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Genetic and Non-Genetic Parameters for Reproductive Traits of Dairy Cattle in Ethiopia: A Review

Nibo Beneberu
Ethiopian Institute of Agricultural Research, Holetta Agricultural Research Center
P.O.Box 2003 Addis Ababa or 31 Holetta, Ethiopia
bnibo1984@gmail.com

Abstract
Estimation of phenotypic and genetic parameters for reproductive traits is an important tool for the definition and evaluation of selection programs. Results from various studies indicated that research should be intensified to identify and utilize animals with greater genetic potential. Some researchers reported high value, whereas another reported low to moderate heritability value for reproductive traits. The contradictory results may be associated with differences in local breed, number and composition of used animals in the estimation procedures and differences in methods and software used in genetic parameter estimation. Knowledge of genetic and phenotypic parameters is required for planning efficient breeding programs in animal husbandry. By knowledge of heritability estimate, animal geneticists can determine whether or not a particular trait can be improved by selection, by improvement of management practices, or both. Genetic parameter estimation of indigenous cattle has been scanty in Ethiopia except limited research activities that have been doing in research centres, universities and some state farms. Even though the country has more than 27 indigenous characterized breeds, only few of them (Boran, Arsi, Fogera and Barka) have estimated their performance for cross breeding purpose. Since livestock are on the hands of farmers and characterized by having small fragmented population and absence of pedigree history, performance testing and selection and breeding programme/ has not been performed over the years. Estimation of phenotypic performance and genetic parameters over time is necessary, because of change in management, increased number of herds and herd size, Ethiopia, import semen from other countries.

Keywords: genetic parameters, non-genetic parameters, reproductive performance
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1. Introduction

Ethiopia is one of the developing countries in Africa known with a huge livestock population. The estimated total cattle population for the country is about 70 million constituting of male (44%) and female (56%). Out of the total cattle population in the country, the proportion of indigenous breeds are 97.4% and the remaining hybrid and exotic breeds are about 2.3% and 0.31%, respectively (CSA 2020/2021). The dairy industry in Ethiopia is still not developed compared to east African countries like Kenya, Tanzania and Uganda (Hunduma 2013).

Genetic improvement strategies of cattle in Ethiopia has been brought through modifying the breed composition of local populations, either by introducing genes from an external source or through direct importation of exotic cattle breeds from other countries (Habtamu et al. 2010). Breed improvement programs for dairy production in Ethiopia had started by importing pure temperate breed of cows during the Italian occupation (Aynalem 2006; Staal et al. 2008). The overall productivity and adaptive efficiency of cattle depends largely on their reproductive performance in a given environment (Nuraddis et al. 2011).

Holstein-Friesian and Jersey breeds are the most common highly productive exotic dairy cattle breeds that were introduced in Ethiopia, and are important sources of milk and income, especially in urban areas. Despite this fact, reproductive performances of these breeds are not well documented after the animals are introduced and distributed to specific locations (Hunduma 2013). Moreover, in Ethiopia particularly in the lowland areas there is a need for critical investigation on reproductive performance of dairy cows (Sisay 2015).

Even though there is concern about adaptation problems of pure exotic dairy cattle to tropical environment (feed, disease challenge and climate) pure Friesian and Jersey dairy breeds have been utilized by large scale private and state dairy farms in Ethiopia. Improved exotic breed would potentially serve selected niches used as a genetic pool for the national artificial insemination center (NAIC) to recruit AI bulls for genetic improvement program of the country (Direba 2012).

Reproductive traits are the most economically important traits, contributing for the profitability of dairy production (Fikre et al. 2007). Age at first service (AFS), age at first calving (AFC), calving interval (CI), days open until conception (DO), and number of services per conception (NSPC) are common reproductive traits of dairy cow that influence breeding animals' performance.

The most common genetic parameters are heritability, repeatability and genetic correlation (Yibrah 2008). The estimates of genetic parameters for reproductive traits are helpful in determining the method of selection to predict direct and correlated response to selection, choosing a breeding system to be adopted for future improvement as well as genetic gains (Edward et al. 2013; Gebeyehu et al. 2014).

Furthermore, development of breeding objectives and effective genetic improvement programs require advanced knowledge of the genetic variation among economically important reproductive traits and accurate estimates of heritability, repeatability and genetic correlations of economically important traits (Solomon et al. 2002; Juma and Alkass 2006).

In Ethiopia there is no well-reviewed works on Genetic and non-genetic parameter estimates for reproductive traits of dairy cattle. This paper is a review of the genetic and non-genetic parameter estimates for reproductive traits of dairy cattle in Ethiopia.

2. Reproductive traits

Reproductive performance of cows and heifers is one of the most important factors that influence the profitability of the dairy sector. As a result of biological mechanisms (Artificial Insemination) associated with getting a cow or heifer breed can be a significant management tool for increasing realized income from the dairy sector (Bainesagn 2015). Reproductive performance is commonly evaluated by analysing female reproductive traits (Aynalem et al. 2011). The main indicators that would be considered in assessing reproductive performance are age at first service (AFS), age at first calving (AFC), calving interval (CI), days open (DO) and number of services per conception (NSPC) (Demissu et al. 2013; Habtamu et al. 2010). The reproductive performance of Ethiopian indigenous and exotic breeds in various farms in Ethiopia is poor mainly due to various environmental factors and management or husbandry practices (Assemu and Garikipati 2014).

2.1. Age at first service (AFS)

Age at first service is the age at which breeding heifers reach for sexual maturity and accept mating for the first time. The economy of the farm can be feasible by showing oestrous as early as possible for female animal. A substantial delay in the attainment of sexual maturity may mean a serious economic loss, due to an additional, non-lactating, unproductive period of the cow over several months (Belay et al. 2012). According to Yosef (2006) and Habtamu et al. (2010) the AFS of Jersey breed are 22.73±0.82 and 24.07±1.2 months, respectively. Whereas, the Holstein breed required 316 more days to reach age at first service than Jersey breed (33.26±0.83 vs. 22.73±0.82 months) (Yosef 2006). The variation of age at first service between Holstein breed and Jersey breed could be because of their differences in grazing ability, nutrition and body size as well as the adaptation to tropical environment (Yosef 2006).

Age at first service is determined by several factors, which are endogenous for example, genotype, growth rates, body size difference and body weight, as well as exogenous, for example, year or season of birth, rainfall, nutrition, thermal environment, photoperiod, rearing method, low level of management, poor feeding of calves and heifers at the earlier stages, grazing ability, utilization of poor pasture, and diseases (Yosef 2006; Tewodros 2008; Belay 2014; Dessalegn et al. 2016).

2.2. 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 have effect on the growth of cattle and management fluctuation among years as well as lower energy intake of calves than the recommended amount (Dessalegn et al. 2016 and (Mengistu et al. 2016). According to (Yosef 2006; Direba 2012; Habtamu et al. 2010) the age at first calving of Jersey breed is 32.41±0.54, 34.51±0.42 and 29.92±0.17 months, respectively. The authors also reported that AFC is affected by variability in management and climatic conditions, nutrition (feed shortage), health problems, year and season of birth.

2.3. Calving interval (CI)

The calving interval is the period between two consecutive parturitions, which is ideally 12 to 13 months. Calving interval (CI) is one of the major components of reproductive performance that influences the profitability of the dairy sector. The calving interval can be divided into three periods: gestation (from effective service to delivery), postpartum anoestrus (from calving to first oestrus) and service period (first postpartum oestrus to conception). The high calving interval may be related to poor management practices and other environmental stress that could affect the animals return to oestrus, heat detection, serving and conception (Dessalegn 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).

2.4. Days open (DO)

Days open is also termed as calving-to-conception interval which is the period between calving and conception in cows (Tewodros 2008). Days open is influenced by the length of time for the uterus to completely involutes, resumption of normal ovarian cycle, occurrence of silent ovulation, accuracy of heat detection, management, semen quality and skill of inseminator or efficiency of bull (Yosef 2006; Melaku et al. 2011). Days open affect lifetime production and generation intervals, and hence the annual genetic gain and it is one of the fertility traits explained in days (Yosef 2006).

Direba (2012) reported that the DO of pure Jersey breed was estimated as 221.95±3.52 days. According to the report of Million et al. (2010) and Destaw and Kefyalew (2018), the overall least square mean of DO of Holstein Friesian cows in Ethiopia was estimated as 148±1.72 days and 228.2±10.2 days, respectively. The significant difference in days open between herds (Dinkity, Holetta and Stella) was related to difference in management such as nutrition, health and heat detection by farmers which affect calving to first service interval (CFSI) and hence days open. The author also reported that breed and season had significantly affected this trait (Million et al. 2010).

Table 1: Age at first service (AFS), age at first calving (AFC), calving interval (CI) and days Open (DO) of different breeds of dairy cows in Ethiopia

	Reproductive performance traits				
Breeds	**AFS (M)**	**AFC (M)**	**CI (Days)**	**DO (Days)**	**Reference**
Jersey	22.73±0.82	32.41±0.54	499.59±21.14	221.95±3.52	Yosef 2006
Jersey	24.07±1.2	34.51±0.42	450.09±6.60	-	Habtamu et al. 2010
Jersey	-	29.92±0.17	497.08±3.69	220.49±19.21	Direba 2012
HF	33.26±0.83	43.31±0.48	452.88±19.93	173.98±11.45	Yosef 2006
HF	32.71±0.69	42.13±0.70	413.04±7.31	139.58±7.91	Mengistu et al. 2016
HF	-	39.2±7.5	446 ±91	148±1.72	Million et al. 2010
HF	-	40.9±0.33	475±2.84	-	Berhanu et al. 2011
HF	-	40.83±0.46	-	-	Gebeyehu et al. 2014
HFxBor	-	40.23	461.34	184.72	Tadesse 2014
HFxBor	26.80±0.34	37.42±0.35	476.35±3.91	197.10±3.88	Kefale 2018
HFxBor	28.7±0.7	40.5±0.7	435±11	141±19	Aynalem et al. 2009
HFxBor	26.22±0.41	34.66±0.56	-	-	Berhanu and Ashim 2014
HFxBor	30.47±0.85	39.49±0.83	476.36±4.73	195.47±4.74	Wassie et al. 2015
HFxArsi	33.62±0.71	42.84±0.84	475.48±4.08	193.77±4.06	Wassie et al. 2015

HF= Holstein Friesian, HF x Boran= Holstein Friesian cross with Boran, HF x Arsi= Holstein Friesian cross with Arisi

2.5. Number of service per conception (NSPC)

Number of services per conception is one of the parameters for measuring cow reproductive efficiency. Number of services per conception shows that how many services are required for a successful conception of breeding animals and it is calculated by dividing the number of conceptions with the number of inseminations. NSPC values greater than 2.0 should be considered as poor considering the definition of repeat breeder. The optimum recommended NSPC for profitable dairy cows ranges from 1 to 1.7 (Evelyn 2001).

According to the report of Yosef (2006); Habtamu et al. (2010) and Direba (2012), the NSPC of pure Jersey breed is 3.07±0.08, 1.79±0.06 and 2.02±0.02, respectively. The average number of service per conception of Holstein Friesian cows in Ethiopia were 1.32±0.03 and 1.81 reported by (Destaw and Kefyalew 2018 and Million et al. 2010).

The variation of NSPC in this review was due to inconsistent feeding management, variation of heat detection, skill of inseminator, time of insemination, semen quality, silent ovulation of cows, fertility of cows, environmental variability and the level of knowledge of owners in managing their dairy cows (Million et al. 2010; Hunduma 2012; Mengistu et al. 2016; Kefale 2018; Destaw and Kefyalew 2018).

Table 0: Number of service per conception of different breeds of dairy cows in Ethiopia

Breeds	NSPC	Reference
Jersey	3.07±0.08	Yosef 2006
Jersey	1.79±0.06	Habtamu et al. 2010
Jersey	2.02±0.02	Direba et al. 2012
HF	2.01±0.07	Yosef 2006
HF	1.81	Million et al. 2010
HF	1.30±0.06	Mengistu et al. 2016
HFxBor	1.75±0.03	Kefale 2018
HFxBor	2.33±0.1	Aynalem et al. 2009
HFxBor	1.39±0.05	Wassie et al. 2015
HFxArsi	1.32±0.06	Wassie et al. 2015

HF= Holstein Friesian, HF x Boran= Holstein Friesian cross with Boran, HF x Arsi= Holstein Friesian cross with Arisi, NSPC= number of service per conception

3. Non-genetic factors influencing reproductive

Non-genetic factors such as birth year or calving year, parity of cow and birth season of cattle influence reproductive performance of dairy cattle, which should be considered in selection for increased production and reproductive efficiency of dairy cattle (Olawumi and Salako 2010). Knowledge on these non-genetic factors and their influence on cattle reproductive performance are important in formulation of management and selection decisions. In various studies, a number of factors have been included in analyses as main factors or their two- and/or three-way interactions either as fixed effects or as continuous effects to account for environmental sources of variation in animal's performance (Wasike 2006). These factors, which can be assisted as fixed effect and other stress causing factors affect the performance of individual reproductive performances in turn, affect the productivity of a given farm (Wasike 2006 and Almaz 2012).

Different authors have reported that AFS and AFC are significantly affected by birth year (Yosef 2006; Aynalem et al. 2009; Habtamu et al. 2010; Berhanu and Ashim 2014; Mengistu et al. 2016) but AFS and AFC were not significantly affected by season (Aynalem et al. 2009; Habtamu et al. 2010; Almaz 2012; Berhanu and Ashim 2014; Wassie et al. 2015; Kefale 2018).

Table 3: Non-genetic factors influencing reproductive performance traits of dairy cattle

Factors	Breeds	Reproductive traits					Reference
		AFS	**AFC**	**CI**	**DO**	**NSPC**	
Period	Jersey & HF	**	**	**	**	**	Yosef 2006
	HFxBo	**	**	**	**	**	Aynalem et al. 2009
	Jersey	***	***	***		***	Habtamu et al. 2010
	HF	***	***	***	***	***	Mengistu et al. 2016
	HFxBo	****	****	****	****	*	Kefale 2018
	HFxBo	**	**				Berhanu and Ashim 2014
	Jersey		****	****	****	****	Direba 2012
	HF		***	***	***		Million et al. 2010
	HF		**	**			Berhanu et al. 2011
	HFxBo		**	**	**		Tadesse 2014
	Fogera		***	***	***		Almaz 2012
Season	Jersey & HF	NS	*	NS	NS	NS	Yosef 2006
	HFxBo	NS	NS	NS	NS	NS	Aynalem et al. 2009
	Jersey	NS	NS	NS		*	Habtamu et al. 2010
	HF	*	*	NS	NS	NS	Mengistu et al. 2016
	HFxBo	NS	NS	***	***	NS	Kefale 2018
	HFxBo	NS	NS				Berhanu and Ashim 2014
	Jersey		****	NS	NS	***	Direba 2012
	HF		NS	***	NS		Million et al. 2010
	HF		NS	NS			Berhanu et al. 2011
	HFxBo		*	*	*		Tadesse 2014
	HFxBo&HFxAr	NS	NS	**	**	**	Wassie et al. 2015
	Fogera		NS	***	***		Almaz 2012
	HFxZebu&JxZebu			***	**	**	Yifat et al. 2009
Parity	Jersey & HF			**	*	**	Yosef 2006
	HFxBo				**		Aynalem et al. 2009
	Jersey				***	NS	Habtamu et al. 2010
	HF			***	***	NS	Mengistu et al. 2016
	HFxBo			****	****	NS	Kefale 2018
	Jersey			****	****	****	Direba 2012
	HF			***	***		Million et al. 2010
	HF			**			Berhanu et al. 2011
	HFxBo			**	*		Tadesse 2014
	HFxBo&HFxAr	NS	**	**	**	NS	Wassie et al. 2015
	Fogera		NS	***	***		Almaz 2012
	HFxZebu&JxZebu			NS	**	***	Yifat et al. 2009

**** ($p< 0.0001$), *** ($P< 0.001$), ** ($P< 0.01$) * ($P< 0.05$) and NS= not significant AFS (Age at First Service), AFC (Age at First Calving), CI (Calving Interval), DO (Days Open) and NSPC (Number of Service per Conception)

4. Genetic Parameter

Genetic parameter are needed for genetic improvement programs to predict the breeding values of candidates for genetic selection, to choose among mating plans and to predict selection response (Montaldo et al. 2010). The potential for genetic improvement of a trait largely depends upon genetic variation existing in the population of interest. The genetic composition of a population can be studied by considering the relative importance of heredity and environmental factors affecting the performance of individual in that population (Gebeyehu et al. 2014). Precise and accurate knowledge of genetic parameters are of paramount importance for planning appropriate selection and breeding strategies for the genetic improvement programs (Choudhary et al. 2003; Wasike et al. 2006; Edward et al. 2013; Gebeyehu et al. 2014).

Studies on estimation of genetic parameters on Ethiopian cattle are scanty which might be attributed to lack of well-structured pedigree data and lack of farm record. However, some estimates of genetic parameters (heritability, repeatability and genetic and phenotypic correlation) of reproductive have been reported (Sindros et al. 2004; Aynalem et al. 2009; Kefena et al. 2011; Gebregziabher et al. 2013; Kefale 2018). The information on heritability, repeatability and genetic correlation estimate for reproductive trait of Ethiopian dairy cattle breed are summarized and discussed below.

4.1. Heritability

Heritability is defined as the proportion of phenotypic variance that is due to additive genetic variance. Heritability as a value that expresses and measures average additive gene effect is one of the major characteristics of quantitative traits from the point of view of creation of genetically highly valuable cattle populations. Heritability is important among the several factors determining how much genetic improvement can be made in any trait (Aynalem 2006). Heritability is critically important for selection of polygenic traits. Knowledge of heritability is necessary in the assessment of breeding value of cattle and it influences considerably the selection of breeding method. The low heritability is caused not only by a low genetic variance but also by a higher phenotypic variance due to small size of the herd and by random or unidentified environmental factors (Khalid et al. 2001). Heritability estimation can be increased by providing uniform environment, use of multiple measurements, adjustment of records and accurate measurement of data (Aynalem 2010). Different estimates of heritability may be found for the same trait in different populations or in one population at different times.

4.1.1. Heritability estimates for reproduction traits

Most reproductive traits are heavily influenced by differences in herd management practices and other environmental factors rather than genetic factors. However, sire selection can make a noticeable difference to the reproductive performance of herds in the long term (Yosef 2006). A study conducted by Sindros et al. (2004) reported that the heritability estimate of reproductive traits of crossbred dairy cattle were 0.44±0.05, 0.08±0.03, 0.04±0.03 and 0.07±0.02 for AFC, CI, DO and NSPC, respectively. On the other hand a heritability value of 0.10±0.05, 0.1±0.05 and 0.1±0.07 were reported by Aynalem et al. (2009) for CI, DO and NSPC with higher heritability values of AFS (0.61±0.15) and AFC (0.7±0.16).

Kefena et al.. (2011) studied Friesian and Jersey crosses for different traits and reported that heritability estimates of age at first calving and calving interval were 0.40 and 0.17, respectively. Heritability of age at first calving is generally low, indicating that this trait is highly influenced by environmental factors. The heritability of jersey and HF dairy cattle for AFS were 0.12±0.02 and 0.42±0.05, respectively (Yosef 2006). According to Kefale (2018) the heritability value of AFS, AFC, CI, DO and NSPC for Friesian and Boran crosses at Holetta research center were 0.22±0.08, 0.30±0.08, 0.071±0.03, 0.082±0.03 and 0.012±0.003, respectively. A study conducted by Tadesse (2014) to estimate heritability value of reproductive traits of Friesian and Boran crosses at Holetta research center were 0.38±0.07, 0.16±0.031 and 0.17±0.032 for AFC, CI and DO, respectively.

Table 4: Heritability of reproductive traits for some Ethiopian dairy cattle

Traits	Breed	h^2±S.E	Reference
AFS	Jersey	0.12±0.02	Yosef 2006
	HF	0.42±0.05	Yosef 2006
	HFxBor	0.22 ± 0.08	Kefale 2018
	HFxBor	0.61±0.15	Aynalem et al. 2009
	HFxBor	0.51±0.10	Berhanu and Ashim 2014
AFC	Jersey	0.16±0.06	Yosef 2006
	HF	0.62±0.09	Yosef 2006
	HF	0.53±0.116	Gebeyehu et al. 2014
	HFxBor	0.30±0.08	Kefale 2018
	HFxBor	0.38±0.07	Tadesse 2014
	HFxBor	0.7±0.16	Aynalem et al. 2009
	HFxBor	0.49±0.13	Berhanu and Ashim 2014
	HFxBo&JBxBor	0.44±0.05	Sindros et al. 2004
CI	Jersey	0.00±0.02	Yosef 2006
	HF	0.08±0.05	Yosef 2006
	HFxBor	0.071±0.03	Kefale 2018
	HFxBor	0.16±0.031	Tadesse 2014
	HFxBor	0.10±0.05	Aynalem et al. 2009
	HFxBo&JBxBor	0.08±0.03	Sindros et al. 2004
DO	Jersey	0.07±0.03	Yosef 2006
	HF	0.15±0.04	Yosef 2006
	HFxBor	0.082±0.03	Kefale 2018
	HFxBor	0.17±0.032	Tadesse 2014
	HFxBor	0.1±0.05	Aynalem et al. 2009
	HFxBo&JBxBor	0.04±0.03	Sindros et al. 2004
NSPC	HFxBor	0.012±0.003	Kefale 2018
	HFxBor	0.1±0.07	Aynalem et al. 2009
	HFxBo&JBxBor	0.07±0.02	Sindros et al. 2004

AFS (Age at First Service), AFC (Age at First Calving), CI (Calving Interval), DO (Days Open) and NSPC (Number of Service per Conception) and h^2 (Heritability)

4.2. Repeatability

In dairy cattle, the measure of repeatability estimate refers to strength of the relationship or correlation between repeated records for a trait in a population and this may be utilized to assess the real producing ability of individual cows in a population (Olawumi and Salako 2010). Repeatability value is greater than heritability value since repeatability estimates include the permanent environmental variance in addition to the additive genetic variance component. When repeatability is high, we can say that a single record of performance on an animal is, on average, a good indicator of that animal's producing ability. When repeatability is low, a single phenotypic value tells us very little about producing ability. Cows should not be culled on single (or only few) initially available records. Lower repeatability estimate for traits could be also due to higher influence of specific environmental effects on a given record that may inflate within animal records variability (Aynalem et al. 2009).

The repeatability value of reproductive traits for Frisian with Boran crossbred dairy in Holeta research center were 0.17±0.02, 0.17±0.02 and 0.129±0.03 for CI, DO and NSPC, respectively (Kefale 2018). Sindros et al. (2004) studied repeatability of reproductive trait of crossbred dairy in the tropical high land of Ethiopia and reported a repeatability estimate of 0.14±0.02, 0.14±0.02 and 0.08±0.01 for CI, DO and NSPC, respectively. Aynalem et al. (2009) reported an approximate average repeatability value of 0.10 and 0.11 for two economic traits (CI and DO) for Borena and Friesian crosses in central Ethiopia. Yosef (2006) reported that the repeatability value of reproductive traits of Jersey dairy cattle were 0.02±0.01and 0.12±0.08 for CI and DO and HF dairy cattle were

0.22±0.07 and 0.25±0.06 for CI and DO, respectively.

Table 5: Repeatability of reproductive traits for some Ethiopian dairy cattle

Traits	Breeds	r^2±S.E	Reference
CI	Jersey	0.02±0.01	Yosef 2006
	HF	0.22±0.07	Yosef 2006
	HFxBor&JBxBor	0.14 ± 0.02	Sindros et al. 2004
	HFxBor	0.17±0.02	Kefale 2018
	HFxBor	0.1	Aynalem et al. 2009
DO	Jersey	0.12±0.08	Yosef 2006
	HF	0.25±0.06	Yosef 2006
	HFxBor&JBxBor	0.14 ± 0.02	Sindros et al. 2004
	HFxBor	0.17±0.02	Kefale 2018
	HFxBor	0.11	Aynalem et al. 2009
NSPC	HFxBor	0.129±0.03	Kefale 2018
	HFxBor&JxBor	0.08 ± 0.01	Sindros et al. 2004

CI (Calving Interval), DO (Days Open), NSPC (Number of Service per Conception), and r^2 (Repeatability)

4.3. Genetic and phenotypic correlations

Correlations are measures of the strength of relationship between two variables. High correlation value implies strong relationship between variables and vice versa (Bourdon 2000). Correlations are important as the aid in prediction of response to selection in one trait due to selection in another and are partitioned into phenotypic, genotypic and environmental correlations. The genetic correlation expresses the extent to which two characters are influenced by the same genes and it is important when selecting for net merit involving several traits. Estimates of genetic correlation between any pair of traits suggest that selection for one trait can lead to an indirect genetic response in the other trait (Edward et al. 2013; Gebeyehu et al. 2014).

Correlations can also be positive or negative implying positive and negative association, respectively. Phenotypic, genetic and environmental correlations are measures of the strength of the relationship between animal performance among traits, breeding values and environmental effects between traits, respectively (Belay 2014). Information of genetic and phenotypic correlations between different traits is useful in formulating breeding program because these parameters determine the direction and magnitude of genetic improvement in others when selection is based on any one of these traits. (Assemu 2015)

According to Tadesse (2014) genetic correlations between CI and DO, was 0.997 in Ethiopian Boran while the genetic correlation between CI and DO, 0.998 in Holstein Frisian with Boran crosses. The phenotypic correlation were also reported to be 0.998 for CI and DO in Ethiopian Boran while the phenotypic correlation were reported to be 0.998 between CI and DO in Holstein Frisian with Boran crosses at Holeta research center.

The negative genetic correlation were observed between AFS and DO (-0.001), AFC and DO (-0.05), AFS and NSPC (-0.022), AFC and NSPC (-0.29) and CI and NSPC (-0.31) (Kefale 2018). The genetic correlation of Holstein Frisian and Jersey with Boran cross breed dairy cows was reported to be 0.10±0.20 between AFS and AFC (Berhanu and Ashim 2014).

There was a positive phenotypic correlation between Age at first service (AFS) and Age at first calving (AFC) (0.85) and strong positive phenotypic correlation was observed between Calving interval and Days open (0.99). Except between DO and GL which showed moderate negative genetic correlation (-0.4662) strong genetic correlations were observed among reproductive traits, which ranged from strong positive (1.00) between AFS and AFC, between CI and DO to strong negative (-1.00) between CI and GL. The strong negative correlation shows that as calving interval increase the dam gets more time to build her body which could help for better fertility and fast growth of the fetus, as a result, the gestation length became short. Due to the strong genetic relationship between these traits, selection of one of them could have high effect on the other through correlated responses (Belay et al. 2016)

The report of Aynalem et al. (2009) showed that the genetic correlations between AFS and AFC in Holstein Frisian and Boran cross was very strong (0.88±0.052) and highly significant ($P<0.01$) as expected. AFC also had significant genetic correlations with NSPC (0.65±0.161).

Table 6: Genetic correlation (rg) and phenotypic correlations (rp)

Genotype	Traits		r_g	r_p	Reference
HFXBor	AFC	NSPC	0.65±0.161	-	Aynalem et al. 2009
HF	AFC	DO	-	-0.02±0.01	Yosef 2006
Jersey	AFC	DO	-	0.13±0.02	Yosef 2006
HFXBor	AFS	AFC	0.98	0.84	Kefale 2018
HFXBor	AFS	AFC	0.10±0.20	0.12±0.21	Berhanu and Ashim 2014
HFXBor	AFS	AFC	1	0.85	Belay et al. 2016
HFXBor	AFS	AFC	0.88±0.052	-	Aynalem et al. 2009
HFxBor	AFS	DO	0.51±0.302	-	Aynalem et al. 2009
HFXBor	AFS	NSPC	0.38±0.208	-	Aynalem et al. 2009
Boran	CI	DO	0.997±0.0009	0.998	Tadesse 2014
HFXBor	CI	DO	0.998±0.00004	0.998	Tadesse 2014
HFXBor	CI	DO	1	0.99	Belay et al. 2016

AFS (Age at First Service), AFC (Age at First Calving), CI (Calving Interval), DO (Days Open), NSPC (Number of Service per Conception), r_g (Genetic correlation) and r_p (phenotypic correlation)

5. Conclusion

In order to improve performance of dairy animals, it is necessary to understand the factors affecting various performance traits. Estimation of genetic parameters over time is necessary, because of change in management, increase number of herds and herd size Ethiopia, import semen from other countries. Selection and culling criteria should be defined on the bases of reproductive performance of cows. Better managements should start at early age to insure optimal reproduction performance. On station and on farm production system should be developed and complete records should be implemented including identity, performance, health care and production recording schemes.

6. References

Almaz Bekele. 2012. Genetic parameter estimation of growth and reproduction traits of Fogera cattle at Metekel Ranch, Amhara Region, Ethiopia. MSc Thesis, Bahir Dar University college of Agriculture and Environmental science, Bahir Dar, Ethiopia, 108 pp.

Assemu Tesfa. 2015. Estimation of Genetic and Non Genetic Parameters for Growth and Reproductive Performance Traits of Fogera Cattle Breed. MSc Thesis, Bahir Dar University, Bahir Dar, Ethiopia, 101 pp.

Assemu Tesfa and D K Garikipati. 2014. Genetic and non-genetic parameter estimates of dairy cattle in Ethiopia: a review. Online Journal of Animal and Feed Research Volume. 4: 83-90.

Aynalem Haile. 2006. Genetic and economic analysis of Ethiopian Boran cattle and their crosses with Holstein Friesian in Central Ethiopia. PhD dissertation in Animal Genetics and breeding, Haryana, India, 197 pp.

Aynalem Haile. 2010. Genetic parameters: a lecture note. International Livestock Research Institute. Addis Abeba, Ethiopia.

Aynalem Haile, B K, Joshi, Workneh Ayalew, Azage Tegegne and A, Singh. 2009. Genetic evaluation of Ethiopian Borena cattle and their crosses with Holstein Friesian in central Ethiopia: Reproductive traits. Journal of Agricultural Science, 147: 81 - 89.

Aynalem Haile, Workneh A, Noah K, Tadelle D and Azage T. 2011. Breeding strategy to improve Ethiopian Boran cattle for meat and milk production. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 26. ILRI, Nairobi, Kenya.

Bainesagn Worku. 2015. Assessment of breeding practices and evaluation of oestrus synchronization and mass insemination technique in dairy cattle in West Shoa zone. MSc Thesis, Haramaya University, Haramaya, Ethiopia, 118 pp.

Belay Duguma, Yisehak Kechero and G P J, Janssens. 2012. Productive and Reproductive Performance of Zebu X Holstein-Friesian Crossbred Dairy Cows in Jimma Town, Oromia, Ethiopia. Global Veterinarian. 8: 67-72.

Belay Zeleke. 2014. Estimation of Genetic Parameters for Growth and Reproductive Traits of Fogera X Holstein Friesian Crossbred Cattle at Metekel Ranch, Amhara Region, Ethiopia. MSc. Thesis, Haramaya University, Ethiopia, 109 pp.

Belay Zeleke, Kefelegn Kebede and Ajay Kumar Banerjee. 2016. Estimation of genetic parameters for reproductive traits of Fogera and Holstein Friesian crossbred cattle at Metekel ranch, Amhara region, Ethiopia. Online Journal of Animal and Feed Research. Volume 6: 90-95.

Berhanu Belay and Ashim Kumar Chakravarty. 2014. Genetic analyses of early-expressed reproduction traits of Borena and their crosses with Holstein Friesian and Jersey in Central Highlands of Ethiopia. Tropical Animal Health and Production. 46:113–119.

Berhanu Yalew, Fikre Lobago and Gebeyehu Goshu. 2011. Calf survival and reproductive performance of

Holstein–Friesian cows in central Ethiopia. Tropical Animal Health and Production. 43:359–365.

Bourdon, R M. 2000. Understanding animal breeding.2nd ed. Upper Saddle River, New Jersey 07458, USA.

Choudhary V, Kothekar M D, Raheja K L., Kasturiwale N N, Khire D W and Kumar P. 2003. Genetic evaluation of first lactation traits in Sahiwal cattle using restricted maximum likelihood technique. Asian Australasian Journal of Animal Sciences (Impact Factor). 16:639-643.

CSA (Central Statistical Agency) Federal Democratic Republic of Ethiopia. 2020/2021. Agricultural Sample Survey Report on livestock and livestock characteristics (private peasant holdings). Addis Ababa, Ethiopia.

Demissu Hundie, Fekadu Beyene and Gemeda Duguma. 2013. Early growth and reproductive performances of Begait cattle and their F1 Jersey crosses in and around-Guduru, Ethiopia livestock Production and Research Center. Science, Technology and Arts Research Journal. 2: 134-141.

Dessalegn Genzebu, Berhanu Tamir and Gebreyohanes Berhanu. 2016. Study of reproductive and production performance of cross breed dairy cattle under smallholder's management system in Bishoftu and Akaki Towns. Global Journal of Animal Science, Livestock Production and Animal Breeding. Vol. 4: 243-247

Destaw Worku and Alemayehu Kefyalew. 2018. Evaluation of the Reproductive Performance of Holstein Friesian Dairy Cows in Alage Atvet College, Ethiopia. International Journal of Livestock Production. 9: 131-139.

Direba Hunde. 2012. Survival, Reproductive and Productive Performance of Pure Jersey Cattle at Adea Berga Dairy Research Center in the Central Highlands of Ethiopia. MSc. Thesis, University of Natural Resources and Life Sciences. Vienna, Austria, 90 pp.

Edward Missanjo, Venancio Imbayarwo-Chikosi, and Tinyiko Halimani. 2013. Estimation of Genetic and Phenotypic Parameters for Production Traits and Somatic Cell Count for Jersey Dairy Cattle in Zimbabwe. Hindawi Publishing Corporation: Volume 2013, Article ID 470585, 5 pages.

Evelyn, C G. 2001. Reproductive Performance of Crossbred Cattle Developed for Milk Production in the Semi-Arid Tropics and the Effect of Feed Supplementation. PhD dissertation, University of Zimbabwe, 163 pp.

Fikre Lobago, Merga Bekana, Hans Gustafsson and Hans Kindahl. 2007. Longitudinal observation on reproductive and lactation performances of smallholder crossbred dairy cattle in Fitche, Oromia region, central Ethiopia. Tropical Animal Health and Production. 39: 395-403.

Gebeyehu Goshu, Harpal Singh, Karl-Johan Petersson and Nils Lundeheim. 2014. Heritability and correlation among first lactation traits in Holstein Friesian cows at Holeta Bull Dam Station, Ethiopia. International Journal of Livestock Production, Vol. 5(3), pp. 47-53.

Gebregziabher Gebreyohannes, SkornKoonawootrittriron, Mauricio, A, Elzo and Thanathip Suwanasopee. 2013. Variance components and genetic parameters for milk production and lactation pattern in an Ethiopian multi-bred dairy cattle population. Asian Australas journal of Animal Science, 26: 1237 - 1246.

Habtamu Lemma, Kelay Belihu and Desie Sheferaw. 2010. Study on the reproductive performance of Jersey cows at Wolaita Sodo dairy farm, Southern Ethiopia. Ethiopian Veterinary Journal. 14: 53-70.

Hunduma Dinka. 2012. Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia. International Journal of Livestock Production Vol. 3: 25-28.

Hunduma Dinka. 2013. Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia. African Journal of Dairy Farming and Milk Production (AJDFMP) 1: 101-103.

Juma K H and Alkass J E. 2006. Genetic and Phenotypic Parameters of Some Economic Characteristics in Awassi Sheep of Iraq: A Review. Egyptian Journal of Sheep, Goat and Desert Animals Sciences. 1: 15-29.

Kefale Getahun. 2018. Genetic and Non-genetic Parameter Estimation for Productive and Reproductive Performances of Crossbred Dairy Cattle at Holetta Research Center. MSc Thesis. Haramaya University, Haramaya, Ethiopia, 109 pp.

Kefena Effa, Zewdie Wondatir, Tadelle Dessie and Aynalem Haile. 2011. Genetic and Environmental trends in the long-term Dairy cattle genetic improvement programmes in the Central Tropical Highlands of Ethiopia. Journal of Cell and Animal Biology, 5: 96 - 104.

Khalid, J, Ghulam M and Pervez, A. 2001. Heritability estimates of some productive traits in Sahiwal cattle. Pakistan Veterinary Journal, 21(3).

Melaku Minale, Zeleke Mekuriaw, Getinet Mekuriaw and Mengistie Taye. 2011. Reproductive Performances of Fogera Cattle at Metekel Cattle Breeding and Multiplication Ranch, North West Ethiopia. J. Anim. Feed Res., 1: 99-106.

Mengistu, W D, Kefyalew, A, Wondimagegn and M H, Demisash. 2016. Reproductive performance evaluation of Holstein Friesian and their crosses with Borena cattle breeds in Ardaita Agricultural Technical Vocational Education Training College dairy farm, Oromia region, Ethiopia. Iranian journal of applied animal science, 6(4): 805-814.

Million Tadesse, J, Thiengtham, A, Pinyopummin and S, Prasanpanich. 2010. Productive and reproductive performance of Holstein Friesian dairy cows in Ethiopia. Livestock research for rural development, 22 (2).

Montaldo, H H, H, Castillo-Juarez, M, Valencia-Posadas, E G, Cienfuegos-Rivas and F J, Ruiz-Lopez. 2010. Genetic and environmental parameters for milk production, udder health and fertility traits in Mexican

Holstein cows. Journal of Dairy Science, 93:2168 - 2175.

Nuraddis Ibrahim, Shebir A, Shiferaw M. 2011. Assesment of Reproductive Performance of Crossbred Cattle (Holstein Friesian X Zebu) in Gondar Town. Global Veterinaria 6: 561-566.

Olawumi S O and Salako A E. 2010. Genetic Parameters and Factors Affecting Reproductive Performance of White Fulani Cattle in South western, Nigeria. Global Veterinarian 5: 255-258.

Sindros Demeke, Neser, F W C and Schoeman, S J. 2004. Estimates of genetic parameters for Borena, Friesian and crosses of Friesian and Jersey with the Borena cattle in the tropical highlands of Ethiopia: reproduction traits. Journal of Animal Breeding and Genetics, 121: 57 - 65.

Sisay Eshetu. 2015. Productive and reproductive performance of dairy cows (Horro, Horro x Friesian and Horro x Jersey) at Bako Agricultural Research Center. MSc Thesis, Haramaya University, Ethiopia, 77 pp.

Solomon Abegaz, Negussie E, Duguma G and Rege JEO. 2002. Genetic parameter estimates for growth traits in Horro sheep. J. Anim. Breed. Genet. 119: 35-45.

Staal, S J, A N, Pratt and M, Jabbar. 2008. Dairy Development for the Resource Poor, Part II. Kenya and Ethiopia dairy development studies: PPLPI (Pro-Poor Livestock Policy Initiative), Working Paper No. 44(2). ILRI (International Livestock Research Institute), Nairobi, Kenya.

Tadesse Birhanu. 2014. Estimation of crossbreeding parameters in Holstein Friesian and Ethiopian Boran-crosses for milk production and reproduction traits at Holeta agricultural research center, Ethiopia. MSc. Thesis, Haramaya University, Ethiopia, 83 pp.

Tewodros Bimerew. 2008. Assessment of Productive and Reproductive Performance of Indigenous and Crossbred Cattle under Smallholder Management System in North Gondar, Amhara Region. MSc. Thesis, Mekelle University, Ethiopia, 136 pp.

Wasike C B. 2006. Genetic evaluation of growth and reproductive performance of the Kenya Boran cattle. MSc. Egerton University, Kenya, 108 pp.

Wassie Teketay, Getnet Mekuriaw and Zeleke Mekuriaw. 2015. Reproductive Performance for Holstein Friesian × Arsi and Holstein Friesian × Borena Crossbred Cattle. Iranian Journal of Applied Animal Science, 5: 35 - 40.

Yibrah Yacob. 2008. Environmental and genetic parameters of growth, reproductive and survival performance of Afar and Blackhead Somali sheep at Werer Agricultural Research Center, Fellowship report submitted to International Livestock Research Institute (ILRI) and Ethiopian Institute of Agricultural Research (EIAR). Ethiopia.

Yifat Deberga, Kelay Belihu, Merga Bekana, Fikre Lobago, Gustafsson H and Kindahl H. 2009. Study on reproductive performance of crossbred dairy cattle under smallholder conditions in and around Zeway, Ethiopia. LRRD. 21(6) 2009.

Yosef Tadesse. 2006. Genetic and Non-Genetic analysis of fertility and production traits in Holetta and Ada'a Berga Dairy herds. MSc. Thesis, Alemaya University, Ethiopia, 143 pp.