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A REVIEW ON EFFICIENCY OF ARTIFICIAL INSEMINATION IN CATTLE BREEDING IN ETHIOPIA

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ABSTRACT

Ethiopia has large cattle population in Africa. The output of decades of crossbreeding programme in Ethiopia through AI service was quite insignificant because the exotic breeds and their crossbreds of the country accounted for about 1.44%. The objective of this review is to present the efficiency of Artificial Insemination (AI) service in cattle breeding in Ethiopia. The optimum recommended mean number of services per conception (NSC) for profitable dairy cow is about 1.4. However, conventional cattle AI breeding indicated that the mean NSC of different studies ranged from 1.14 in local cows up to 2.47 in different genotypes of cows kept under different management systems and conception rate at first insemination (CR[1]) ranged from 7.14% to 75.5% in different genotypes of dairy cows kept under extensive and intensive management systems. Estrus synchronization followed AI breeding indicated that CR[1] ranged from 24.69% to 70.6% in Zebu cows kept under semi-intensive management system. Calving rate (CR) is the most appropriate measure of fertility of dairy cows which is defined as the number of calves born per 100 services. The poor efficiency of the country cattle AI service is a huge biological economic loss in cattle production and managerial monetary losses. Strategic interventions on cattle AI service efficiency improvement options should be identified and practiced considering breed type, production system and agro-ecology.

INTRODUCTION

Livestock production provided approximately 35 to 49% of the total agricultural GDP and 16 to 17% of national foreign currency earnings of Ethiopia (Metaferia *et al*., 2011). The output of decades of crossbreeding programme in Ethiopia through Artificial Insemination (AI) was quite insignificant because the total number of exotic and crossbred female cattle are few (CSA, 2013). About 98.56% of the total Ethiopian cattle populations are indigenous Zebu (*Bos indicus*) cattle while exotic breeds and their crossbreds account for about 1.44% (CSA, 2016). However, crossbreeding of indigenous cattle with highly productive exotic cattle have been considered a realistic solution to improve the low productivity of indigenous cattle (Tadesse, 2002). For example, the types of exotic cattle breeds used for crossbreeding through the use of AI in Tigray region, Ethiopia comprised of Holstein Friesian (HF) and Jersey, and 50% crossbred of HF and the indigenous Begait cattle (Ashebir *et al*., 2016).

AI is one of the most important techniques ever devised for the genetic improvement of farm animals (Bearden *et al*., 2004). The greatest advantage of AI is maximum use of superior sires whilst the use of one bull is limited to less than 100 mating per year. The use of AI enabled one dairy sire to provide semen for more than 60,000 services in one year (Webb, 2003). AI service enables maximum use of outstanding males, rapid dissemination of superior genetic material, improve the rate and efficiency of genetic selection, introduction of new genetic material by import of semen rather than live animals (Verma *et al*., 2012). The critical factors in artificial reproductive management are estrus detection and insemination of the cow at the correct time in the estrus cycle. Estrus detection and conception rates are the main determinants of reproductive efficiency (Bekana *et al*., 2005).

Reproductive failure is a major source of economic loss in dairy and beef industry (Perry, 2005). The application of reproductive technologies accelerates genetic progress and enhance the reproductive performance of farm animal genetic resources (Gizaw *et al*., 2016). AI has a good potential to improve cattle productivity in Ethiopia. However, its use is limited

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due to the challenges related to infrastructure and the availability and skills of AI technicians (Ndambi *et al*., 2017). Infrastructure, managerial and financial constraints, poor heat detection, improper timing of insemination and embryonic death were the factors which resulted in very low level efficiency of the AI service in Ethiopia (Shiferaw *et al*., 2003).

Although the use of cattle AI service is increasing in Ethiopia, oestrus detection is difficult in Zebu breeds due to their poorly expressed estrus (Bekuma & Ketema, 2019). Failure to accurately detect estrus is the major factor limiting optimum reproductive performance on many farms (Graves, 2012). Reproductive management tools such as estrus synchronization involves induction of estrous in a group of females to breed relatively in around the same time (Schafer *et al*., 2007; Rick, 2013). Estrus synchronization (ES) and AI are influential technologies for cattle producers in terms of genetic improvement, reproductive management and performance (Jinks *et al*., 2013). Mean number of services per conception (NSC), conception rate at first insemination (CR^1) and calving rate (CR) are essential parameters which enable breeders to determine the efficiency of AI service. Therefore, the objective of this review is to present the efficiency of AI service in cattle breeding in Ethiopia.

DISCUSSIONS

The major determinants of efficiency of AI in cattle breeding in Ethiopia are presented below (Table 1). The mean NSC, CR^1 and CR mainly determine fertility and efficiency of dairy cattle.

Number of services per conception (NSC)

NSC as an indicator of reproductive efficiency has been defined as the number of services required for a successful conception (Albero, 1993; Haile Mariam *et al*., 1993; Negussie *et al*., 1998; Shiferaw *et al*., 2003). The optimum recommended NSC for profitable dairy cow ranges from 1-1.7 (Evelyn, 2001). The NSC under conventional cattle AI breeding ranged from 1.14 in local dairy cows kept under mixed crop-livestock production up to 2.47 in different genotypes kept under mixed crop livestock and Urban dairying whilst under fixed time AI breeding the NSC ranged from 1.44 in crossbred cows kept under extensive production system up to 2.36 in local cows kept under extensive production system (Table 1). The differences in NSC could be due to intrinsic (genotype, age, parity, body condition score, semen quality) and extrinsic (ecology, production system, heat detection, time of insemination, skill of inseminator, type of insemination, semen handling procedures) factors.

Conception rate at first insemination (CR^1)

In most African countries, poor semen quality, poor semen handling procedure, inadequate insemination skill, poor estrus detection and wrong time of insemination resulted in low CR^1 (Tegegne *et al*., 1995).

The CR^1 under conventional cattle AI breeding ranged from 7.14% in different genotypes of cows kept under mixed crop livestock and Urban dairying up to 75.5% in crossbred dairy cows kept under extensive and intensive production systems whilst under timed AI breeding the CR^1 ranged from 24.69% in Zebu cows kept under unknown production system up to 70.6% in Boran cows kept under semi-intensive production system (Table 1). The differences in CR^1 could be due to ecology, genotype, parity, body condition score, skill of inseminator, insemination time, production system and semen quality.

Calving Rate (CR)

The most appropriate measure of fertility is CR which is defined as the number of calves born per 100 services (Mohamed, 2004). The CR under conventional cattle AI breeding ranged from 22.0% in local dairy cows kept under mixed crop-livestock production system up to 54.8% in HF x Zebu crossbred cows kept under Urban and Peri-urban production system whilst under fixed time AI breeding the CR ranged from 10.67% in dairy cows kept under extensive production system up to 13.58% in Zebu cows kept under unknown production system (Table 1). The differences in CR could be due to prevalence of reproductive diseases, production system and number of services provided per cow.

Therefore, as per the reviewed publications, average NSC is the same in conventional cattle AI breeding (1.74) and fixed time AI breeding (1.74) whilst the average CR in conventional cattle AI breeding (38.4%) and fixed time AI breeding (12.1 %) are not comparable which reveal poor AI efficiency.

Table 1. Efficiency of Artificial Insemination in different parts of Ethiopia

AI type	Cattle breed group	Management system	NSC (mean)	CR^1 (%)	CR (%)	Author(s)
Conventional AI	Local dairy cows	Extensive and intensive systems	-	72.9	-	Befkadu *et al*., 2019
	Crossbred dairy cows	Extensive and intensive systems	-	75.5	-	Befkadu *et al*., 2019
	Local dairy cow	Extensive and intensive systems	-	53.5	-	Hamid *et al*., 2021
	Crossbred cows	Extensive and intensive systems	-	69.1	-	Hamid *et al*., 2021
	Local Zebu cows	Extensive system	-	48.9	-	Abdula and Bilal, 2022
	Local Zebu cows	Extensive system	-	37.4	-	Abdula and Bilal, 2022
	Zebu cows	Extensive system	-	24	-	Hamid, 2012

	HF x Zebu crossbred cows	Extensive system	-	60	-	Hamid, 2012
	Zebu x Holstein-Friesian	Farmer's management system	1.8	-	-	Kumar *et al*., 2017
	HF x Zebu, Jersey x Zebu cows	Intensive system	-	62.5	-	Abdula and Bilal, 2022
	HF x Zebu, Jersey x Zebu cows	Intensive system	-	41.5	-	Abdula and Bilal, 2022
	Not specified	Mixed crop livestock	1.78	34.29	-	Gebreegziabiher, 2008
	Not specified	Mixed crop livestock, Urban dairying	1.91	33.33	-	Gebreegziabiher, 2008
	Not specified	Mixed crop livestock, Urban dairying	2.47	7.14	-	Gebreegziabiher, 2008
	Not specified	Mixed crop livestock, Urban dairying	1.55	20.31	-	Gebreegziabiher, 2008
	Local cows	Mixed crop-livestock production	1.14	-	-	Tadesse *et al*., 2022
	Crossbred cows	Mixed crop-livestock production	1.15	-	-	Tadesse *et al*., 2022
	Local and crossbred cows	Mixed crop-livestock production	-	51.03	-	Tadesse *et al*., 2022
	Indigenous cattle	Mixed crop-livestock production system		23.36	22	Bayew, 2019
	82.3% crossbred dairy cows	Not specified	-	64.8	-	Yehalaw *et al*., 2018
	Fogera x Holstein Friesian	Not specified	1.56	-	-	Sena *et al*. 2014
	>80% crossbred cows and <20% local cows	Not specified	-	17.64	-	Ashebir *et al*., 2016
	>80% crossbred cows and <20% local cows	Not specified	-	30.12	-	Ashebir *et al*., 2016
	>80% crossbred cows and <20% local cows	Not specified	-	48.47	-	Ashebir *et al*., 2016
	HF x Zebu crossbred	Urban and Peri-urban	1.67	64.6	54.8	Birhanemeskel *et al*., 2017
	Dairy cows	Urban dairy farming	1.6	48.1	-	Engidawork, 2018
	Not specified	Urban dairying	1.7	40.23	-	Gebreegziabiher, 2008
	Local and crossbred cows	Extensive and intensive system	-	47.8	-	Woldu *et al*., 2011
	Local and crossbred cows	Extensive system	1.95	49.3	-	Jemal *et al*., 2016
	local cows	65% Mixed crop-livestock system	2.15	-	-	Yousuf, 2022
	F_1 crossbred	65% Mixed crop-livestock system	2.0	-	-	Yousuf, 2022
	F_2 crossbred	65% Mixed crop-livestock system	1.6	-	-	Yousuf, 2022
Average			***1.74***	***45.0***	***38.4***	
Fixed time AI	Local cows	Extensive system	-	45	-	Abiyot and Eyob, 2019
	Crossbred cows	Extensive system	-	50.2	-	Abiyot and Eyob, 2019
	Local cows	Extensive system	1.85	54	-	Belay *et al*., 2016
	Crossbred cows	Extensive system	1.44	69.6	-	Belay *et al*., 2016
	Dairy cattle	Extensive system	-	34.61	10.67	Zewude, 2018
	Local dairy cow	Extensive system	1.7	59	-	Duro, 2022
	Crossbred cows	Extensive system	1.5	67	-	Duro, 2022
	Zebu cows	Extensive system	-	48.4	-	Hamid, 2012
	HF x Zebu crossbred cows	Extensive system	-	46.7	-	Hamid, 2012
	Boran cows	Intensive system	-	28.6	-	Demisse, 2018
	HF x Boran crossbred cows	Intensive system	-	31.3	-	Demisse, 2018
	Local cows	Not specified	1.71	58.49	-	Worku, 2015
	Crossbred cows	Not specified	1.78	56.1	-	Worku, 2015
	Zebu (95.8%), Sheko (2.8%) and crossbred (1.4%)	Not specified	-	24.69	13.58	Fantahun, and Admasu, 2017
	Local cows	Not specified	1.7	59.5	-	Shanku, 2022.
	Crossbred cows	Not specified	1.5	65.0	-	Shanku, 2022
	Local cows	Not specified	-	40.8	-	Haile *et al*., 2023
	Crossbred cows	Not specified	-	64.8	-	Haile *et al*., 2023
	Boran cows	Semi-intensive	-	70.6	-	Tilahun, 2018

	Zebu x Holstein cross	Semi-intensive	-	50	-	Tilahun, 2018
	Local cows	Extensive system	2.2	45.7	-	Amanuel and Amanuel, 2023
	Crossbred cows	Extensive system	1.4	70.5	-	Amanuel and Amanuel, 2023
	Local cows	Extensive system	2.36	42.3	-	Amanuel and Amanuel, 2023
	Crossbred cows	Extensive system	1.7	60.2	-	Amanuel and Amanuel, 2023
Average			***1.74***	***51.8***	***12.1***	

NSC=Number of Services per Conception, CR^1=Conception Rate at first insemination, CR=Calving Rate

CONCLUSIONS

Cattle AI service was widely practiced in Ethiopia, however, the efficiency of cattle AI service in Ethiopia was extremely poor due to different intrinsic and extrinsic factors. Mean number of services per conception (NSC), conception rate at first insemination (CR^1) and calving rate (CR) under both conventional cattle AI breeding and fixed time AI breeding indicated poor efficiency of AI service. The poor efficiency of the country cattle AI service is a biological economic loss in cattle production and managerial monetary losses. Strategic interventions on cattle AI service efficiency improvement should be identified and practiced.

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