology that has been in operation in Ethiopia for over 30 years with different levels of intensification, the efficiency and impact of the operation has not been well- documented (Webb, 2003). Furthermore, according to Sinishaw's report (2005), itis widely believed that the AI service in the country has not been successful to improve reproductive performance of dairy industry. From the previous little study, AI service is weak and even declining due to inconsistent service in the small holder livestock production system of the Ethiopian highlands (Gebremedhin, 2005).

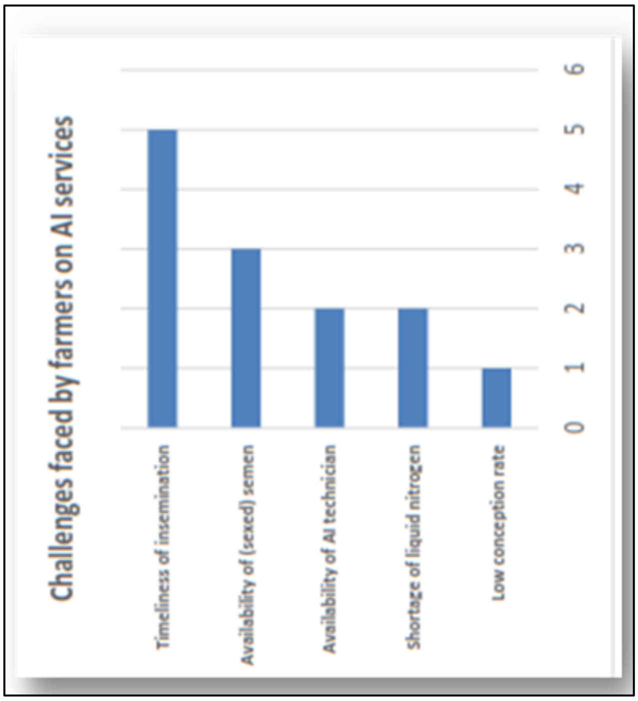
Because of inefficiency in AI services and consequently reproductive inefficiency, there has been a wide belief among dairy producers that dairy animals perform better when bulls are used than AI (Binici, 2006).

2.4. Major Factors Affecting Efficiency of AI in Ethiopia

The efficiency of AI in the country has remained at a very low level due to many constraints including; infrastructural, managerial and financial constraints and also due to technical problems such as; poor heat detection, improper timing of insemination and embryonic death. The artificial insemination program in rural bovines is greatly influenced by the status of the farmer's i.e. large marginal, small, and land less farmers (Kumar, 2005). In addition, conception rate per AI service is affected by; cow related factors including cow fertility, body condition, environmental stresses, bull fertility/ quality of semen, efficiency of AI techniques, skills of the inseminators, care of the semen collected, processed and stored etc. (Nichlson and Butherworth, 1986; Ntombizakhe, 2002; Rogers, 2001). The risk of all these factors vary as the type of production system, level of the dairy business and even with agro ecology (Franklin, 2003;). The problem is more aggravated by wrong selection and management of AI bulls along with poor motivation and skills of inseminators (Gebremedhin, 2005).

The better managed and well-fed heifers grew faster, serve earlier and result in more economic benefit in terms of sales of pregnant heifers and/or more milk and calves during the life time of the animal (Lobago, 2006; Masama,2003).

Even though, smaller farms often rely on AI service because of the cost or difficulty of keeping a breeding bull for natural insemination (Lemma and Kebede, 2011; Rocha, 2001; Kelay, 2002), several factors associated with the success of AI particularly detection of heat, efficiency of inseminator, communication and transport problems and quality of the semen have contradictory effect (Rocha, 2001; Kelay, 2002).



Fiegure 2:
Source: Ashebir *et al.*, (2016)

Problems with estrous detection as one of constraints become more important in affecting the reproductive performance of dairy cows as herd size increases (Smith, 2004). As also reported in a study (Kelay, 2002), accessing an AI service has many technical and logistic hurdles contributing to the failure of the timely service of estrous cows hence results in poor reproductive performance. So, many dairy farmers use natural service to overcome problems associated with estrous detection (Risco, 2000).

3. CONCLUSION

By way of conclusion, after a hiatus following its introduction, Artificial insemination is receiving renewed attention in dairy cows recently. AI technology maximizes animals' productivity and harvests individual sires with traits of superior quality through: the use of outstanding males, disseminating superior genetic material, improvement of the rate and efficiency of genetic selection, introducing new genetic material by import of semen rather than live animals and enables the use of frozen semen even after the donor is dead. It also reduces the risks of spreading sexually transmitted diseases. In several developing countries in particular, in spite of the efforts made to introduce large-scale AI breeding services, growth in its use has generally not been very strong and conception rate is very low. Therefore, the desired effect in terms of animal improvement has not been achieved. The reasons behind are inefficient heat detection, lack of proper management and technical skill. Many dairy farmers incline to use NS than AI because of fear of loss due to poor heat detection.

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