Review on Reproductive Performance of Crossbred Dairy Cows in Ethiopia

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Abstract
The economy of livestock production largely depends upon the reproductive efficiency of the animals. This review was conducted to review and generate compiled information about the reproductive traits of crossbred cattle such as age at first service (AFS), age at first calving (AFC), calving interval (CI), days open (DO), and number of services per conception (NSPC) under Ethiopian conditions. All published materials are cited to provide some information on the values of reproductive traits of crossbred dairy cattle. It is concluded that improving the management system such as efficient heat detection and timely insemination, better health management, genetic improvement of crossbreeding, and supplementing of good quality feed resources are required for optimal reproduction performance.
Keywords: Age at first conception, Age at first service, Calving interval, Days open, Number of services per conception
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INTRODUCTION

Ethiopia is one of the developing countries in Africa known for a huge livestock population. The estimated total cattle population for the country is about 70 Tadesse constituting males (44%) and females (56%). Out of the total cattle population in the country, the proportion of indigenous breeds is 97.4% and the remaining hybrid and exotic breeds are about 2.3% and 0.31%, respectively (CSA, 2021). The dairy industry in Ethiopia is still not developed compared to East African countries like Kenya, Tanzania, and Uganda (Dinka, 2013).

The overall productivity and adaptive efficiency of cattle depend largely on their reproductive performance in a given environment. Reproduction is an indicator of reproductive efficiency and the rate of genetic progress in both selection and crossbreeding programs particularly in dairy production systems.

The reproductive traits are crucial factors, contributing to the profitability of dairy production (Lobago *et al.,* 2007). One of the most important considerations regarding livestock production is the reproductive performance of females. Reproductive performance can be measured by AFS, AFC, CI, DO, and NSPC. According to Birhanu (2014), the lifetime productivity of a cow is influenced by its reproductive effectiveness. Calving interval and days open are most likely the best indicators of a cattle herd's reproductive success whereas first calving marks the beginning of a cow's productive life and is closely related to generation interval. Therefore, the objective of this review was focused on reviewing and generating compiled information on the reproductive traits of crossbred dairy cattle in Ethiopia.

Reproductive performance traits

The lifetime productivity of a cow is influenced by its reproductive performance traits. According to Genzebu *et al*. (2016) said that poor management of dairy cattle was the most probable factor affecting the standard expected reproductive performance of cross-breed cattle. Efficient heat detection and timely insemination, better health management, genetic improvement of crossbreeding, and supplementing of good quality feed resources are required for optimal reproduction performance. The reproductive performance traits of dairy herds can be determined by measuring age at first service, age at first calving, calving interval, days open, and the number of services per conception etc.

Age at First Service (AFS)

Age at first service (AFS) is the age at which heifers attain body condition and sexual maturity for accepting service for the first time. The largest age at first service resulted from the low level of management and poor feeding of calves and heifers at the earlier stages, which consequently had reduced growth rate and delayed puberty (Genzebu *et al*., 2016).

Table 1: Age at first service of crossbred dairy cows with different genetic groups in Ethiopia

No	breed/ genotype	AFS (months)	Study sites	Source
1	50% F1 Friesian	28.3±0.52	on station	Getahun, 2018
2	50% F2 Friesian	36.33±0. 87	on station	Getahun, 2018
3	50% F3 Friesian	34.31±1.08	on station	Getahun, 2018
4	50% HF	27±0.7	on station	Haile *et al*., 2009
5	50% HFx Local	28.80±5.48	on farm	Muluye, 2016
6	75% F1 Friesian	32.49±0.86	on station	Getahun, 2018
7	75% F2 Friesian	31.6±1.60	on station	Getahun, 2018
8	75% HF	28±0.9	on station	Haile *et al*., 2009
9	75% HFxLocal	25.20±4.88	on farm	Muluye, 2016
10	87.5% HF	28±1.2	on station	Haile *et al*., 2009
11	93.75% HF	30.5±0.60	on station	Kassa, 2018
12	HFxArsi	33.62±0.71	on station	*Wassie et al*., 2015
13	HFxBorena	40.9±0.33	on station	Yalew *et al*., 2011
14	HFXBorena	26.4±0.8	on station	Gojam *et al*., 2017
15	HF x Borena	30.47±0.85	on station	*Wassie et al*., 2015
16	HF x Borena	31.33±0.44	on station	Mengistu *et al*., 2016
17	HF x Fogera	36.8±0.8	on station	Gebeyehu *et al*., 2005
18	HF x Fogera	18.96	on farm	Sena *et al*., 2014
19	Horro-Jersey F1	33.3±10.90	on farm	Dinka, 2013
20	Jersey x Horro	31.32±1.0	on station	Eshetu, 2015

Age at first calving (AFC)

Age at first calving is the age at which heifers calve for the first time. The high age at first calving may be related to environmental conditions, husbandry practices which may affect the cattle growth and due to management fluctuation over years, and the recommended amount of energy was not fed for calves (Genzebu *et al*., 2016; Mengistu *et al*., 2016). First calving also marks the beginning of a cow's productive life. Age at first calving is closely related to generation interval and, therefore, influences response to selection (Rahman *et al*., 2008).

Table 2: Age at First Calving of crossbred dairy cows with the different genetic groups in Ethiopia

No	breed/ genotype	AFC (months)	Study sites	Source
1	50% F1 Friesian	38.70±0.53	on station	Getahun, 2018
2	50% F2 Friesian	46.13±0.91	on station	Getahun, 2018
3	50% F3 Friesian	45.99±1.12	on station	Getahun, 2018
4	50% HF	39±0.6	on station	Haile *et al*., 2009
5	50% HF x Local	39.72±6.04	on farm	Muluye, 2016
6	50%F1 Friesian	39.61	on station	Birhanu, 2014
7	50%F2 Friesian	46.25	on station	Birhanu, 2014
8	50%F3 Friesian	47.23	on station	Birhanu, 2014
9	50%Friesian xArsi(F1)	29.2±1.4	on station	Negussie *et al*. 1998
10	50%HF x local(F1)	43.77±4.2	on station	Tadesse *et al*., 2006
11	50%HF x local(F2)	35.91±1.3	on station	Tadesse *et al*., 2006
12	50%HF x local(F3)	41.91±1.8	on station	Tadesse *et al*., 2006
13	50%Jersey x Arsi (F1)	28.5±1.3	on station	Negussie *et al*. 1998
14	50%Jersey x Borena (F1)	46.91±3.8	on station	Tadesse *et al*., 2006
15	50%Jersey x Borena (F2)	34.25±4.6	on station	Tadesse *et al.,* 2006
16	50%Jersey x local(F1)	45.32±2.7	on station	Tadesse *et al*., 2006
17	75% F1 Friesian	43.97±0.89	on station	Getahun, 2018
18	75% F2 Friesian	41.48±1.69	on station	Getahun, 2018
19	75% Friesian	41.29±9	on station	Effa *et al*., 2006
20	75% HF	40±0.9	on station	Haile *et al*., 2009
21	75% HF x Local	36.36±4.56	on farm	Muluye, 2016
22	75% Jersey	42.52±5	on station	Effa *et al*., 2006
23	75%HF x Borena	46.46	on station	Birhanu, 2014
24	75%HF x local(F1)	45.60±2.6	on station	Tadesse *et al*., 2006
25	75%HF x local(F2)	40.77±1.2	on station	Tadesse *et al*., 2006

No	breed/ genotype	AFC (months)	Study sites	Source
26	87.5% HF	39±1.3	on station	Haile *et al*., 2009
27	93.75% HF	39.76±0.67	on station	Kassa, 2018
28	F1 Friesian	42.35±9	on station	Effa *et al*., 2006
29	F1 Jersey	39.50±8	on station	Effa *et al*., 2006
30	F2 Friesian	48.56±5	on station	Effa *et al*., 2006
31	F2 Jersey	44.07±5	on station	Effa *et al*., 2006
32	HF x Arsi	42.84±0.84	on station	*Wassie et al*., 2015
33	HF x Borena	39.49±0.83	on station	*Wassie et al*., 2015
34	HF x Borena	41.08±0.44	on station	Mengistu *et al.,* 2016
35	HF x Fogera	29.52	on farm	Sena *et al*., 2014
36	HF x Local	38.8±0.5	on station	Negussie *et al*. 1999
37	HFx (Jersey x Arsi)	35.2±0.9	on station	Negussie *et al*. 1999
38	Jersey x GH	48.57±1.89	on farm	Wondossen *et al*., 2018
39	Jersey x Horro	42.2±11.45	on farm	Dinka, 2013
40	Jersey x Horro	42.02±1.1	on station	Eshetu, 2015

Calving interval (CI)

The calving interval is the period between two consecutive parturitions and ideally should be 12 to 13 months. Calving interval (CI) is one of the major components of reproductive performance that influences livestock production systems. The calving interval can be divided into three periods: gestation (from effective service to delivery), postpartum anestrus (from calving to first estrus), and service period (first postpartum estrus to conception). The high calving interval may be related to poor management practices, and other environmental stress that could affect the animal's return to estrus, heat detection, serving, and conception (Genzebu *et al*., 2016). Hence, the calving interval affects both the total milk production of the dairy herd and the number of calves born and it is considered an important index of reproductive performance (Arbel *et al*., 2001).

Table 3: Calving Interval of crossbred dairy cows with different genetic groups in Ethiopia

No	breed/ genotype	CI (days)	Study sites	Source
1	50% F1 Friesian	461.17±6.06	on station	Getahun, 2018
2	50% F2 Friesian	500.83±13.69	on station	Getahun, 2018
3	50% F3 Friesian	471.74±17.78	on station	Getahun, 2018
4	50% HF	422±10	on station	Haile *et al*., 2009
5	50% HF x Local	16.30±2.59	on farm	Muluye, 2016
6	50%F1 Friesian	433.33±4.51	on station	Birhanu, 2014
7	50%F2 Friesian	457.49±9.63	on station	Birhanu, 2014
8	50%F3 Friesian	451.84±11.66	on station	Birhanu, 2014
9	50%Friesian xArsi(F1)	358.1±10.4	on station	Negussie *et al*. 1998
10	50%FriesianxZebu(F1)	397.5±12.5	on station	Negussie *et al*. 1998
11	50%HF x Arsi	440.8±7.7	on station	Negussie *et al*. 1999
12	50%HF x local(F1)	438.90±10.49	on station	Tadesse *et al*., 2006
13	50%HF x local(F2)	494.66±5.45	on station	Tadesse *et al*., 2006
14	50%HF x local(F3)	457.01±29.08	on station	Tadesse *et al*., 2006
15	50%HF x Zebu	481.9±11.1	on station	Negussie *et al*., 1999
16	50%Jersey x Arsi	435.9±14.9	on station	Negussie *et al*., 1999
17	50%Jersey x Arsi (F1)	351.2±10.9	on station	Negussie *et al*., 1998
18	50%Jersey x local(F1)	417.02±16.35	on station	Tadesse *et al*., 2006
19	75% F1 Friesian	517.84±14.49	on station	Getahun, 2018
20	75% F2 Friesian	385.44±34.14	on station	Getahun, 2018
21	75% Friesian	546.40±9	on station	Effa *et al*., 2006
22	75% HF	443±11	on station	Haile *et al*., 2009
23	75% HF x Local	15.70±3.21	on farm	Muluye, 2016
24	75% Jersey	528.06±5	on station	Effa *et al*., 2006
25	75%HF x Borena	447.03±23.28	on station	Tadesse, 2014
26	75%HF x local(F1)	479.23±12.92	on station	Tadesse *et al*., 2006
27	75%HF x local(F2)	438.72±29.97	on station	Tadesse *et al*., 2006
28	75%HF x Zebu	479±9.6	on station	Negussie *et al*., 1999
29	75%HFxArsi	491.4±14.1	on station	Negussie *et al*., 1999

No	breed/ genotype	CI (days)	Study sites	Source
30	87.5% HF	423±21	on station	Haile *et al*., 2009
31	93.75% HF	446.1±6.80	on station	Kassa, 2018
32	F1 Friesian	477.77±12	on station	Effa *et al*., 2006
33	F1 Jersey	459.00±9	on station	Effa *et al*., 2006
34	F2 Friesian	512.6±5	on station	Effa *et al*., 2006
35	F2 Jersey	515±5	on station	Effa *et al*., 2006
36	HF x Arsi	475.48±4.08	on station	*W*assie *et al*., 2015
37	HF x Borena	475±2.84	on station	Yalew *et al*., 2011
38	HF x Borena	476.36±4.73	on station	*W*assie *et al*., 2015
39	HF x Borena	405.50±3.32	on station	Mengistu *et al.,* 2016
40	HF x Fogera	391.8	on farm	Sena *et al*., 2014
41	HFx (Jersey x Arsi)	422.9±18.3	on station	Negussie *et al*., 1999
42	Jersey x GH	597.3±65.4	on farm	Wondossen *et al*., 2018
43	Jersey X Horro	382.8±7.8	on station	Eshetu, 2015

Days open (DO)

Days open is also termed as calving-to-conception interval which is the period between calving and conception in cows (Bimerew, 2008). The days open period should not be exceeding 80-85 days to achieve the ideal calving interval of 12 months (Dayyani, 2013). Days open is influenced by the length of time for the uterus to completely involutes, resumption of the normal ovarian cycle, the occurrence of silent ovulation, the accuracy of heat detection, management, semen quality, and skill of inseminator or efficiency of bull (Tadesse, 2006; Melaku *et al*., 2011). Days open affect lifetime production and generation intervals, and hence the annual genetic gain Tadesse (2006) and it is one of the fertility traits explained in days (Dayyani *et al*., 2013).

Table 4: Days Open of crossbred dairy cows with different genetic groups in Ethiopia

No	breed/ genotype	DO (days)	Study sites	Source
1	50% F1 Friesian	180.82±6.03	on station	Getahun, 2018
2	50% F2 Friesian	222.67±13.48	on station	Getahun, 2018
3	50% F3 Friesian	192.06±17.64	on station	Getahun, 2018
4	50% Friesian x Zebu (F1)	120.8±10.8	on station	Negussie *et al*., 1998
5	50% HF	127±7	on station	Haile *et al*., 2009
6	50% HF x Local	109.80±54.00	on farm	Muluye, 2016
7	50%F1 Friesian	155.97±4.50	on station	Birhanu, 2014
8	50%F2 Friesian	181.81±9.60	on station	Birhanu, 2014
9	50%F3 Friesian	175.88±11.63	on station	Birhanu, 2014
10	50%Friesian x Arsi (F1)	82.9±12.3	on station	Negussie *et al*., 1998
11	50%Jersey x Arsi (F1)	76.3±10.3	on station	Negussie *et al*., 1998
12	75% F1 Friesian	243.03±14.39	on station	Getahun, 2018
13	75% F2 Friesian	108.55±33.45	on station	Getahun, 2018
14	75% Friesian	169.17±3	on station	Effa *et al*., 2006
15	75% HF	142±8	on station	Haile *et al*., 2009
16	75% HF x Local	103.50±36.00	on farm	Muluye, 2016
17	75%HF x Borena	166.61±23.22	on station	Birhanu, 2014
18	87.5% HF	134±14	on station	Haile *et al*., 2009
19	93.75% HF	181.7±7.00	on station	Kassa, 2018
20	F1 Friesian	173.19±5	on station	Effa *et al*., 2006
21	F1 Jersey	162.75±4	on station	Effa *et al*., 2006
22	F2 Friesian	173.5±2	on station	Effa *et al*., 2006
23	F2 Jersey	183±2	on station	Effa *et al*., 2006
24	HF x Borena	134.84±3.51	on station	Mengistu *et al*., 2016
25	HF x Fogera	93	on farm	Sena *et al*., 2014
26	Jersey x GH	105.86±20.44	on farm	Wondossen *et al*., 2018
27	Jersey X Horro	79.2±3	on station	Eshetu, 2015

Number of services per conception (NSPC)

The number of services per conception is another widely used index of fertility. The number of services per conception depends largely on the breeding system used. It is higher under uncontrolled natural breeding than hand-mating and artificial insemination (Kiwuwa *et al*., 1983). The number of services per conception higher than 2 should be considered as poor (Mukassa-Mugrewa, 1989).

Table 5: Number of services per conception of crossbred dairy cows with different genetic groups in Ethiopia

No	breed/ genotype	NSPC (r)	Study sites	Source
1	50% F1 Friesian	1.64±0.04	on station	Getahun, 2018
2	50% F2 Friesian	1.79±0.09	on station	Getahun, 2018
3	50% F3 Friesian	1.84±0.11	on station	Getahun, 2018
4	50% Friesian x Zebu (F1)	2.0±0.2	on station	Negussie *et al.,* 1998
5	50% HF	2.2±0.10	on station	Haile *et al*., 2009
6	50% HF x Local	1.51±0.34	on farm	Muluye, 2016
7	50%Friesian x Arsi (F1)	2.0±0.1	on station	Negussie *et al.,* 1998
8	50%Jersey x Arsi (F1)	1.8±0.1	on station	Negussie *et al.,* 1998
9	75% F1 Friesian	1.97±0.09	on station	Getahun, 2018
10	75% F2 Friesian	1.33±0.19	on station	Getahun, 2018
11	75% Friesian	1.59±5	on station	Effa *et al*., 2006
12	75% HF	2.2±0.17	on station	Haile *et al*., 2009
13	75% HF x Local	1.66±0.41	on farm	Muluye, 2016
14	75% Jersey	1.23±2	on station	Effa *et al*., 2006
15	87.5% HF	2 .1±0.28	on station	Haile *et al*., 2009
16	93.75% HF	1.6±0.05	on station	Kassa, 2018
17	F1 Friesian	1.46±6	on station	Effa *et al*., 2006
18	F1 Jersey	1.59±4	on station	Effa *et al*., 2006
19	F2 Friesian	1.4±4	on station	Effa *et al*., 2006
20	F2 Jersey	1.68±4	on station	Effa *et al*., 2006
21	HF x Borena	1.36±0.03	on station	Mengistu *et al*., 2016
22	HF x Fogera	1.56	on farm	Sena *et al*., 2014
23	HFx Fogera	1.54±0.1	on station	Gebeyehu *et al*., 2005
24	Jersey x GH	2.14±0.16	on farm	Wondossen *et al*., 2018
25	Jersey X Horro	1.75±0.11	on station	Eshetu, 2015
26	Jersey X Horro	1.8±0.94	on farm	Dinka, 2013

CONCLUSION

It is concluded that improving the management system such as efficient heat detection and timely insemination, better health management, genetic improvement of crossbreeding, and supplementing of good quality feed resources are required for optimal reproduction performance. It is possible to improve the reproductive performances of crossbred dairy cattle in the country. On-station and on-farm production systems should develop and implement complete records including identity, performance, health care, and production recording schemes. Selection and culling criteria should be defined on the bases of the reproductive performance of cows.

CONFLICTS OF INTEREST

The authors declares no conflicts of interest regarding the publication of this review paper.

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