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Review Article

Performance of Holstein Frisian×Local Crossbred Dairy Cattle: A Review

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ABSTRACT
The current review deals with the growth, milk, and reproductive performance of Holstein Frisian crosses in Ethiopia. The growth performance of Holstein Frisian crosses ranged from 22.13±0.14 kg to 31.74±0.29 kg of birth weight (BW), 47.5±0.58 to 140.72±2.26 kg of weaning weight (WW), and 314.7±4.5 to 492.9±9.6 gram of pre-weaning average daily gain (PrWADG). Holstein Frisian x Boran had better growth performance, followed by Holstein Frisian×Barka. The Holstein Frisian x Horro had the least performance when compared to other Holstein Frisian cross. The reproductive performance of Holstein Frisian crosses ranged from 23.7±4.08 to 36.8 ± 0.8 months for age at first service (AFS), 33.36±4.6 to 53.60±3.44 months for age at first calving (AFC), 1.2 ± 0.34 to 2.7±0.18 for number of service preconception (NSPC), and 13.2±1.45 to 21.36±3.84 months for calving interval (CI). The reproductive performance of all HF crosses was not substantially different; all crosses had a broad range of performance values in various farming systems. The daily milk yield (DMY), lactation milk yield (LMY), and lactation length (LL) varied from 5.4±0.24 to 9.14±4.3 kg, 1918±51 3579±842 kg, and 9.13±1.99 to 12.68±3.12 months, respectively. Dairy cow performance is affected by genotype, season, age, production system, feed and nutrients, management, environment and climate, and sickness (disease). This unjustifiable performance of the HF crossbred breed needs planned technical and institutional action for support services, a suitable breeding program for the production system, skilled manpower (veterinarian and AI technicians), and increased forage production.

Keywords: Growth, Holstein Frisian crosses, Milk, Reproductive Performance

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INTRODUCTION

Among other livestock sub-sectors, the dairy sector has been identified as a significant industry in Ethiopia. The domestic cow milk production in the year 2021 was 4.9 billion liters (CSA, 2021). Genetic improvement of indigenous livestock has been suggested as one option for meeting the ever-increasing demand for milk, milk products, and their input to economic growth. For the past seven decades, Ethiopian indigenous cattle have been genetically improved, mainly through crossbreeding (Addisu, 2013). In Ethiopia, crossbred cattle mainly cross of zebu with Holstein-Friesian cattle have been used for milk production with little success (Niraj *et al.*, 2017).

Cross-breeding with selection as an improvement tool has been given less attention and as such there have been no systematic and organized selection schemes for cattle genetic improvement in Ethiopia (Fikre, 2007). Crossbreeding experiments concerning European and indigenous breeds in the tropics estimated high heterosis contributions to milk production traits in the F1 cows, and a significant deterioration in the performance of the F2 generations in all traits compared with the F1 generation (Metekia and Nezif, 2017). Crossbreds in Ethiopia outperform native breeds in terms of growth, reproduction, and production performance (Addisu, 2013).

The evaluation of dairy cattle growth, productivity and reproductive performance is critical for the success of the entire dairy business development (Wondossen *et al.*, 2018). Crossbreeding performance evaluation and information generation could provide useful documentation for creating a future national breeding strategy. The current review deals with the growth, milk, and reproductive performance of Holstein Frisian crosses in Ethiopia.

Cattle Crossbreeding in Ethiopia

Ethiopia has the largest livestock population in Africa, with 70.2 million cattle, 42.9 million sheep, 52.46 million goats, and 78.85 million chickens (CSA, 2021). Indigenous breeds was accounting for 97.4%, 99.52%, 99.99%, and 78.85% of cattle, sheep, goat, and fowl, respectively, with hybrid and exotic species accounting for the remaining. Despite their genetic variation and large population of Ethiopian cattle, the productivity of indigenous breeds and human population increase is uneven. Poverty, hunger, changing climatic circumstances, and livestock costs influenced by both internal and worldwide consumer demand create significant development problems for emerging nations (Freeman *et al.*, 2007; Zeleke *et al.*, 2020). Genetic enhancement of indigenous livestock has been advocated as one of the primary solutions to address the ever-increasing demand for animal products and hence contribute to economic progress (Haile *et al.*, 2011; Zeleke *et al.*, 2020).

Domestication and the use of traditional livestock breeding practices have been substantially responsible for the recent improvements in livestock product production

(Leakey, 2009). Crossbreeding of indigenous and improved cattle breeds has been widely used as a genetic improvement approach to improve dairy cattle performance across the tropics (Roschinsky et al., 2015). Because Zebu cattle have limited productive and reproductive potential, crossbreeding with B. Taurus (which combines the additive, dominance, and epistatic effects of the two genotypes) assures high productive and reproductive performance (Chebo and Alemayehu, 2012). Crossbreeding is taking place in Ethiopia to combine indigenous cattle's greater hardiness, heat tolerance, disease resistance, and environmental adaptation with exotic, temperate breeds' superior high milk production, rapid growth rates, and early maturity (Tadesse and Dessie, 2003, Gebrehiwet, 2020).

Ethiopia acquired its first exotic cattle (Holstein Friesian and Brown Swiss) from the UN Relief and rehabilitation administration in the 1950s, and commercial liquid milk production at government stations subsequently started (Ahmed et al., 2004; Tinsae, 2018; Gebrehiwet, 2020). When the Chilalo Agricultural Development Unit (CADU) was founded at Asela station, the initial application of crossbreeding for the production of milk was held. Similar dairy development programs were conducted in Ethiopia with international agency aid after recognizing the genetic improvement opportunities (Gebrehiwet, 2020).

The Institute of Agricultural Research initiated crossbreeding by establishing an on-station dairy cattle crossbreeding program with Friesian, Jersey, and Simmental sires crossed with local Horro, Boran, and Barka dams intending to evaluate the productivity of crossbred dairy cows with different levels of exotic blood (Ahmed *et al*., 2004; Gebrehiwet, 2020). Since the 1970s, governmental and non-governmental organizations have worked to strengthen the dairy sector through the establishment of dairy cow development ranches and the distribution of crossbred F1 heifers to smallholder farmers (Kelay, 2002). National Artificial Insemination Centre (NAIC, now Livestock Development Institute (LDI)) has delivered fresh sperm from genetically superior bulls to various parts of the country and commercial farms since 1981 (Zeleke *et al*., 2020). Currently, Crossbreeding, primarily focused on zebu crosses with Holstein-Friesian cattle, followed by Jersey cattle, has been used to improve milk production in Ethiopia for decades (Niraj *et al*., 2017). Many ranches and research centers (Holetta, Debre Zeit, Adaberga, Metekel ranch, Andasa, and Adami Tulu research centers) are producing Holstein Frisian (HF) with local crossbred cattle and distributing them to farmers after examining their performance (Zeleke *et al*., 2020).

Dairy cattle improvement programs typically take longer to provide the desired research findings due to their prolonged gestation period and inherent genetic features. Thus, the first preliminary findings of long-term dairy cattle crossbreeding trials in Ethiopia were published in 1987, 20 years after the experiment began (Sendros *et al.,* 1987). The results showed that first-generation (F1) crossbred dairy cows produced three to five times more milk than indigenous cows. Furthermore, because of its smaller body size, better reproductive performance, an adequate amount of milk with higher milk fat content, as well as moderate heat tolerance, the Jersey crossbred has been proposed as one ideal breed for low-input smallholder circumstances than Friesian and Simmental crosses (Haile *et al.*, 2011), Similarly, crossbred calves were discovered to have a greater birth weight and growth rate, allowing them to reach puberty earlier than indigenous calves (Kefena *et al.*, 2016). In intensive and semi-intensive production systems, Holstein Friesian has been the preferred breed (Zeleke *et al.*, 2020).

The majority of crossbred cattle are found in urban and peri-urban livestock production systems, including commercial farms with milk sheds (Zijlstra *et al.*, 2015, Zeleke *et al.*, 2020). However, the cattle crossbreeding program's efficiency is lower. This lower efficiency might be attributed to inadequate AI service efficiency, a lack of infrastructure, extension service, and support from the government.

Therefore, increasing the number of service providers, private farms, financial and technical assistance for ranches, and actively engaged farmers can be a smart way to improve the effectiveness of the present crossbreeding program (Zeleke *et al.*, 2020). The selection of suitable exotic gene levels is critical for a successful crossbreeding program. Growth, milk production, reproductive performance, and milk composition attributes all favored the 50% Holstein Frisian cross in Ethiopia (Haile *et al.*, 2011; Kefal *et al.*, 2018, Fikadu, 2020).

As a result, the distribution of introducing exotic genes at a 50% level may be excellent for highland mixed farming and smallholder dairy farming systems. Higher levels of unusual inheritance, on the other hand, may be suitable for intense production systems (Zeleke *et al.*, 2020). Furthermore, selecting appropriate breeds based on the production system is critical to ensuring the effectiveness of the crossbreeding program. The growth, milk, and reproductive performance of HF with zebu cross in Ethiopia are presented in Table 1-4.

Performances of Holstein Frisian (HF) with Local Cross in Ethiopia

Growth Performance of HF Crosses in Ethiopia

Many non-genetic variables (genotype, calf sex, season, and year of birth) impact growth traits and have a direct influence on the expression of the real genetic value of animals (Mohammad *et al.*, 2015). The birth weight performance of Holstein Friesian (HF) x Fogera (FO) crossbred cattle at the Andassa livestock research center was 23.5 kg (Addisu *et al.*, 2010). The study performed at Metekel cattle breeding improvement ranch for 50%, 75%, and 87.5% HF×Fogera was 24.58±0.10, 26.56±0.26, and 26.45±0.73 kg, respectively (Belay, 2014) (Table 1). Based on Aynalem *et al.* (2011), the birth weight performance for 50%, 62.5%, 75%, and 87.5% HF×Boran was 26±0.15, 29.2±0.36, 31.1±0.28, and 31.4±0.27 kg, respectively. The birth weight performance of the cattle improves as HF blood levels rise in both Boran and Fogera crosses.

Habtamu *et al.*, (2012) recorded a weaning weight performance of 47.5±0.36 kg for HF×Horro. The weighted weaning weight performance of 62.5% HF×Boran 56.8±0.5 kg, 50% HF×Boran 54.2±1.2 kg, 75% HF×Boran 55±0.8 kg, and 87.5% HF×Boran 56.6±0.8 kg (Aynalem *et al.*, 2011). According to Sendros *et al.*, (2003), the Pre-weaning average daily gain (PrWADG) was higher in 50% HF×Barka (F1) crossbred calves (492.99.6 grams).

Table 1: Growth performance of HF×local crossbred dairy cattle in Ethiopia

Genotype	BW(Kg)	WW(Kg)	PrWADG (g)	Source
50% HF×A	21.5±0.5	-	-	(Abdinasir and Eskil, 2001)
50% HF×Z	24.6±0.5	-	-	
75%HF×A	24.6±0.6	-	-	
75% HF×Z	25.7±0.8	-	-	
50% HF×Ba	25.5±0.4	114.7±1.8	492.9±9.6	(Sendros *et al.*, 2003)
50% HF×BO	25.7±0.3	111.9±1.0	479.6±5.6	
50% HF×HO	22.9±0.4	104.5±1.7	453.7±9.2	
62.5% HF×BO	28.9±0.7	106.5±2.6	429.5±13.8	
75% HF×Ba	29.3±0.6	105.7±2.2	423.3±12	
75% HF×BO	29.7±0.4	109.6±1.5	444.3±7.9	
75% HF×HO	28.4±0.5	103±1.9	416.3±9.9	
HF×FO	24.92±0.37	130.5±2.29	-	(Addisu and Hegede, 2003)
50% HF×BO	28.2±0.65	61.2±1.35	365±0.01	(Gizachew *et al.*, 2003)
62.5% HF×BO	28.6±0.94	60.1±2.6	331±0.02	
50 % HF×BO	24.36±0.14	140.72±2.26	-	(Ababu *et al.*, 2006)
50% HF×BO	25.38±0.26	-	-	(Berhanu, 2008)
75%HF×BO	31.74±0.29	-	-	
HF×FO	23.5	-	-	(Addisu *et al.*, 2010)
50% HF×BO	26±0.15	56.8±0.5	-	(Aynalem *et al.*, 2011)
62.5% HF×BO	29.2±0.36	54.2±1.2	-	
75% HF×BO	31.1±0.28	55.2±0.8	-	
87.5% HF×BO	31.4±0.27	56.6±0.8	-	
HF×HO	22.13±0.14	47.5±0.58	314.7±4.5	(Habtamu *et al.*, 2012)
50 % HF×FO	24.58±0.10	110.35±1.30	0.35±0.01kg	(Belay, 2014)
75% HF×FO	26.56±0.26	128.03±3.61	0.41±0.01kg	
87.5% HF×FO	26.45±0.73	129.103±7.62	0.42±0.032kg	

BW: Birth Weigh; WW: Weaning Weight; PrWADG : per-weaning average daily gain; Kg: Kilo Gram; g: gram; HF: Holstein Friesian; HF×BO, Holstein Friesian cross with Boran; HF×Ba: Holstein Friesian cross with Barka; HF×HO: Holstein Friesian cross with Horro; HF×Z: Holstein Friesian cross with Zebu, Z: Zebu, HO: Horro; BO: Boran; Ba: Barka.

Reproductive Performance of Holstein Frisian Crosses

Reproductive performance is one of the most important concerns of the worldwide modern dairy industry. Improved fertility of dairy animals increases profit by reducing culling costs and increasing revenue from milk sales and shortened calving periods (Berihulay and Mekash, 2018). Genotype, season, age, production system, feed and nutrition, management, environment and climate, and illness (disease) all have an impact on dairy cow reproductive efficiency (Endris, 2017).

The Age at First Service (AFS) is the age at which heifers reach the physical and sexual development required to receive service for the first time. According to some researchers on farm reports, AFS for heifers of HF crosses ranged from 23.1 months for HF×Zebu (Nuraddis *et al.*, 2011) to 25.16±5.24 for 50% HF×Boran (Zelalem *et al.*, 2015), it might be due to heterosis effect of 50% crosses. Furthermore, according to the station research, the AFS ranged from 27±0.7 for 50% HF×Boran (Haile *et al.*, 2009a) to 33.62±0.71 for HF×Arsi (Wassie *et al.*, 2015) and 36.8±0.8 for HF×Fogera (Gebeyehu *et al.*, 2005) (Table 2).

Age at first calving (AFC) is the age at which heifers calve for the first time. Early age at first breeding affects the cow's lifetime output and reduces generation intervals, resulting in quicker genetic gain per generation (Endris, 2017). In Ethiopia, the age at first calving (AFC) in months for Holstein Frisian crosses was 33.73±4.5 for HF×Zebu (Zelalem *et al.*, 2015), which was lower than the performance of HF×Boran (34.66 0.56) (Berhanu and Chakravarty, 2014) and HF x Arsi (42.84±0.84) (Wassie *et al.*, 2015). Other researchers reported a value of 53.60±3.44 for the HF×Gurage crossbred heifers (Wondossen *et al.*, 2018) (Table 2). The age at first calving of Holstein Frisian crossbred cows in Ethiopia varied from 29.1 to 55.4 months for Frisian crosses (Million *et al.*, 2006). Age at first calving is closely linked to rearing activity (management) and is influenced by nutrition, year, and month of birth.

The number of services per conception (NSPC) is the amount of services (natural or artificial) needed for effective conception. The number of inseminations needed to produce a live calf is one of the most important measures of reproductive effectiveness, which is primarily determined by the mating method used. The number of services per conception of HF crosses reported by Niraj *et al.* (2014a) for HF×Zebu was 1.5±0.3, Belay *et al.* (2012) for HF×Zebu was 1.56±0.57, Nuraddis *et al.* (2011) for HF×Zebu was 1.29, and Demeke *et al.,* (2004) for HF×Boran was 1.60 ± 0.06 at Holetta agricultural research center (Table 3). Gebeyehu *et al.*, (2005) reported NSPC for HF×Fogera was 1.54± 0.1. Another study performed by Gizaw *et al.*, (2011) for HF×Horro was 1.97 at Bako Agricultural research center and Haile *et al.*, (2009) for 50 % HF×Boran 2.2±0.1. It ranges from 1.5±0.3 to 2.2±0.1 for Frisian crosses. The NSPC was significantly affected by herd, breed, and season which are related to availability of feed, lactation length, and milk yield (Azage *et al.*, 2000; Lema *et al.*, 2010).

Table 2: Age at First service (AFS) and Age at First calving (AFC) of HF crosses

Breed	Site of experiment	AFS (mean±sd) (month)	AFC (mean±sd) (month)	Authors
HF×GH	On farm	-	53.60±3.44	(Wondossen *et al.*, 2018)
75 % HF×BO	On Station	31.40 ± 0.95	42.12 ± 0.66	(Mengistu *et al.*, 2016)
87.5 %HF×BO	On Station	29.88 ± 0.68	39.35 ± 0.75	
HF×Arsi	On Station	33.62 ± 0.71	42.84 ± 0.84	(Wassie *et al.*, 2015)
HF×BO	On Station	30.47 ± 0.85	39.49 ± 0.83	
50 % HF×Z	On farm	25.16 ±5.24	34.6 ± 5.37	(Zelalem *et al.*, 2015)
75 % HF×Z	On farm	23.8 ± 3.73	33.7±4.1	
87.5 % HF×Z	On farm	23.7±4.08	33.36±4.6	
93.75 % HF×Z	On farm	24.34 ±3.9	33.96±4.06	
HF×BO	On Station	26.22±0.41	34.66 ± 0.56	(Berhanu and Chakravarty, 2014)
50% HF×BO	On Station	30.33±0.44	38.07±0.68	
75 % HF×BO	On Station	28.04±0.55	39.21 ± 0.69	
HF×Zebu	On farm	24.30±8.01	36.6±7.8 (3.05±0.65yr)	(Belay *et al.*, 2012)
HF×Zebu	On farm	23.1	34.7	(Nuraddis *et al.*, 2011)
HF×BO	On station	-	43.4±0.6	(Kefena *et al.*, 2011)
50 % HF×BO	On Station	27±0.7	-	(Haile *et al.*, 2009a)
62.5% HF×BO	On Station	28±1.0	-	
75 % HF×BO	On Station	28±0.9	-	
87.5% HF×BO	On Station	28±1.2	-	
HF×FO	On Station	36.8 ± 0.8	-	(Gebeyehu *et al.*, 2005)
HF×BO(F1)	On station	-	36.0±0.4	(Demeke *et al.*, 2004a)
62.5 % HF×BO	On station	-	38.5±1	
75 % HF×BO	On station	-	36.7±0.7	

AFS; Age at first service, AFC; Age at first calving, HF, Holstein Friesian; HF×BO, Holstein Friesian cross with Boran; HF×Ba, Holstein Friesian cross with Barka; HF×HO, Holstein Friesian cross with Horro; HF×Z; Holstein Friesian cross with Zebu, Z; Zebu, HO, Horro; BO, Boran; Ba, Barka.

Table 3: Number of services per conception (NSPC) and Calving interval (CI) of HF crosses

Breed	Site of experiment	NSPC (mean ± sd)	CI (mean ± sd) in month	Authors
HF×GU	On farm	-	20.49±1.72	(Wondossen *et al.*, 2018)
75 % HF×BO	On Station	1.42 ±0.04	13.23 ± 0.17 (397.13 ± 5.19 days)	(Mengistu *et al.*, 2016)
87.5 %HF×BO	On Station	1.37±0.04	13.5 ± 0.15 (406.33 ± 4.55 days)	
HF x Arsi	On Station	-	15.85 ± 0.14 (475.48 ± 4.08 days)	(Wassie *et al.*, 2015)
HF×BO	On Station	-	15.88 ± 0.16 (476.36 ± 4.73 days)	
50 % HF×Z	On farm	1.2 ± 0.34	13.2±1.45	(Zelalem *et al.*, 2015)
75 % HF×Z	On farm	1.34±0.38	14.42 ±1.78	
87.5 % HF×Z	On farm	1.4±0.49	15.3±2.3	
93.75 % HF×Z	On farm	1.3±0.35	14.63±2	
HF×Zebu	On farm	1.5±0.3	14.27 ± 2.14 (428.11±64.32 days)	((Niraj *et al.*, 2014a)
HF×Zebu	On farm	1.56±0.57	21.36±3.84	(Belay *et al.*, 2012)
HF×Zebu	On farm	1.29	13.93	(Nuraddis *et al.*, 2011)
HF×Z	On Station	-	15.76±0.27 (472.8±8.0 days)	(Kefena *et al.*, 2011)
HF×HO	On station	1.97	-	(Gizaw *et al.*, 2011)
50 % HF×BO	On Station	2.2±0.1	14.06±0.33(422±10days)	(Haile *et al.*, 2009a)
62.5% HF×BO	On Station	2.7±0.18	14.87±0.4(446±12days)	
75 % HF×BO	On Station	2.2±0.17	14.77±0.37(443±11days)	
87.5% HF×BO	On Station	2.1±0.28	14.1±0.7 (423±21 days)	
HF x FO	On station	1.54± 0.1	-	(Gebeyehu *et al.*, 2005)
HF×BO	On Station	1.49 ± 0.04	13.9 ± 0.2 (417 ±6 day)	(Demeke *et al.*, 2004a)
62.5 % HF×BO	On Station	1.41 ±0.11	14.2±0. 6 (426±18 day)	
75 % HF×BO	On Station	1.70 ± 0.09	14.8 ± 0.43 (444±13 day)	
50 % HF×BA	On Station	-	13.33±0.47(400±14 days)	(Million and Tadelle, 2003)
50 % HF×BO	On Station	-	14.2±0.63(426±19 days)	
75 % HF×BA	On Station	-	14.93±0.53(448±16 days)	
75% HF×BO	On Station	-	14.5±0.5(436±15 days)	
87.5 % HF×BA	On Station	-	16.3±1(498±30 days)	
87.5 % HF×BO	On Station	-	15.4±0.8(464±24 days)	
50 % HF x Arsi	On Station	2.01± 0.2	14.69± 0.25(440.8 ± 7.7 day)	(Negussie *et al.*, 1999)
50 % HF×Z	On Station	1.76±0.2	16.06± 0.37 (481.9 ± 11.1day)	
75 %HF x Arsi	On Station	1.96±0.2	15.97±0.32 (479.0±9.6 day)	
75 % HF×Z	On Station	2.01±0.1	16.38± 0.47(491.4 ± 14.1 day)	
87.5 % HF×Z	On Station	2.07±0.1	16.65 ± 0.58(499.5 ± 17.4 day)	

NSPC; Number of services per conception,, CI; Calving Interval, HF, Holstein Friesian; HF×BO, Holstein Friesian cross with Boran; HF×BA, Holstein Friesian cross with Barka; HF×HO, Holstein Friesian cross with Horro; HF×Z; Holstein Friesian cross with Zebu, Z; Zebu, HO, Horro; BO, Boran; Ba, Barka

The period between two successive calvings is referred to as the calving interval (CI). Calving intervals of 12 months are considered best when considering 280 days for typical gestation duration and approximately 85 days for post-calving rest time until conception (Endris, 2017). Calving interval estimates varied from 13.21.45 to 21.363.84 (Negussie *et al.*, 1999; Million and Tadelle, 2003; Niraj *et al.*, 2014a; Demeke *et al.*, 2004a; Haile *et al.*, 2009a; Kefena *et al.*, 2011; Belay *et al.*, 2012; Zelalem *et al.*, 2015; Wassie *et al.*, 2015; Mengistu *et al.*, 2016; Wondossen *et al.*, 2018) (Table 3). The calving interval in months was 20.49±1.72 for HF×GUtragie (Wondossen *et al.*, 2018) and 16.06±0.37 (481.9 ±11.1day) for 50% HF×Zebu at Asella Livestock Farm (Negussie *et al.*, 1999). HF×Boran crossbred cow calving intervals were 13.9±0.2 (417 ± 6 days) at Holetta agricultural research center (Demeke *et al.*, 2004) and 16.31(498±30 days) for 87.5% HF×BArka crossbred cows (Million and Tadelle, 2003). This indicated the Barka cross had a longer calving interval than Boran and zebu crosses. Crossbred animals' calving intervals increased as their HF blood levels increased (Million and Tadelle, 2003). The accuracy of estrus detection and conception has a significant influence on the calving interval, which is likely the greatest measure of cow reproductive efficiency.

Productive Performance of Holstein Frisian Crosses

Breeding failure has an obvious negative impact on milk production and farm revenue, and it decides the future viability of a dairy farming business (Wondimagegn, 2021). The average daily milk yield, lactation milk yield, and lactation length are typically used to assess dairy cattle milk production performance. The 50% crossbreds were most likely more productive in a minimal input production scheme than high-grade crossbreds. This could be owing to either a complementary or a heterosis impact. The concept also supported the level of management attainable under most peasant circumstances in Ethiopia, because the higher exotic heredity levels require more intensive management than 50% inheritance (Aynalem *et al.*, 2009b).

A systematic increase or decrease in daily milk yield can be used as a tool for early warning management choices and forecasting cow production capacity (kefal, 2018). The daily milk productions/yields (in litter) of HF crossbred dairy cows reported by different researchers (Table 4) were 5.19±0.08 for HF×Boran at Bako agricultural research center (Gebregziabher *et al.*, 2014), 5.4±0.24 for HF×Boran (F2) at Holetta agricultural research center (HARC) (Demeke *et al.*, 2004b), 8.52±3.04 for HF×Zebu on farm (Belay *et al.*, 2012) and 8.10±0.09 for HF×Guragie at Gurage (Wondossen *et al.*, 2018). The management of animals, genetic group, calving year, season of calving, and parity all had a substantial impact on daily milk production. Daily milk production was higher for 50% and 75% Holstein Friesian crosses than for 87.5% Holstein Friesian crosses (Table 4). The epistatic effect may be responsible for the declines in daily milk production of high grade (above 75% Holstein Friesian) compared to 50% F1 cross.

According to this review, the average lactation milk yield (in litter) of HF crosses reported by different authors was 1703.2±125.06 for HF×Boran at Bako agricultural research center (Gebregziabher *et al.*, 2014). Demeke *et al.*, (2004b) reported 1928±108 litter of lactation milk yield for HF×Boran (F2) at Holetta agricultural research center (Demeke *et al.*, 2004b). This result was lower than the performance of HF×Zebu (2069.16±78.44) (Wondossen *et al.*, 2018). Kefal (2018) found 2204.05±21.12 Kg lactation milk yield for HF×Boran crossbred cattle (Table 4), which was slightly higher than the report of Gebrgziabher *et al.*, (2014) who found 2111.91±16.88 for HF×Boran in central Ethiopia and Niraj *et al.*, (2014b) reported 2123.43±65.67 kg for crossbred in Gondar, Ethiopia. The differences in results obtained by various scholars could be attributed to breed/genetic makeup, production system, feeding practice, and other uncontrolled environments in which animals were handled.

The milk produced by dairy cows during a specific lactation time can be used to evaluate their performance. Lactation length (LL) refers to the time interval between when a bovine begins to produce milk after parturition and the time of drying off. Lactation duration (in months) for HF cross-breed cows was 9.13±1.99 HF×Zebu (Belay *et al.*, 2012), which was less than the 10.27±0.3 months reported for HF×Boran(F2) at Holetta agricultural research center (HARC) (Demeke *et al.*, 2004b) and 10.45±0.67 for HF×Guragie at Gurage zone of Ethiopia (Wondossen *et al.*, 2018). Demeke *et al.* (2004b) found 11.60.2 for HF×Boran (F1), which was similar to Niraj *et al.* (2014b) (11.060.433) for HF×Zebu and Kefena *et al.* (2011) (11.46 0.12) for HF×Boran (Table 4). Variation in lactation length found in the same animal may be due to lactation physiology, which is the defined collection of genes and their reaction to non-genetic factors (Ayeneshet *et al.*, 2018). A lactation length of 305 days is generally recognized as a benchmark in the majority of improved dairy farms. This guideline allows calving every 12 months, with a 60-day dry interval in between. If a cow milked for more than 305 days, the lactation output was calculated using her yield for the first 305 days. Some cows are not milked for the entire 305-day period because they go dry or the lactation is ended for any of many causes (For example; breed disease, management problem).

Table 4: Daily milk yield (DMY), Lactation milk yield (LMY), and Lactation Length (LL) of HF crosses

Breed	Site of experiment	DMY (mean±sd) (Liter)	LMY (mean±sd) (Liter)	LL (mean±sd) (month)	Authors
HF×GU	On farm	8.10±0.09	2430.92±154.56	10.45±0.67	(Wondossen *et al.*, 2018)
HF×Z	On farm	8.52±3.04		9.13±1.99	(Belay *et al.*, 2012)
50 % HF×BO	On station	6.0±0.1	2019±26	11.23±0.1(337±3 days)	(Haile *et al.*, 2009b)
62.5% HF×BO	On station	5.7 ±0.1	1918±51	11.37±0.2(341±6 days)	
75 % HF×BO	On station	6.3±0.1	2182±45	11.7±0.2(351±6 days)	
87.5% HF×BO	On station	6.9±0.1	2360±91	11.83±0.37(355±11 days)	
HF×BO(F1)	On station	7.1±0.17	2355±71	11.6±0.2(348±6days)	(Demeke *et al.*, 2004b)
HF×BO(F2)	On station	5.4±0.24	1928±108	10.27±0.3(308±9days)	
62.5 % HF×BO	On station	6.2±0.46	2187±203	11.7±0.5(351±17days)	
75 % HF×BO	On station	7.2±0.32	2528±141	11.03±0.4(331±12days)	
HF×BO	On station	6.57±0.05	2111.91 ± 16.88	-	(Gebregziabher *et al.*, 2014))
50%HF×Z	On farm	9.14±4.3	-	-	(Kefyalew and Damitie, 2015)
75 % HF×Z	On farm	6.99±3.43	-	-	
50%HF×Z	On farm	6.27±2.7	-	-	
75 % HF×Z	On farm	6.91±2.4	-	-	
50%HF×Z	On farm	6.95±2.33	-	-	
75 % HF×Z	On farm	6.46±2.03	-	-	
50 % HF×BA	On station	7.21±0.26	-	-	(Million and Tadelle, 2003)
50 % HF×BO	On station	6.36±0.30	-	-	
75 % HF×BA	On station	7.15±0.28	-	-	
75% HF×BO	On station	6.92±0.25	-	-	
87.5 % HF×BA	On station	6.28±0.52	-	-	
87.5 % HF×BO	On station	5.98±0.50	-	-	
50 % HF×Z	On farm	-	2520±842	11.96±2.5	(Zelalem *et al.*, 2015)
75 % HF×Z	On farm	-	3467±773	11.6±1.58	
87.5 % HF×Z	On farm	-	3579±842	12.68±3.12	
93.75 % HF×Z	On farm	-	3554±867	11.89±2.16	
HF×Z	On farm	-		11.06±0.433(331.77±12.99days)	(Niraj *et al.*, 2014b)
HF×BO	On station	-	2088.7±29.4	11.46± 0.12(343.8±3.6 days)	(Kefena *et al.*, 2011)
HF×Z	On farm	-	2069.16 ± 78.44		(Mengistu *et al.*, 2016)

DMY;Daily milk yild,,, LMY; lactation milk yild, LL; lactation length, HF, Holstein Friesian; HF×BO, Holstein Friesian cross with Boran; HF×BA, Holstein Friesian cross with Barka; HF×HO, Holstein Friesian cross with Horro; HF×Z; Holstein Friesian cross with Zebu, Z; Zebu, HO, Horro; BO, Boran; Ba, Barka

CONCLUSION

The evaluation of dairy cattle growth, productivity and reproductive performance is critical for the success of the entire dairy business development. Many non-genetic variables (genotype, calf sex, season, and year of birth) impact growth traits and have a direct influence on the expression of the real genetic value of animals. Improved fertility of dairy animals increases profit by reducing culling costs and increasing revenue from milk sales and shortened calving periods. Many studies have shown that HF crossbred dairy cows with more than half HF blood in Ethiopia had better performance under comparable management circumstances. But, the 50% crossbreds were most likely more productive in a minimal input production scheme than high-grade crossbreds. The reproductive performance of all HF crosses was not substantially different; all crosses had a broad range of performance values in various farming systems. Dairy cow performance is affected by genotype, season, age, production system, feed and nutrients, management, environment and climate, and sickness (disease). It is suggested that planned technological and institutional interventions enhance support services for suitable breeding programs, improved cows, and sufficient veterinary health services.

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CONFLICTS OF INTEREST

The author declares no potential conflicts of interest regarding the publication of this review article either for financial, commercial, or intellectual purposes.

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