Journal of Livestock Science and Production
p-ISSN 2598-2915
e-ISSN 2598-2907

REVIEW ON FERTILITY PERFORMANCES OF LOCAL AND CROSSES OF EXOTIC BREED DAIRY CATTLE IN ETHIOPIA

Molla Shumye and Kefale Getahun*
Ethiopian Institute of Agricultural Research, Holeta Research Center

*) corresponding author
corresponding email: kefalegetahun@gmail.com.

ABSTRACT

Review was carried out on fertility or reproductive performances of Ethiopian locals' cattle and their Friesian and Jersey crosses. The objectives were to review research results on age of puberty, age at first calving, days open, postpartum anestrus interval, Service period, Number of Services per Conception and calving interval. The available review result showed that F_1 Jersey and Friesian crosses had 7.65 and 5.89months shorter AFC than their F_2 counterparts, respectively. Likewise, these crosses also had 12.63 and 11.35-months shorter AFC than that of local cows, respectively. Crossbred cows having 75% Friesian inheritance had comparable age at first calving with that of F_1 Friesian and Jersey crosses. F_1 Friesian crosses were observed to have 37.67 and 33.96 days shorter calving interval as compared to crosses with 75% Frisian inheritances and F_2 Friesian crosses, respectively. F_1 Friesian and Jersey crosses had 33.96 and 54.91 days shorter calving interval than their F_2 counterparts, respectively. Crossbred cows having 75% Jersey had better reproductive performances than that of other crosses in reproductive traits considered except in age at first calving. Therefore, if the reproductive performance of local cows is to be improved, cows must be genetically upgraded to the level 50% exotic inheritances (Friesian/Jersey). Upgrading local cattle up to 75% exotic inheritance could also be done for better reproductive efficiency provided that the level of management is good enough to meet the relatively higher managerial demand of these animals. F_1 crossbred dairy cattle is suitable to be used as dairy cattle under small holder management conditions and crossbred having 75% exotic blood level for urban and peri-urban dairy producers.

Keywords: Calving interval, Crossbred, Dairy cattle, Local cattle, Reproductive performance

INTRODUCTION

Reproductive performance is of major importance in dairy enterprises. The main traits related to reproductive performance are age at first calving, the interval between successive calving (calving intervals) and, from these two, and the potential lifetime production.

In cattle production, good reproductive performance is essential to efficient management and production, although specific reproductive targets may depend to an extent on local conditions and on individual farm systems and targets. Reproductive traits describe the animal's ability to conceive, calve down and suckle the calf to weaning successfully (Davis, 1993). These traits are important since they affect the herd size and off take of the animals. Reproductive performance is commonly evaluated by analyzing female fertility traits.

The indigenous cattle of Ethiopia are well adapted to the environment in the tropics. This is from the fact that they possess a high degree of heat tolerance

and resistance to most of endemic diseases. However, their production and reproduction performances are poor. To increase their productivity exotic dairy breeds, in particular the Friesian were crossed with the local Zebu breeds for many years. The aim has been to combine the desirable characteristics such as adaptability, hardiness, disease resistance and heat tolerance of indigenous cattle with the high milk potential and faster growth rate of temperate cattle (Beyene, 1992).

Different results on reproduction performance of Ethiopian locals and their crosses were obtained by (Gifawosen et al., 2003; Demeke et al., 2004; Kefena et al., 2006; Million et al., 2006). These research findings needed to be well described to provide necessary information on reproductive performances of cows obtained at research dairy farms found at central highlands of Ethiopia. The objective of this paper is, therefore, to review research results on puberty age, age at first calving, days open, calving interval and other reproductive performances of local cattle and their Friesian and Jersey crosses and, compile those review results in one information.

Age at puberty

In female cattle age at puberty is time at which a heifers show first behavioral estrus accompanied by ovulation and development of a normal corpus luteum in the ovary. It is determined by genotype, growth, nutrition, thermal environment, rearing method and disease. The success of dairy farm is determined by the efficiency of rearing replacement heifers to their reproductive age. Perera (1999) suggested that it is advantageous to breed heifers as early as it is physiologically feasible since it results in earlier age at first calving, which in turn result in increased number of calves produced in lifetime.

Cattle heifers attain puberty when they reach 55 to 60 percent of their adult body weight. However, the age at which they attain puberty can be highly variable, ranging from 12 to 40 months in cattle. Thus, growth rate and body weight are more important determinants of puberty than age (Perera, 1999). It was also indicated that the mean age at first service of Boran, 50%, 62.5%, 75%, and 87.5% Friesian crosses were found to be 32.4, 26.7, 28.2, 28.4, 27.6 months, respectively (Haile et al., 2009).

DISCUSSION

Age at first calving

Age at first calving is not only affected by feeding systems, health care, genetic and other factors, but also by reproduction managements like effective heat detection and efficient insemination/mating at the right time after the attainment of puberty in growing dairy replacements. Reviews results for age at first calving of local and crossbred dairy cattle are summarized in Table 1. Among these, Kefena et al. (2006)

indicated that the means for AFC were 48.09, 50.02 and 55.85 months for Boran, Barka (Begait) and Horro local cattle, respectively. The results showed that the highest AFC for Horro cows followed by Barka and Borana. Poor performances in early growth traits for Horro breed might be contributed to late maturity and consequently resulted in longer age at first calving for this breed.

Among crosses, F_1 Jersey crosses had 1.28 months shorter AFC than F_1 Friesian crosses. Shorter AFC in this breed is supposed to originate from inherited genetic differences between the two crosses. F_1 Jersey and Friesian crosses had 7.65 and 5.89 months shorter AFC than their F_2 counterparts, respectively (Table 1). They had also 12.63 and 11.35 months shorter AFC than that of local cows, respectively. Comparison of AFC between F_2 crosses showed that F_2 Jersey crosses had comparable AFC with their F_2 Friesian counterparts. Crossbred cows having 75% Friesian inheritance had shorter AFC than F_2 Jersey and Friesian crosses but, comparable with that of F_1 Friesian and Jersey crosses (Table 1). The result agreed with that of (Kiwuwa et al., 1983) who reported that shorter age at first calving for 3/4 Exotic x 1/4 Arsi crosses in crossbreeding experiment at Asella research station. In addition, the overall mean age at first calving of F_1 Arsi and Zebu Friesian and Jersey crosses was reported to be 38.8 months (Enyew et al., 1999).

Table 1: Means of age at first calving in local and crossbred dairy cows by genetic groups.

Genetic groups	AFC (months)	Sources	Herd
Locals			
Boran	48.09	Kefena et al. (2006)	Holetta Research Center
Barka	50.02	"	"
Horro	55.85	"	"
Average	**51.32**		
Friesian crosses		"	"
F_1 FBo	44.02	"	"
F_1 (1/2Fx1/2L)	35.91	Million et al. (2006)	Asela Research Center
Average	**39.97**		
F_2 FBo	49.80	Kefena et al. (2006)	Holetta Research Center
F_2 (1/2Fx1/2L)	41.91	Million et al. (2006)	Asela Research Center
Average	**45.86**		
3/4Fx1/4Bo	38.52	Kefena et al. (2006)	Holetta Research Center
3/4Fx1/4L	40.77	Million et al. (2006)	Asela Research Center
Average	**39.65**		
Jersey crosses			
F_1 JBo	38.76	Kefena et al. (2006)	Holetta Research Center
F_1 (1/2Jx1/2L)	38.61	Million et al. (2006)	Asela Research Center
Average	**38.69**		
F_2 JBo	48.24	Kefena et al. (2006)	Holetta Research Center
F_2 (1/2J×1/2L)	44.43	Million et al. (2006)	Asela Research Center
Average	**46.34**		
3/4Jx1/4Bo	39.72	Kefena et al. (2006)	Holetta Research Center
3/4Jx1/4L	46.91	Million et al. (2006)	Asela Research Center
Average	**43.32**		

Seasons			
Dry Season	42.3	Million et al. (2006)	Asela Research Center
Short rainy Season	43.5	"	"
Long Rainy Season	41.3	"	"

AFC = Age at first calving; Bo = Boran; F = Friesian; J = Jersey; F_1FBo = F_1 Friesian x Boran; F_1JBo = F_1 Jersey x Boran; F_2F Bo = Friesian x Boran F2; F_2JBo = Jersey x Boran F_2; 3/4F:1/4Bo = 75% Friesian inheritances; 3/4J:1/4Bo = 75% Jersey inheritances; L= Locals; F_1, F_2 and 75% (¾) crosses are crosses with local breeds of Borena (Bor), Barca (Bar)-Begait, Arsi (Ar) and Horro (Hor). Dry Season = (Oct-Jan); Short rainy Season =(Feb-Apr); Long Rainy Season = (Jun- Sep).

However, the result of (Million et al., 2006) indicated that among Holstein Friesian crosses, age at first calving significantly increased by 4.86 months from F_1 (F×L) to 75% (3/4F×1/4L) crosses, i.e., the F_1 (½ F× ½ L) crosses gave the first calf by 4.86 months earlier than 75% (3/4F×1/4L) crosses (Table 1). Those different results attributed to the difference in management given to crossbred dairy cows. It is known that the level of management to be given is different for cows having different exotic blood levels, that is, cow having higher exotic blood level should be managed well to express their genetic potentials. The breed group F_2 (½ F× ½ L) crosses had significantly longer age at first calving by 6 months than F_1 (1/2F×1/2L) (Table 1). For Jersey crosses, it was also showed that the genetic group F_2 (½ J× ½ L) Jersey crosses had longer age at first calving (by 5.82 months) than F_1 (1/2J×1/2L) Jersey crosses. This could be due to the reason that F_1 crosses are favored with the advantage of heterosis.

The review results for the effects of seasons on age at first calving (AFC) are also presented in Table 1. The report of (Million et al., 2006) showed that heifers born during long wet season calved at younger age (41.4 months) than those calved during other seasons. The better age at first calving during long wet season could be related to availability of green feed during the mating period and its positive effect to cyclicity in the breeding cows.

Days Open

Day's open is a period which covers from calving up to conceiving time in dairy cows. It includes postpartum anoestrus period (interval from calving to first oestrus) and service period (interval from first estrus to conception). It is affected by genetic and environment factors like feed, health care, breeding management and others. Review results of (Gifawosen et al., 2003) on days open (DO), postpartum an estrus Interval (PPAI), service period (SP), and number of services per conception (NSC) showed in (Table 2). The result in that study confirmed that days open was significantly influenced by genetic group. Boran cows had 34 days and 35 days longer days open than the F_1- Friesian Boran (F_1FBO) and F_1-Jeresy Boran (F_1JBO) crosses respectively (Table 2). Similarly, earlier study by (Azage,1981) who reported that crossbred cows had 81.8 days shorter DO than the local cows. Tesfu (1990) also studied on

crossbred and Zebu cows in the central highlands of Ethiopia and had reported mean DO of 157.8 and 199.8 days, respectively.

The review result also showed that first crosses, especially, the F_1 Friesian Boran crosses (F_1FBO) had shorter DO than crossbred with F_2 and 3/4 Friesian Boran crosses (Gifawosen et al., 2003) (Table 2). This result agreed with the reports of (El-Amin et al., 1986). However, Gifawosen et al. (2003) indicated that ¾ Jersey x Boran crosses had shorter periods of DO than crossbreds with F_1 and F_2 Jersey crossbred dairy cows. This could be due to the high blood level of Jersey as the breed has a better adaptability to the local environment as compared to other crosses.

The same author reported that although the effect of season on DO was similar, cows calving at the end of the dry and during the short rainy seasons had a relatively shorter DO than those calving during the main rainy season (Table 2). This could be the advantage of calving during this period is related to better nutritional status in the subsequent favorable months of the rainy seasons to meet the higher nutrient requirements of postpartum cows for maintenance and lactation.

Table 2: Mean DO, PPAI, SP and NSC of Locals and different crossbred dairy cows at Holleta Agricultural Research Center

Genetic group	DO (days)	PPAI (days)	SP (days)	NSC (days)
Locals (BO)	178	123	65	2.06
F_1FBO	144	115	30	1.74
F_2FBO	183	150	36	1.58
3/4Fx1/4BO	164	146	38	1.52
F_1JBO	143	121	30	1.65
F_2JBO	185	160	37	1.59
3/4Jx1/4BO	121	114	21	1.41
Seasons				
Dry Season	174	139	19	1.55
Short rainy Season	129	108	45	1.47
Long Rainy Season	185	166	47	1.87

DO = Days Open; PPAI = Post Partum Anestrus Interval; SP = Service Period; NSC = Number of Service Per conception; BO = Borena breed; FBO = Friesian x Borena; F = Friesian breed; J = Jersey breed; JBO = Jersey x Borena; Dry Season = (Oct-Jan); Short rainy Season =(Feb-Apr); Long Rainy Season = (Jun- Sep)
Source: Gifawosen et al. (2003)

Post-partum anestrus interval (PPAI)

Post-partum anestrus interval is an interval between calving and first service of cows. After calving, the reproductive tract of the cow goes through a period of recovery called involution, during which the uterus returns to its non- pregnant size and state. This usually completed in 25 to 35 days. However, this process can be delayed due to abnormal delivery, such as dystocia, retained placenta or prolapse of uterus (perera, 1999) which determine both calving interval and calving rate of a herd. The research reports showed that first crosses, especially, the F_1FBO had shorter PPAI than the F_2 and 3/4 exotic inheritance

(Table 2). The fact that crossbreds with higher levels of exotic inheritance had longer PPAI which agreed with the reports of (El-Amin et al., 1986). However, ¾ Jersey- Boran crosses had been found to have shorter PPAI than crossbred with F_1 and F_2 Friesian and Jersey crossbred cows. Gifawosen et al. (2003) reported that 3/4JBO/ crosses had shortest (114 days) PPAI, followed by F_1FBO) and F_1JBO required 115 and 121 days respectively (Table 2). This could be due to the fact that Jersey has a better adaptability to the local environment as compared to Friesian crosses. Earlier report by Kebede et al. (1977) also reported that Jersey, being a small breed, might be better in feed efficiency and adaptation to local environment as compared to the large exotic breeds. The shortest PPAI for F_1 Friesian and Jersey crosses is caused by heterosis advantage as compared to F_2 crosses.

The report of Gifawosen et al. (2003) also showed that the effect of season on PPAI was similar to DO, cows calving at the end of the dry and during the short rainy seasons had a relatively shorter PPAI than those calving during the main rainy season (Table 2). This could also be related with the advantage of calving during this period is related to better nutritional status in the subsequent favorable months of the rainy seasons to meet nutritional requirements of postpartum cows for maintenance and lactation.

Service period (SP)

Service period is an interval between first estrus and conception which affected mainly by right heat detection method, the efficiency of AI technicians and timing of AI services. The research results indicated that the first crosses, especially, the F_1FBO and F_1JBO had shorter service period (30 days) than F_2 crosses. However, ¾ Boran x Jersey crosses had shorter service period (21 days) than F_1 and F_2 crosses, as well as local's cows (Table 2). This could be due to the small size of Jersey crosses that Jersey, being small breed, may be more drought resistant and may have a better feed efficiency as compared to the other large breeds and besides, may adapted better to warmer regions (Beyene, 1992). In dairy cattle, extended service period would increase the generation interval, limiting the number of lactations and calves born. On the other hand, too short a service period and a DO would adversely affect the length of lactation. It is therefore necessary that an optimum service period and DO commensurate with normal reproduction so that economic production could be obtained.

Gifawosen et al. (2003) had also investigated the effect of season on service days and other reproductive parameters of crossbred dairy cattle at Holetta research

center. They indicated that service period was longest in long rainy season (47 days), shortest in dry season (19 days) calvers and intermediate in short rainy season (45 days) Table 2. The long service period in long rainy season calvers might be attributed to scarcity of green fodders since the grazing are protected for hay making and water logging problems.

Number of Services per Conception (NSC)

Reviewed research result showed that a clear trend of improvement in fertility with increasing levels of exotic inheritance was observed (Table2). The NSC tended to decrease with increasing exotic blood (Friesian and Jersey) inheritance among cow breeds. Hence, the highest NSC (2.06) was found for Boran cows and the lowest (1.41) for ¾ JBO crossbred cows. The finding is agreed with the report of Mekonnen and Goshu (1987) who evaluated the reproductive performance of Zebu, Friesian and their crosses, and reported that the number of services required per conception tended to decrease with increasing Friesian inheritance among dam breeds.

The result obtained also showed that Boran cows needed more NSC than the F1 crossbred cows. Azage (1981) reported similar result on Zebu and their crosses with temperate breeds that the NSC decreased in the crosses as compared with the Zebu breeds.

The lowest mean number of services required per conception was obtained for ¾ JBO crosses (1.41). This could be due to small size of Jersey crosses that might make them compatible to the local environment as compared to Friesian.

The NSC showed seasonality that cows bred during the dry, short and main rainy seasons required 1.55, 1.47 and 1.87 services per conception, respectively (Table 2). Thus, cows inseminated during the short rainy seasons required low NSC than those cows bred in the main rainy season (Gifawosen et al., 2003). This could be due to the favorable climatic conditions and abundant green fodder availability. This report is in agreement with that of Azage (1981) who indicated that NSC increases in the dry months of the year as compared with rainy months of the year in Zebu and their temperate crosses in Ethiopia.

Calving Intervals

The calving interval (CI) is possibly the single reproductive index which provides most information on reproductive efficiency, whether in an individual cow or on herd basis. CI consists of three components such as postpartum anoestrus period, service period and gestation period (Interval from conception to calving). In order to maintain optimum economic

benefits under modern intensive dairy systems, it is generally accepted that the CI should be around one year. Since the average gestation length is 280 to 285 days, a cow must become pregnant by 80 to 85 days after calving in order to achieve this target (Perera, 1999). The same author also suggested achievable targets of reproductive performances in small holder dairy production systems through the use of appropriate genotypes, strategic changes in nutrition and better reproduction managements.

The available review result showed that F_1 Friesian crosses were observed to have 37.67 and 33.96 days shorter calving interval as compared to crosses with 75% Frisian inheritances and F_2 Friesian crosses, respectively (Table 3). However, F_1 Jersey crosses were observed to have 29.75 days longer calving interval as compared to 75% Jersey crosses and 54.91 days shorter than that of F_2 Jersey crosses respectively. When we compare in comparison of Friesian and Jersey crosses, F_1 Jersey and Friesian crosses have almost comparable CI. Likewise, F_2 Frisian and Jersey crosses have also almost the same CI. But ¾ Jersey crosses had 83.40 days shorter CI than ¾ Friesian crosses. The better reproductive performance F_1 crosses than those of F_2 crosses could be attributed to maximum heterotic effect obtained by crossing the two diverse cattle breeds. Relatively better reproductive performances of ¾ Jersey crosses than other types of crosses implies that the small size of Jersey crosses that Jersey being small breed, may be more drought resistant, may have a better feed efficiency and may adapted better to warmer regions as compared to the other large breeds (Beyene, 1992).

Table 3: Mean calving interval of crossbred dairy cows by genetic groups and seasons.

Genetic groups	CI (days)	Sources	Herd
Friesian crosses			
F_1 FBO	474.25	Kefena et al. (2006)	Holetta Research Center
F_1 (1/2Fx1/2L)	438.90	Million et al. (2006)	Asela Research Center
Average	**456.60**		
F_2 FBO	486.46	Kefena et al. (2006)	Holetta Research Center
F_2 (1/2Fx1/2L)	494.66	Million et al. (2006)	Asela Research Center
Average	**490.56**		
3/4Fx1/4BO	509.30	Kefena et al. (2006)	Holetta Research Center
3/4Fx1/4L	479.23	Million et al. (2006)	Asela Research Center
Average	**494.27**		
Jersey crosses			
F_1 JBO	464.21	Kefena et al. (2006)	Holetta Research Center
F_1 (1/2Jx1/2L)	417.02	Million et al. (2006)	Asela Research Center
Average	**440.62**		
F_2 JBO	502.56	Kefena et al. (2006)	Holetta Research Center
F_2 (1/2Jx1/2L)	488.09	Million et al. (2006)	Asela Research Center

Average	**495.33**		
3/4Jx1/4BO	450.30	Kefena et al. (2006)	Holetta Research Center
3/4Jx1/4L	371.44	Million et al. (2006)	Asela Research Center
Average	**410.87**		
Seasons		Million et al. (2006)	Asela Research Center
Dry Season	449	“	“
Short rainy Season	453	“	“
Long Rainy Season	441	“	“

CI = Calving Interval; BO = Borena breed; FBO = Friesian x Borena; F = Friesian breed; J = Jersey breed; JBO = Jersey x Borena; L = Local breed; F_1 = First filial generation; F_2 = Second filial generation; Dry Season = (Oct-Jan); Short rainy Season =(Feb-Apr); Long Rainy Season = (Jun- Sep)

The result was supported by report of Million et al. (2006) who indicated that mean calving interval significantly increased by 40 days from F_1 (F×L) to 75% (¾ F×¼ L). The same authors also showed that F_2 (½ F× ½ L) crosses had longer calving interval by 55.7 days than their parent F_1 (½ F× ½ L). The reviewed result also indicated that the breed group F_2 (½ J× ½ L) Jersey crosses had significantly longer calving interval by 71.07 days than F_1 (½ F× ½ L) crosses (Table 3).

The report also showed that even though there is no consistent trend, calving interval slightly decreased from parity one to parity three and increased from parity three to parity four and decreased then after (Million et al., 2006). However, Addisu Bitew (1999) and Wilson and Traore (1988) reported significant effect of parity on calving interval. The shorter calving intervals at later parities caused by selective culling against repeat breeder cows and were as expected for a well-managed herd. Shorter calving interval for parity six and above was reported on crossbreeding Frisian with local breed at Debre Zeit (Million, 1997). Kiwuwa et al. (1983) also reported a declined calving interval from parity one to parity four on crossbreeding of Friesian and Jersey with local breeds at Arsi.

Location effects also investigated on calving intervals of dairy cows. Mean calving interval was longer (466 days) at Holetta herd, while similar CI for Asella and Debre Zeit herds was reported (Table 4). This difference in calving interval across herd ascribed to the difference in management (feed, health and reproductive) provided to the animal as well as genotype of animals maintained in the location

Table 4: Mean calving interval (CI) of crossbred dairy cattle by parity across different research station in Ethiopia.

Research Stations	CI (days)
Asella	448
Debre Zeit	429
Holetta	466
Parity	
1	471
2	469
3	429
4	443
5	428

Source: Million et al. (2006).

CONCLUSION

The reproductive performance of dairy cattle is affected by both genetic and environmental factors like nutrition, health care, reproductive management and others. Reproductive performances such as age at first calving and calving intervals determine the lifetime productivity of dairy cattle. The reproductive performance of pure local cattle is low as compared to crossbred cattle. F_1 crossbred cows had better reproductive performances in most of reproductive parameters than other type of crosses except, ¾ Friesian crosses for age at first calving and Jersey for Calving interval. Crossbred cows having 75% Friesian inheritance had comparable age at first calving with that of F_1 Friesian and Jersey crosses. Crossbred cows having 75% Jersey had better reproductive performances than that of other crosses in reproductive traits considered except in age at first calving.

RECOMENDATION

Therefore, if the reproductive performance of local cows is to be improved, cows must be genetically upgraded to the level 50% Exotic inheritance. Upgrading local cattle up to 75% exotic inheritance could be done for better reproductive efficiency provided that the level of management is good enough to meet the relatively higher managerial demand of these animals. F_1 crossbred dairy cattle can be recommend for suitable dairy animal under small holder management conditions and crossbred having 75% exotic blood level for urban and peri-urban dairy producers.

REFERENCES

Addisu, B. 1999. Evaluation of reproductive and growth performance of Fogera cattle and their F_1 Friesian crosses at Metekel Ranch. MSc Thesis. Alemaya university of Agriculture, Alemaya, Ethiopia.

Azage, T. Galal, E.S.E. and Beyene K. 1981. A study on the reproduction of local Zebu and F_1 crossbred (European Zebu) cows.1. Number of services preconceptions, gestation length and days open till conception. *J. Agri. Sci.* 3:1-14.

Beyene, K. 1992. Estimation of Additive and non-additive genetic effects for growth, milk yield and reproduction traits of crossbred (*Bostaurs* x *Bos indicus*) Cattle in the wet and dry environments in Ethiopia. Ph.D. thesis, Cornell University, USA.

Davis, G.P. 1993. Genetic parameters for tropical beef cattle in Northern Australia: A review. *Australian Journal of Agricultural Research*. 44:179-198.

Demeke, S., Neser, F.W.C. and Schoeman, S.J. 2004. Estimates of genetic parameters for Boran, Friesian, and crosses of Friesian and Jersey with the Boran cattle in the tropical highlands of Ethiopia:

reproduction traits. *J. Anim. Breed. Genet.* 121:57-65.

El-Amin, F.M., Simerl, N.A. and Wilcox, C.J.1986. Genetic and Environmental effects upon reproductive performances of Holstein crossbreds in the Sudan. *J. Dairy. Sci*. 69:1093-1097.

Enyew N., Brannang, E. and Rottman, O.J.1999. Reproductive performance and wildlife of crossbred dairy cattle with different levels of European inheritance in Ethiopia. In: proceedings of the 7th Annual Conference of the Ethiopian Society of Animal production (ESAP).26-27 May 1999.Addis Ababa, Ethiopia.65-76.

Gifawosen T., Alemu, G.W. and Jayaparakash. 2003. Study on Reproductive Efficiency of Boran and its Crosses at Holetta Research Farm: Effect of genotype, management and environment**.** *Ethiopian Journal of Animal Production*. 3(1): 89-107**.**

Haile, A., Joshi, B.K., Workneh, A., Azage, T. and Singh, A. 2009. Genetic evaluation of Boran cattle and their crosses with Holstein Friesian in central Ethiopia: reproduction traits. *Journal of Agricultural Science*. 147:81–89.

Kebede, B., E.S.E. Galal, Alemu, G.W., P.B. O. Donouon, Sebhatu, G, Abraham, W. G. and Hailu, G. M.1977. Cattle cross breeding (European x Zebu) studies. Study on growth rate of F_1 calves. IAR, *Anim. Prod. Bull.* 1:4, Addis Ababa, Ethiopia.

Kefena, E., Tesfaye, K. and Yohannis, G. 2006. Review of the performance of crossbred dairy cattle in Ethiopia. In: proceedings of the 14th Annual Conference of the Ethiopian Society of Animal production (ESAP). September 5–7, 2006, Addis Ababa, Ethiopia.198.

Kiwuwa, G.H., Trail, J.C.M., Kurtu, M.Y., Worku, G., Anderson, F. and Durkin, J. 1983. Crossbred dairy cattle productivity in Arsi Region, Ethiopia. ILCA Research Report II, International Livestock Centre for Africa. pp. 1-29.

Mekonnen, H.M. and Goshu, M. 1987. Reproductive performance of Fogera Cattle and their Friesian crosses. *Ethiopian J. Agrc. Sci*. 9(2):95-114.

Million, T., Tadelle, D., Gifawesen, T., Tamirate, D. and Yohanis, G. 2006. Study on Age at First Calving, Calving Interval and Breeding Efficiency of Bos taurus, Bos indicus and their Crosses in the Highlands of Ethiopia. *Ethiopian Journal of Animal Production.* 6(2): 1-16.

Million, T. 1997. The performance of crossbreed of Holstein Friesian with Local Arsi at Central highlands of Ethiopia. Msc. Thesis, Wagenengen Agricultural University, the Netherlands.

Perera.1999. Management of Reproduction. Flavery. L and chantalakhana C. (eds). Smallholder dairying in tropics. ILRI (internaqtional Livestock Research Institiute), Nairobi, Kenya. Pp 244-248.

Tesfu, K. 1990. Postpartum reproductive activity of indigenous Zebu and Friesian x Zebu crossbred cows under small holder management conditions in Ethiopia. Improving productivity of indigenous African livestock coordinated Research program organized by the joint FAOL IAEA Division of Nuclear Techniques in food and agriculture, 21-25, Ghana Accra.

Wilson, R. T. and Traoer, A. 1988. Livestock production in central Mali: reproductive performance and reproductive wastage in ruminants in the Agro-pastoral system *Theriogenology.* 29:931-944.