STM JOURNALS

Research and Reviews: Journal of Dairy Science and Technology
ISSN: 2319-3409(online), ISSN: 2349-3704(print)
Volume 5, Issue 3
www.stmjournals.com

Influence of Genetic and Non-Genetic Factors on Lactation Traits in Dairy Cattle: A Review

***Poonam Ratwan*[1,*], *Manoj Kumar*[1], *Ajoy Mandal*[2]**
[1]Animal Genetics and Breeding, ICAR-National Dairy Research Institute, Karnal, Haryana, India
[2]Animal Genetics and Breeding, ERS, ICAR-National Dairy Research Institute, Kalyani, West Bengal, India

Abstract

India has about 39.73 million crossbred cattle out of total 190.90 million (37.28%) cattle population as per the all India livestock census, 2012. The decade wise trend in livestock population (1997 to 2012) shows a distinctive swing in composition of dairy animal stock in favor of crossbred cattle, as their number increased by 20.18%, while that of indigenous cattle declined by 8.94%. Selection of dairy animals is usually based on the lactation traits. All the lactation traits are affected by various genetic and non-genetic factors like sire, season of calving, period of calving, parity of animals, age group and genetic group of animals. Accurate estimation or unbiased prediction of genetic parameters depends upon the adjustment of significant effect of environmental or non-genetic factors on lactation traits. The lactation traits reviewed were 305 days milk yield (305MY), total lactation milk yield (TMY), lactation length (LL), peak yield (PY) and milk production efficiency traits comprised of milk yield per day of lactation length (MY/LL) and milk yield per day of calving interval (MY/CI). In order to enhance the productivity, it is essential to develop an understanding of the factors affecting lactation traits in dairy cattle.

Keywords: *Genetic and non-genetic factors, dairy cattle, lactation traits*

****Author for Correspondence*** E-mail: punam.ratwan@gmail.com

INTRODUCTION

Agriculture is foundation of the Indian economy as agriculture and associated sectors contribute nearly 14 per cent of the gross domestic production. Livestock sector alone contributes nearly 25.6% at current prices of total value of output in agriculture, fishing and forestry sector [1]. In India, about 58 % of the population is engaged in agriculture and rearing of livestock. As per the all India livestock census, 2012, India has 190.90 million (37.28%) cattle and 108.7 million (21.23%) buffaloes. The population of crossbred cattle is about 39.73 million in the country. The decade wise trend in livestock population (1997 to 2012) shows a distinct shift in composition of dairy animal stock in favor of buffaloes and crossbred cattle, as their numbers increased by 3.19 and 20.18% respectively, while that of indigenous cattle declined by 8.94% [1].

Milk productivity in the country remains one of the lowest as compared to many leading countries of the world. In India, there are 40 registered breeds of cattle [2]. The productivity of cows remains low in the country for various reasons such as inadequate nutrition, poor genetic potential, inadequate animal health services, harsh climatic conditions and other management related problems despite of having large and diverse cattle genetic resources. Indigenous cattle breeds are low producers, have late maturity and delayed conception coupled with long calving intervals.

The productivity of dairy animals could be increased by crossbreeding the low yielding non-descript cows with high yielding suitable exotic breeds. Thus, systematic cross breeding of indigenous dairy cattle is mainly undertaken to get the benefit by combining high milk yield and early sexual maturity of exotic dairy breeds with hardiness, disease resistance and adaptability of indigenous cattle. Hence, cross breeding of local non-descript cattle with exotic breeds of high genetic potential is considered to be a rapid and effective method of improvement.

The demand for milk and milk products has augmented sharply because of increasing trend of human population. The main tools to improve the milk production potential of indigenous breeds are selective breeding and cross breeding. The lactation performance records of dairy animals are important criteria for selection of animals to be parents for next generation.

The prerequisite for establishing any selection or breeding programme is knowledge of genetic properties of lactation traits. A large number of genetic and non-genetic factors affect the lactation traits of dairy animals. Therefore, for accurate and unbiased estimates of genetic parameters, adjustment of effect of genetic and non-genetic factors is important. The present review deals with the effect of various genetic and non-genetic factors affecting the lactation traits of crossbred cattle and the average values and genetic parameters of different lactation traits.

AVERAGE VALUES OF LACTATION TRAITS

The average of different lactation traits of purebred and crossbred cattle as reviewed is as follows:

305 Days Milk Yield

The overall least squares means of 305 days milk yield in Karan Fries cattle varied from 2470.35–4113.61 kg as shown in Table 1. Singh and Gurnani (2004) reported overall least squares mean of 305 days first lactation milk yield as 2616±82 kg in Karan Swiss. In Ayrshire cattle, Amimo *et al.* reported overall mean of 305DMY as 3009.8±1098 kg [3]. As evident from Table 1, the crosses of HF with Indian breeds yielded 305 days milk ranging from 1707.25–3027.11 kg as reported by several workers [4–6]. In Sahiwal and its crosses, 305 days milk yield varied from 1633–1894.11 kg as presented in Table 1.

Total Lactation Milk Yield

Milk production during a specified period of lactation is helpful in judging the performance of dairy animals. Variations are observed in total lactation milk yield from lactation to lactation in the same animal. The given set of genes and their interaction with non-genetic factors is main reason of variations attributed to the physiology of lactation. The total milk yield for Indian breeds like Jersey, Sahiwal and their crosses varied from 1537–2154.07 kg as reported by several workers [7–11]. Pure bred HF cattle and its crosses yielded comparatively more milk as compared to others as reviewed in Table 1. Highest recorded total milk yield was 6404.77 kg in Holstein cattle as reported by Tekereli and Gundogan [12]. Belay and Chakravarty [13] observed that Boran and its crosses produced 1662.10 kg total milk in Ethiopia. Total milk production in some other breeds as reported by other workers is presented in Table 1.

Lactation Length

Lactation length is an important production trait as it influences the total milk yield. In most modern dairy farms, a lactation length of 305 days is commonly accepted as a standard. This standard permit for calving every 12 months with a 60 days dry period. The 12 month interval has been considered “Ideal” for many years. If a cow milked longer than 305 days, her yield for the first 305 days is taken as the lactation yield. Some cows are not milked for a full 305 days because they go dry or the lactation terminated for any of several reasons. These short records projected to a 305 days equivalent.

The lactation length for Sahiwal and its crosses with other breeds varied from 240–329 days as evident from the Table 1. Holstein Friesian and its crosses showed higher lactation length ranging from 296–365 days. The lowest lactation length was reported by Wondifraw *et al.* in HF × Deoni cattle [5]. Rahman *et al.* reported that when local cattle were crossed with HF and Jersey, lactation length observed was 357 and 330 days, respectively [14].

Peak Yield

The point where cow attains the highest milk production level during entire lactation is peak yield. Heifers peak at 70 to 75 percent of mature cows and second lactation cows peak at 90 percent of mature cows. Normally the peak is attained 4-10 weeks after calving.The time it takes to reach peak yield varies with many factors, for example breed, nutrition and yield potential. Higher producing animals tend to peak later than low producing ones. A high peak yield generally reflects a higher total yield. It has been found that each one kilogram increase in peak yield usually means an additional 100 to 200 kg of milk produced during the actual lactation. Reaching high peak yields requires a very well managed and balanced feeding programme.

For crossbred cattle, peak yield ranged from 11.86 to 13.3 kg as shown in the Table 1. However, peak yield observed by several other workers was comparatively low [15–17].

Milk Production Efficiency Traits
For selection of dairy animals, usually first lactation milk yield is used as a general criterion. We can select better animals based on their milk production efficiency rather than milk yield. High production efficiency in livestock production is an economically desirable attribute that targets ultimately for genetic up gradation. In fact, the economy of dairy industry mainly relies upon the performance parameters of dairy animals; therefore, it becomes more relevant to tackle out the means for ameliorating the performance efficiencies by developing certain guidelines for selection.

Milk production efficiency can be estimated as:

- Total lactation milk yield/lactation length (MY/LL), and
- Total milk yield/calving interval (MY/CI).

Milk yield per day of lactation length and milk yield per day of calving interval ranged from 8.76–19.04 and 6.4–15.44 kg/day in HF pure bred and its crosses as reported by many workers as shown in Table 1. The mean milk yield per day of lactation length in Jersey and its crosses ranged from 5.3 to 6.97 kg/day whereas milk yield per day of calving interval varied from 4.68 to 6.02 kg/day.

Table 1: *Average Values of Lactation Traits of Purebred and Crossbred Cattle.*

Cattle	305 Days Milk Yield (kg)	Total Milk Yield (kg)	Lactation Length (Days)	Peak Yield (kg)	Milk Production Efficiency Traits (kg/Day)	References
Jersey	-	1944±81.7	-	-	-	Hayman [7]
HF × Sahiwal	-	-	-	12.77	-	Deshpande and Bonde [66]
Friesian × Zebu Jersey × Zebu	-	2706±143.1	326±15	-	-	Banda [37]
Jersey	-	2028.91±21.76	-	-	-	Baruah *et al.* [67]
Sahiwal cattle	-	1579.04±18.17	260.52±2.64	-	-	Javed *et al.* [68]
Hariana cattle	-	-	-	6.24	-	Dhaka *et al.* [15]
Jersey	-	-	-	-	MY/CI 4.68±0.81	Das *et al.* [61]
Jersey × Red Sindhi	-	-	-	-	MY/CI 5.104±0.129	Das *et al.* [61]
Sahiwal × Friesian	-	-	260.38±4.48	-	-	Das *et al.* [69]
Karan Fries	3173±82	-	346±11	-	MY/FLL 10.6±0.2 MY/CI 8.9±0.2	Singh and Gurnani (2004)
Karan Swiss	2616±82	-	328±8	-	MY/FLL 8.9±0.2 MY/CI 7.2±0.3	Singh and Gurnani (2004)
Crossbred Cattle	-	-	-	-	FLMY/FLL 7.53±0.33 FLMY/Days of	Singh *et al.* (2005) [70]

					AFC 2.23±0.1 LTMY/LTLL 8.12±0.18 LTMY/Days of total age at calving 1.73±0.05	
Holstein	-	6404.77	-	-	MY/LL 19.04 MY/CI 15.44 MY/ASC 4.91	Tekereli and Gundogan [12]
Sahiwal	-	1617±35.09	-	-	-	Rehman *et al.* (2006) [99]
Crossbred Cattle	-	3064.74±49.40	356.63±5.12	-	-	Singh *et al.* [63]
Local Friesian × Local Jersey × Local Overall mean	-	700.07±39.88 1753.28±90.31 1492.8±48.28 1517.01±0.25	275.25±7.95 357.60±4.57 330.78±7.28 337.18±3.38	-	-	Rahman *et al.* [14]
Ayrshire (Kenya)	3009.8±1098	-	-	-	-	Amimo *et al.* [3]
Jersey cattle	-	1663.15±70.25	-	-	MY/LL 5.3±0.117	Ahmad *et al.* [45]
Frieswal cattle	-	2871.11±32.64	313.34±2.21	-	-	Kumar *et al.* [71]
Sahiwal	-	1537±9.03	262±1.04	-	-	Zafar *et al.* [8]
Crossbred cattle	2070.5±59.1	-	-	11.858±1.41	-	Thomas and Kumar [73]
Iranian Holstein	-	5123.20±1519.9	-	-	-	Hashemi *et al.* [74]
HF × Sahiwal	2593.84	2864.32	329.03	13.3	MY/LL 8.69 MY/CI 6.4	Lakshmi *et al.* [4]
Karan Fries	2470.35±80.75	2822.91±121.94	315.25±10.10	-	MY/FLL 8.76±0.29 MY/FCI 7.78±0.28	Saha *et al.* [22]
HF × Jersey × Sahiwal	2700.52±144.84	-	-	-	-	Dandapat *et al.* [75]
Girhalf breds	-	2971.94±101.84	333.59±6.34	-	-	Jadhav *et al.* [52]
Butana cows	-	1709.50±892.10	248.40±91.30	-	-	Badri *et al.* [76]
HF Cross Brown Swiss Cross	-	2722.68±1541.1 2489.19±914.58	-	-	-	Gorbani *et al.* [50]
HF cattle	-	3438±887.19	366.5±76.71	-	-	Usman *et al.* [77]
Tunisian Holstein	5807.83±78.27	-	309.60±7.01	-	-	M'hamdi *et al.* [26]
Sahiwal Cattle	1894.11	-	290.41	-	-	Manoj *et al.* [28]
Jersey crossbred cattle	2234.27±74.94	2881.35±124.34	373.63±15.64	-	-	Mandal *et al.* [23]
HF	3408.17±48.54	-	-	-	-	Katok and Yanar [27]
HF × Deoni	1707.25±13.25	1661.35±15.17	296.80±2.29	-	-	Wondifraw

						et al. [5]
Boran and cross (Ethiopia)	1495.69±114.17	1662.10±124.24	349.01±18.70	-	-	Belay and Chakravarty [13]
Sahiwal cross	1633±47	-	240±5.5	-	-	Hassan and Khan [78]
Jersey × Sahiwal	-	2154.07±16.88	300.16±0.06	-	-	Varaprasad *et al.* [9]
Red Sindhi × Jersey	-	-	-	-	ADMY/LL 6.78±0.17 ADMY/CI 5.61±0.16	Verma and Thakur [64]
Frieswal cattle	-	2957.80	299	-	MY/LL 9.88	Singh *et al.* [56]
Indigenous cow HF crossbred Overall mean	-	403.21±90.34 2123.43±65.67 1407.34±71.34	204.33±70.35 325.12±61.28 275.11±65.23	2.54±0.41 9.87±0.29 6.88±0.38	-	Kumar *et al.* [16]
HF Crossbred	-	2069.16±78.44	331.57±12.77	12.15±0.82	-	Kumar *et al.* [16]
Jersey cattle	-	1997.88±79.43	-	-	-	Patond *et al.* [10]
HF Crossbred	3027.11±203.1	3415.05±31.96	335.23±2.39	-	MY/FLL 10±0.05 MY/FCI 8.64±0.06	Dash *et al.* [6]
Deoni Cattle	-	358.31±27.18	213.9±13.74	3.14±0.18	-	Bhutkar *et al.* [17]
HF	-	3919.66±42.99	298.28±5.48	-	-	Al-Samarai *et al.* [35]
Karan Fries cattle	4113.61±55.90	4677.84±50.35	365.10±3.34	-	MY/LL 12.93±0.99 MY/CI 11.08±0.13	Japheth *et al.* [31]
Sahiwal cattle	1782.97±68.37	1880.39±73.82	-	-	-	Verma *et al.* [11]
Jersey crossbred cattle	2141.26±79.32	2496.14±82.57	337.73±6.9	11.89±0.28	TMY/LL 6.97±0.21 TMY/CI 6.02±0.23	Ratwan *et al.*, Ratwan *et al.* [19, 65]

EFFECT OF GENETIC AND NON-GENETIC FACTORS ON DIFFERENT LACTATION TRAITS

305 Days Milk Yield

Significant effect of sire on 305 days milk yield was reported by Atil *et al.* in HF cattle [18]. Singh and Gurnani (2004) also reported significant (P<0.01) effect of sire on 305 FLMY in Karan Fries and Karan Swiss cattle. In Jersey crossbred and Sahiwal cattle, Verma *et al.* and Ratwan *et al*. reported that sire had significant influence on 305DMY [11, 19]. Several workers reported the significant effect of genetic group of animals on milk yield at different milking days in crossbred cattle [20–23]. Sahana and Gurnani as well as Ratwan *et al*. reported significant effect of genetic group on 305 days milk yield in cattle [24, 19].

Significant effect of year and season of calving was reported by Atil *et al.* in HF cattle [18]. Singh and Gurnani (2004) reported significant effect of period of calving on 305 FLMY in Karan Swiss cattle. Amimo *et al.* reported significant (P<0.01) effect of year of calving and parity on 305DMY in Ayrshire cattle whereas effect of season was non-significant in their study [3]. Lakshmi *et al.* observed significant effect of genetic group, period of calving and parity of animal on 300 days milk yield [25]. The analysis of variance of means for 305 days milk yield has verified that effect of period of calving, parity and season were significant (P<0.01) in Tunisian Holstein as reported by M'hamdi *et al.* [26]. Katok and Yanar reported significant (P<0.01) effect of parity and year of calving on 305 days milk yield [27]. They also reported significant

(P<0.05) effect of season of calving on 305DMY. Manoj *et al.* reported significant (P<0.01) effect of period of calving on FL305DMY whereas effect of season was non-significant [28]. Kumar *et al.* and Kumar *et al.* observed non-significant effect of season of calving on milk and its constituents in dairy animals [29, 30]. Significant effect of period and season of calving was observed by Ratwan *et al*. in Jersey crossbred cattle [19].

The analysis of variance of means for 305 days milk yield has verified that the effect of period of calving and parity were significant (P<0.01) whereas, the effect of season of calving and AFC were non-significant on 305 days milk yield as reported by Wondifraw *et al.* in HF × Deoni cattle [5]. Mandal *et al.* reported significant (P<0.01) effect of period of calving and genetic group, whereas non-significant effect of age group at calving on first lactation 305DMY in Jersey crossbred cattle [23]. Patond *et al.* reported significant effect of period of calving and non-significant effect of season, parity and age at first calving on 305DMY in Jersey cattle [10]. Significant (P<0.05) effect of period, season of calving and parity of animal was shown by Japheth *et al.* in Karan Fries cattle [31]. Verma *et al.* reported significant influence of period of calving and parity of animal whereas, non-significant effect of season of calving on 305DMY in Sahiwal cattle [11].

Total Lactation Milk Yield (TLMY)
Ayied *et al.* [32] and Nawaz *et al.* reported significant influence of sire on TLMY [32, 33]. Pantelici *et al.* [34] also reported significant (P<0.01) effect of sire on TLMY in Simmental cattle [34]. Significant effect of sire on TLMY was observed by Al-Samarai *et al.*, Verma *et al.* and Ratwan *et al*. in HF, Sahiwal and Jersey crossbred cattle [11, 19, 35].

Dhumal *et al.* reported non-significant effect of season on lactation milk yield in Jersey × Red Khandhari [36]. Banda reported significant effect of season of calving on TLMY in crosses of Friesian and Jersey with Zebu cattle [37]. Cows calving in dry season produced 20% more (P<0.001) milk than those calving in wet season in his study. The LMY was significantly (P<0.05) affected by season of calving as reported by Wondifraw *et al.* [5]. Maximum production occurred during winter season. Milk production was depressed for cows calving in summer. Similar findings were reported by Gaur and Mishra and Joshi [38, 39]. However, Nagare and Patel and Auradkar reported non-significant effect of season of calving on LMY [40, 41]. Mudgal *et al.* in Holstein Friesian × Sahiwal cows noticed significant influence of season of calving on various production traits [42], whereas Jadhav and Khan in Holstein Friesian × Sahiwal cows [43] and Kothekar in Holstein Friesian cows found that season of calving was not a significant source of variation in various production traits [44]. This variation could be due to the type of feed, environmental deviations and management, which varies greatly during different seasons. Ahmad *et al.* reported significant (P<0.001) effect of season of calving in Jersey cattle on LMY [45]. Abou-Bakr and Al-Masri reported non-significant effect of season on total lactation milk yield [46, 47]. Varaprasad *et al.* reported non-significant effect of season on FLMY in Jersey × Sahiwal [9]. Significant (P<0.01) effect of season of calving was reported by Kumar *et al.* in Indigenous cattle and HF crossbred cattle [16]. Al-Samarai *et al.* reported non-significant effect of season on TLMY in HF cattle [35]. Highly significant (P<0.01) variations in TMY in different seasons were reported by Japheth *et al.* and Ratwan *et al.* in Karan Fries and Jersey crossbred cattle [19, 31]. Verma *et al.* reported non-significant effect of season of calving on TMY in Sahiwal cattle [11].

Banda reported significant effect of year of calving on TLMY in crosses of Friesian and Jersey with Zebu cattle [37]. According to his observations, milk increased by 14.1% from 1977 to 1978, thereafter yield decreased significantly (P<0.01) by 9–10% reaching the lowest values in 1981. The lactation milk yield was affected by period of calving (P<0.01) as reported by Wondifraw *et al.* [5]. The variation in LMY observed in different periods indicates the level of management as well as environmental effects. Similar observations were reported by Thombre and Komatwar *et al.* [48, 49]. However, Gadmade reported non-significant effect of period of calving on LMY [50]. Das *et al.* in Holstein Friesian × Sahiwal cows also observed non-significant influence of period of calving on various production traits [21]. Ahmad *et al.* reported significant (P<0.001) effect of period of calving in Jersey cattle on LMY [45]. Pundir *et al.* reported non-significant effect of period of calving on LMY in Red Sindhi × Jersey [51]. Jadhav *et al.* reported significant (P<0.01) effect of period of calving on TMY in Gir halfbreds [52]. Lakshmi *et al.* reported that period of calving significantly affected TLMY in HF × Sahiwal cattle [25]. Mandal *et al.* reported significant (P<0.01) effect of period of calving on TLMY in Jersey crossbred cattle [23]. Bhutkar *et al.* reported significant effect of period of calving on TLMY [17]. Pantelici *et al.* and Al-Samarai *et al.* reported significant (P<0.01) effect of year of calving on TMY [34, 35]. Different periods of calving had highly significant (P<0.01) influence on TMY in Karan Fries cattle as observed by Japheth *et al.* [31]. Verma *et al.* reported non-significant effect of period of calving on TMY in Sahiwal cattle [11].

Banda reported significant effect of parity on TLMY in crosses of Friesian and Jersey with Zebu cattle [37]. There was a significant (P<0.01) linear increase in milk yield with parity. Habib *et al.* (2003) [100] reported non-significant effect of parity on TLMY. Significant effect of parity on TLMY was reported by Lateef *et al.* and Lakshmi *et al.* [53, 25]. Jadhav *et al.* reported significant (P<0.01) effect of parity on TMY [52]. Tadesse *et al.* and Al-Masri *et al.* reported significant effect of parity on TLMY [47, 54]. The lactation milk yield as significantly (P<0.01) affected by parity. First lactation cows had lowest milk production and highest production occurred in 5th parity as reported by Wondifraw *et al.* in HF × Deoni [5]. Their findings were in agreement with reports of Thakur and Singh (2001) [101] and Komatwar *et al.* [49]. In contrast, Gadmade have reported non-significant effect of parity on LMY [55]. Significant influence of parity on various production traits was reported by Singh *et al.* (1997) [102] in Sahiwal cows while contrary findings were recorded by Mudgal *et al.* in Holstein Friesian × Sahiwal cows [42]. Singh *et al.* reported non-significant effect of parity on TLMY in Frieswal cattle [56]. Kumar *et al.* and Al-Samarai *et al.* reported significant (P<0.01) effect of parity on TLMY [16, 35]. In Karan Fries cattle, Japheth *et al.* reported significant (P<0.05) influence of different parities on TMY [31].

Mandal *et al.* reported non-significant effect of age group on first lactation total milk yield in crossbred cattle [23].

Banda reported non-significant effect of genetic group on TLMY in crosses of Friesian and Jersey with Zebu cattle [37]. Sahana and Gurnani reported significant effect of genetic group on first lactation total milk yield (FLTMY) [24]. Lakshmi *et al.* reported significant effect of genetic group on TLMY [25]. Elemam *et al.* reported significant (P<0.05) effect of exotic blood on TLMY in crossbred cattle [57]. Singh *et al.* reported significant (P<0.01) effect of GG on TMY in Frieswal cattle [56]. Mandal *et al.* reported significant (P<0.01) effect of genetic group on TLMY in Jersey crossbred cattle [23]. Kumar *et al.* observed significant (P<0.01) effect of GG on LMY [16].

Lactation Length (LL)

Pantelici *et al.* reported significant (P<0.01) effect of sire on LL [34]. However, Al-Samarai *et al.* reported non-significant effect of sire on LL [35].

Banda reported significant effect of season of calving on LL in crosses of Friesian and Jersey with Zebu cattle [37]. Cows calving in dry season were milked significantly (P<0.05) longer than those calving in rainy season. Singh and Gurnani (2004) [103]reported significant (P<0.05) effect of season of calving on FLL in Karan Fries cattle. The lactation length was not significantly affected by season of calving as reported by Wondifraw *et al.* in HF × Deoni [5]. Similar results were reported by Gadmade and Chavan [55, 58]. However, Auradkar [41] and Komatwar *et al.* reported significant effect of season on lactation length [49]. Jadhav *et al.* reported non-significant effect of season on LL in Gir halfbreds [52]. Manoj *et al.* reported non-significant effect of season of calving on FLL [28]. Kumar *et al.* also reported non-significant effect of season on LL [16].

Banda reported non-significant effect of period of calving on LL in crosses of Friesian and Jersey with Zebu cattle [37]. The lactation length was significantly (P<0.01) affected by period of calving as reported by Wondifraw *et al.* [5]. Differences may be due to the reason of better feeding management that led to early conception of cows resulting on time of subsequent calving. Similar results were reported by Chavan and Komatwar *et al.* [58, 49]. However, Gadmade and Auradkar reported non-significant effect of period of calving on lactation length [55, 41]. Jadhav *et al.* reported non-significant effect of period of calving on LL in Gir halfbreds [52]. Manoj *et al.* observed significant (P<0.01) effect of period of calving on FLL [28]. Significant (P<0.01) effect of year of calving was reported by Nyamushamba *et al.* on LL [59].

Singh *et al.* reported non-significant effect of period on LL in Frieswal cattle [56]. Mandal *et al.* reported non-significant effect of period of calving on LL in Jersey crossbred cattle [23]. Pantelici *et al.* reported significant (P<0.01) effect of year of calving on LL in Simmental cattle [34]. Bhutkar *et al.* reported non-significant effect of period of calving on LL in Deoni cattle [17]. Significant (P<0.01) effect of period of calving on LL was observed by Al-Samarai *et al.* and Japheth *et al.* in HF and Karan Fries cattle respectively [35, 31].

Banda reported significant effect of parity on LL in crosses of Friesian and Jersey with Zebu cattle [37]. Lactation length linearly increased (P<0.01) with increasing parity. Lactation length was not significantly affected by parity as reported by Wondifraw *et al.* [5]. Their findings were in agreement with reports of Gadmade and Chavan [55, 58] but Auradkar and Komatwar *et al.* reported significant effect of parity on lactation length [41, 49].

Jadhav *et al.* reported non-significant effect of parity on LL in Gir halfbreds [52]. Significant effect of parity on LL was observed by Topaloglu and Gunes [60]. Singh *et al.* reported non-significant effect of parity on LL in Frieswal cattle [56]. Kumar *et al.* reported significant (P<0.01) effect of parity on LL [72]. Significant (P<0.05) effect of parity on LL was reported by Japheth *et al.* in Karan Fries cattle [31].

Non-significant effect of age group on first lactation length was reported by Mandal *et al.* in crossbred cattle [23].

Banda reported non-significant effect of genotype on LL in crosses of Friesian and Jersey with Zebu cattle [37]. Mandal *et al.* reported non-significant effect of genetic group on LL in Jersey crossbred cattle [23]. Kumar *et al.* reported significant (P<0.01) effect of genetic group on LL [16].

Peak Yield

Dhaka *et al.* reported significant (P<0.05) effect of period of calving on first lactation peak yield (FPY) in Hariana cattle [15]. They also reported non-significant effect of season on FPY. Lakshmi *et al.* reported significant effect of genetic group, period of calving and parity on peak yield in HF × Sahiwal [25].

Kumar *et al.* reported significant (P<0.01) effect of genetic group, parity and season on PY in indigenous cattle and HF crossbred cattle [16]. In Deoni cattle, Bhutkar *et al.* reported significant effect of period of calving on peak yield [17].

Ratwan *et al*. found significant effect of sire, period of calving, season of calving, parity and genetic group on PY in Jersey crossbred cattle [19].

Milk Production Efficiency Traits

Das *et al.* reported significant effect of genetic group on average daily milk yield per lactation length (ADMY/LL) and average daily milk yield per calving interval (ADMY/CI) [61]. Singh and Gurnani (2004) [102]reported significant (P<0.01) effect of sire on MY/FLL and MY/FCI in Karan Fries and Karan Swiss cattle. They also reported significant effect of period of calving on MY/FLL and MY/FCI.

Singh *et al.* reported significant effect of genetic group, period of calving and season on first lactation milk yield per first lactation length (FLMY/FLL) and lifetime milk yield per lifetime lactation length (LTMY/LTLL) in crossbred cattle [62]. They also observed significant effect of genetic group and period of calving on FLMY/Days of AFC and LTMY/Days of total age at calving in crossbred cattle. But non-significant effect of season was reported by them on FLMY/Days of AFC and LTMY/Days of total age at calving. Significant effect of genetic group was reported by Singh *et al.* on ADMY/LL and ADMY/CI [63]. In HF × Sahiwal cattle, Lakshmi *et al.* reported significant effect of genetic group, period of calving and parity on MY/LL and MY/CI [25]. Verma and Thakur reported non-significant effect of genetic group, season and period of calving on ADMY/LL and ADMY/CI in Red Sindhi × Jersey cattle whereas significant (P<0.05) effect of parity and significant (P<0.01) effect of sire was reported on ADMY/LL and ADMY/CI [64]. Singh *et al.* reported significant (P<0.01) effect of GG and period of calving on MY/LL in Frieswal cattle [56]. Significant effect of period, season of calving and parity of animal on MY/LL and MY/CI was observed by Ratwan *et al*. and Japheth *et al.* in different crossbred cattle [65, 31].

Heritability Estimates

The role of heritability is very prominent in predicting the genetic worth as well as in predicting the genetic improvement expected in any selection programme. The heritability estimates as reviewed in different breeds of cattle for lactation traits are presented in Table 2.

Table 2: *Summary of Some Published Values of Heritability for Different Lactation Traits of Cattle.*

Cattle	Trait	h^2	References
	MY	0.38	Gacula *et al.* [79]
Southern dairy cattle	MY	0.25	Wilcox *et al.* [80]
	MY	0.26	Benya *et al.* [81]
	MY	0.26	Sharma *et al.* [82]
	MY	0.31	Moya *et al.* [83]
HF cattle	MY	0.3±0.02	Albuquerque *et al.* [84]
	305MY PY	0.26 0.26	Rekaya *et al.* [85]
Jersey cattle	MY	0.26 ± 0.11	Roman *et al.* [86]
Sahiwal Cattle	FLMY FLL	0.01±0.02 0.06±0.04	Javed *et al.* [68]
Holstein Friesian	MY305 TMY LL	0.29 0.25 0.09	Ojango and Pollot [87]
Hariana cattle	FLMY FLPY	0.26±0.12 0.29±0.13	Dhaka *et al.* [15]
Moroccan HF cattle	MY	0.29	Boujenane [88]
Sahiwal × Friesian	LL	0.46±0.33	Das *et al.* [69]
Holstein	MY305	0.25	Lee and Han [89]
Karan Fries Karan Swiss	FLMY MY/FLL MY/FCI FLMY MY/FLL MY/FCI	0.41±0.13 0.51±0.15 0.41±0.14 0.49±0.17 0.42±0.16 0.44±0.19	Singh and Gurnani (2004)
Friesian	MY305	0.22	Khattab *et al.* [90]
Crossbred cattle	FLMY/FLL FLMY/Days of AFC LTMY/LTLL LTMY/Days of total age at calving	0.55±0.19 0.76±0.22 0.68±0.28 0.37±0.27	Singh *et al.* [62]
Iranian Holstein	MY	0.15-0.23	Edriss *et al.* [91]
Crossbred cattle in Brazil	MY LL	0.28 0.19	Filho *et al.* [92]
Brown Swiss	FLMY	0.14±0.08	Cilek *et al.* [93]
Crossbred Cattle	FLMY FLL TLL	0.23±0.08 0.22±0.07 0.13±0.06	Singh *et al.* (2007) [104]

Ayrshire (Kenya)	305DMY	0.12 ±0.05	Amimo *et al.* [3]
Local Friesian × local Jersey × local Pooled Local Friesian × Local Jersey × Local Pooled	FLMY FLL	0.43 0.49 0.49 0.49 0.48 0.49 0.49 0.49	Rahman *et al.* [14]
Ethiopian Boran cattle	LMY 305DMY LL TMY/LL	0.20±0.03 0.18±0.03 0.26±0.03 0.13±0.03	Haile *et al.* [94]
Ethiopian Boran cattle × HF	LMY 305DMY LL TMY/LL	0.10±0.002 0.11±0.003 0.63±0.02 0.45±1.05	Haile *et al.* [94]
Frieswal Cattle	FLMY FLL	0.35±0.11 0.04±0.06	Kumar *et al.* [71]
BCB-1	LMY LL PY MY/CI	0.40 0.33 0.34 0.23	Deb *et al.* [95]
Karan Fries	FL305DMY FLMY FLL MY/FLL MY/FCI	0.30±0.02 0.27±0.06 0.21±0.05 0.39±0.07 0.40±0.09	Saha *et al.* [22]
Iranian Holstein	MY	0.26	Hashemi *et al.* [74]
Frieswal cattle	FL300DMY FLMY LL PY	0.18±0.07 0.20±0.08 0.06±0.05 0.16±0.07	Lakshmi *et al.* [25]
Sahiwal Cattle	FLMY T305DMY FLL	0.10 0.22 0.09	Banik and Gandhi [96]
Iranian Brown Swiss crossbred	MY FY	0.24 0.16	Gorbani *et al.* [50]
HF cattle	LMY LL	0.26±0.33 0.18±0.16	Usman *et al.* [77]
Butana cows	TMY LL	0.02±0.01 0.01±0.01	Badri *et al.* [76]
HF	LL	0.03-0.04	Hossein-Zadeh [97]
Boran and cross (Ethiopia)	305DMY FLL	0.38±0.05 0.21±0.3	Belay and Chakravarty [13]
Holstein	FLMY	0.34±0.01	Zavadilova and Zink [98]
HF cattle	TMY	0.32	Nawaz *et al.* [33]
HF cattle	TMY LL	0.35 0.06	Al-Samarai *et al.* [35]
Jersey crossbred cattle	MY/LL MY/CI	0.54 0.63	Ratwan *et al.* [65]
Jersey crossbred cattle	305MY TMY LL PY	0.58±0.14 0.51±0.13 0.15 0.51±0.13	Ratwan *et al.* [19]

CONCLUSION

Genetic improvement through selection in a breeding program depends on the accuracy of identifying genetically superior animals. Selection of dairy animals is generally based on the records of lactation traits. The variations in lactation traits may be more of environmental nature as opposed to genetics and sampling of population. As per literature, all important genetic and non-genetic factors like sire, season of calving, period of calving, parity of animals, age group and genetic group of animals had significant influence on the lactation traits in dairy cattle. Sire had significant influence on lactation traits in several studies, which suggest that superior sires can be used effectively to improve lactation traits in dairy cattle. Differences in lactation traits over different periods and seasons may be attributed to differences in management, selection of sires and different environmental conditions such as temperature, rainfall, humidity etc. Therefore, adjustment of effect of genetic and non-genetic factors is important for accurate and unbiased estimates of genetic parameters so that superior germplasm of dairy animals can be selected for future generations.

REFERENCES

1. *19th Livestock Census.* 2012. All India Report. http://www.dahd.nic.in/dahd/WriteReadData/Livestock.pdf
2. NBAGR. 2016. Available from http://www.nbagr.res.in/registeredbreed.html
3. Amimo JO, Wakhungu JW, Inyangala BO, *et al*. The Effects of Non-Genetic Factors and Estimation of Genetic and Phenotypic Parameters and Trends for Milk Yield in Ayrshire Cattle in Kenya. *Livestock Res Rural Dev*. 2007; 19: 13p.
4. Lakshmi SB, Gupta BR, Prakash MG, *et al.* Genetic Analysis of Production Performance of Holstein Friesian × Sahiwal Cows. *Tamil Nadu J Vet Anim Sci*. 2009; 5(4): 143–148p.
5. Wondifraw Z, Thombre BM, Bainwad DV. Effect of Non-Genetic Factors on Milk Production of Holstein Friesian × Deoni Crossbred Cows. *Int J Livest Prod.* 2013; 4(7): 106–112p.
6. Dash SK, Gupta AK, Singh A, *et al.* Evaluation of Efficiency of Sire Model and Animal Model in Holstein Friesian Crossbred Cattle Considering First Lactation Production and Fertility Traits. *Vet World*. 2014; 7(11): 933–937p.
7. Hayman RH. The Development of the Australian Milk Zebu. *World Anim Rev*. 1974; 11: 31–35p.
8. Zafar AH, Ahmad M, Rehman SU. Study of Some Performance Traits in Sahiwal Cows During Different Periods. *Pakistan Vet J*. 2008; 28(2): 84–88p.
9. Varaprasad AR, Raghunandan T, Kumar MK, *et al.* Studies on the Productive Performance of Jersey × Sahiwal Cows in Chittoor District of Andhra Pradesh. *Afr J Agric Res*. 2013; 8(14): 1200–1203p.
10. Patond MN, Gulhane VM. Effect of Non-Genetic Factors on 305 Days Milk Yield in Jersey Cattle. *Adv Life Sci.* 2014; 3(1): 16–17p.
11. Verma MK, Sachdeva GK, Yadav AK, *et al.* Effect of Genetic and Non-Genetic Factors on Milk Yield and Milk Constituents on Sahiwal Cattle. *Indian J Anim Res*. 2015; 49.
12. Tekereli M, Gundogan M. Effect of Certain Factors on Productive and Reproductive Efficiency Traits and Phenotypic Relationships among these traits and Repeatabilities in West Anatolian Holsteins. *Turk J Vet Anim Sci.* 2005; 29: 17–22p.
13. Belay B, Chakravarty AK. Genetic Analyses of First Lactation Traits of Boran and their Crosses with Holstein and Jersey in Central Highlands of Ethiopia. *J Cell Anim Biol*. 2013; 7(1): 9–15p.
14. Rahman M, Islam R, Mohammad MR, *et al.* Estimation of Genetic Parameters for Economic Traits in Dairy Cattle of Bangladesh. *Asian J Anim Vet Advac*. 2007; 2(1): 9–14p.
15. Dhaka SS. Genetic Studies on Production Efficiency Traits in Hariana Cattle. *Asian-Aust J Anim Sci*. 2002; 15(4): 466–469p.
16. Kumar N, Eshetie A, Tesfaye A, *et al.* Productive Performance of Indigenous and HF Crossbred in Gondar, Ethiopia. *Vet World*. 2014; 7(3): 177–181p.
17. Bhutkar SS, Thombre BM, Bainwad DV. Effect of Non-Genetic Factors on Production Traits in Deoni Cows. *IOSR-Journal of Agriculture and Veterinary Science (IOSR-JAVS).* 2014; 7(12): 09–14p.
18. Atil H, El Ariain MN, Khattab AS. Age Correction Factors for Some Productive Traits in a Commercial Herd of Holstein Friesian Cattle in Egypt. *Journal of Biological Sciences.* 2001; 1: 663–665p.
19. Ratwan P, Mandal A, Kumar M, *et al.* Genetic Analysis of Lactation Traits in

Jersey Crossbred Cattle. *Indian J Dairy Sci*. 2016; 69(2): 1–4p.
20. Dutt T, Gaur GK, Bhusan B. Maximum Likelihood Estimates of First Lactation Traits in Halfbreds and Three Breed Crosses of Friesian, Brown Swiss and Jersey with Hariana. *Indian J Anim Prod Manage*. 1999; 15(4): 150–53p.
21. Das D, Goswami RN, Mill DC, *et al.* Monthly and Cumulative Monthly Milk Yield of Jersey and Holstein Friesian Cattle in Assam. *Indian Vet J*. 2006; 83: 35–37p.
22. Saha S, Joshi BK, Singh A. Generation Wise Genetic Evaluation of Various First Lactation Traits and Herd Life in Karan Fries Cattle. *Indian J Anim Sci.* 2010; 80(5): 451–456p.
23. Mandal A, Roy PK, Ghosh MK, *et al.* Genetic and Environmental Effects on First Lactation Traits of Jersey Crossbred Cattle in an Organized Herd of Eastern India. *Indian J Dairy Sci*. 2013; 66(2): 130–133p.
24. Sahana G, Gurnani M. Performance of Crossbred Cattle and Comparison of Sire Evaluation Methods under Organized Farm Condition. *Indian J Anim Sci*. 2000; 70(4): 409–414p.
25. Lakshmi SB, Gupta BR, Prakash MG, *et al.* Genetic Analysis of the Production Performance of Frieswal Cattle. *Tamilnadu J Veterinary & Animal Sciences (TNJVAS)*. 2010; 6(5): 215–222p.
26. M'hamdi N, Bouallegue M, Frouja S, *et al.* Effects of Environmental Factors on Milk Yield, Lactation Length and Dry Period in Tunisian Holstein Cows. 2012. http://dx.doi.org/10.5772/50803.
27. Katok N, Yanar M. Milk Traits and Estimation of Genetic, Phenotypic and Environmental Trends for Milk and Milk Fat Yields in Holstein Friesian Cows. *Int J Agric Biol*. 2012; 14: 311–314p.
28. Manoj M, Gandhi RS, Raja TV, *et al.* Effect of Non-Genetic Factors on First Lactation Production and Reproduction Performance in Sahiwal Cattle. *Indian J Dairy Sci*. 2012; 65(3): 264–265p.
29. Kumar M, Vohra V, Ratwan P, *et al.* Influence of FASN Gene Polymorphism on Milk Production and its Composition Traits in Murrah Buffaloes. *Indian J Anim Res.* 2015. DOI: 10.18805/ijar.7077.
30. Kumar M, Vohra V, Ratwan P, *et al.* Estimates of Genetic Parameters for Fat Yield in Murrah Buffaloes. *Vet World.* 2016; 9(3): 295–298p.
31. Japheth KP, Mehla RK, Imtiwati, *et al.* Effect of Non-Genetic Factors on Various Economic Traits in Karan Fries Crossbred Cattle. *Indian J Dairy Sci*. 2015; 68(2): 163–169p.
32. Ayied SA, Jadoa AJ, Abdulrada AJ. Heritabilties and Breeding Values of Production and Reproduction Traits of Holstein Cattle in Iraq. *J Basrah Res (Sciences).* 2011; 37: 66–70p.
33. Nawaz A, Nizamani AH, Marghazani IB, *et al.* Influence of Genetic and Environmental Factors on Lactation Performance of Holstein Friesian Cattle in Balochistan. *J Anim Plant Sci*. 2013; 23: 17–19p.
34. Pantelici V, Petrovici MM, Ostojic-Andrici D, *et al*. The Effect of Genetic and Non-Genetic Factors on Production Traits of Simmental Cows. *Biotechnol Anim Husb.* 2014; 30(2): 251–26p.
35. Al-Samarai FR, Abdulrahman YK, Mohammed FA, *et al.* Comparison of Several Methods of Sire Evaluation for Total Milk Yield in a Herd of Holstein Cows in Yemen. *Open Vet J*. 2015; 5(1): 11–17p.
36. Dhumal MV, Sakhare PS, Deshpande KS. Factors Affecting Lactation Milk Yield and Lactation Length in Red Kandhari and Crossbred Cows. *Indian J Dairy Sci*. 1989; 42(1): 102–104p.
37. Banda JW. Evaluation of the Productive and Reproductive Performance of Friesian × Zebu and Jersey × Zebu crossbred cattle at Bunda College Farm in Malawi. *Malawi Journal of Science and Technology (MJST)*. 1996; 3.
38. Gaur GK. Environmental Factors Affecting Various Performance Traits of Holstein Friesian × Sahiwal Cattle. *Indian J Dairy Sci*. 2007; 54: 209–213p.
39. Mishra SS, Joshi BK. Genetic and Non-Genetic Factors Affecting Lactation Milk Constituents and Yield Traits in Holstein Friesian × Karan Crossbred Cows. *Indian J Dairy Sci.* 2009; 57: 69–72p.
40. Nagare WK, Patel AM. Comparative Performance of Gir Crossbreds under Maharashtra Conditions. *Indian J Animal*

Prod Manage. 1997; 13(2): 87–92p.

41. Auradkar SK. *Genetic and Non-Genetic Factors Affecting Production and Reproduction Performance of Crossbred Cows (Friesian × Sahiwal).* Ph.D. Dissertation. Parbhani: Marathwada Agricultural University; 1999.

42. Mudgal KC, Taylor CM, Singh A. Gestation and Lactation Periods in Holstein Friesian X Sahiwal Crossbreds. *Indian Vet Med J*. 1985; 9: 245–246p.

43. Jadhav A, Khan FH. Genetic and Non-Genetic Factors Affecting First Lactation Yield in Holstein × Sahiwal Crossbreds. *Indian J Dairy Sci*. 1995; 48: 251–252p.

44. Kothekar MD. Effect of Environmental Factors on Performance of Holstein Friesian Cattle. *Indian Vet J*. 2004; 81: 283–285p.

45. Ahmad B, Khan S, Manan A, *et al.* Production and Reproduction Performance of Jersey Cattle at Cattle Breeding and Dairy Farm Harichand Charsadda NWFP. *Journal of Agricultural and Biological Science (JABS)*. 2007; 2(1).

46. Abou-Bakr S. Genetic and Phenotypic Trends of 305-Day Milk Yield of Holstein Cows Raised at Commercial Farm in Egypt. *Egyptian J Anim Prod*. 2009; 46: 85–92p.

47. Al-Masri OA, Salhab SA, Mousa SK. Factors Affecting the Total Milk Yield in Holstein Friesian Cattle at Kharabo Dairy Station. *J Damascus Univ*. 2012; 28: 259–272p.

48. Thombre BM. *Studies on Genetic Architecture of a Few Economic Characters in Holstein Friesian × Deonihalf Breds.* Ph.D. Dissertation. Parbhani: Marathwada Agricultural University; 1996.

49. Komatwar SJ, Deshpande AD, Kulkarni MD, *et al.* Study on the Production Traits in Holstein Friesian × Sahiwal Crossbreds. *Indian J Animal Prod Mgmt*. 2010; 26(3–4): 177–181p.

50. Gorbani A, Salamatdoust Nobar R, Mehman Navaz U, *et al.* Heritability and Repeatability Estimation in Iranian Brown Swiss Crossbred Dairy Cattle Population. *Int J Anim Vet Adv*. 2011; 3(4): 335–337p.

51. Pundir RK, Kailla OP, Mishra SK, *et al.* Genetic Analysis of Performance Traits of Red Sindhi and Jersey Crossbreds. *Indian Vet J*. 2007; 84(7): 705–709p.

52. Jadhav SS, Deshmukh AR, Deokar DK, *et al.* Effect of Non-Genetic Factors on Production Traits of Girhalf Breds. *The Asian Journal of Animal Science (TAJAS)*. 2010; 5(1): 23–24p.

53. Lateef M, Ateef KZ, Gondal M, *et al.* Milk Production Potential of Pure Bred Holstein Friesian and Jersey Cows in Subtropical Environment of Pakistan. *Pakistan Vet J*. 2008; 28: 9–12p.

54. Tadesse MJ, Thiengtham J, Pinyopummin A, *et al.* Productive and Reproductive Performance of Holstein Friesian Dairy Cows in Ethiopia. *Livestock Res Rural Dev*. 2010; 22(2). Cited in http://www.lrrd.org/lrrd22/2/tade22034.htm

55. Gadmade SS. *Studies on Factors Affecting Performance of Tharparkar, Jersey and Jersey × Tharparkar Crossbred Cows.* M.V.Sc. Thesis. Parbhani: Marathwada Agricultural University; 1999.

56. Singh S, Das AK, Taggar RK, *et al.* Effect of Genetic and Non-Genetic Factors on Production Traits of Frieswal (Holstein Friesian × Sahiwal) Crossbred Cows. *Indian J Vet Res*. 2013; 22(1): 63–66p.

57. Elemam MB, Nekheila AM. Some Productive Traits of Crossbred Dairy Cows in the Farm of University of Khartoum, Sudan. *Emir J Food Agric.* 2012; 24(2): 155–158p.

58. Chavan SB. *Genetic and Non-Genetic Factors Affecting Growth, Production and Reproduction Performances of Holstein Friesian × Sahiwal Crossbred Cows.* M.V.Sc. Thesis. Parbhani: Marathwada Agricultural University; 2001.

59. Nyamushamba GB, Tavirimirwa B, Banana NYD. Non-Genetic Factors Affecting Milk Yield and Composition of Holstein-Friesian Cows Nested within Natural Ecological Regions of Zimbabwe. *Sci J Anim Sci*. 2013; 2: 102–108p.

60. Topaloglu N, Guneş H. Effects of Some Factors on Milk Yield and Components of Holstein-Friesian Cattle in England. *J Fac Vet Med Istanbul Univ*. 2010; 36: 65–74p.

61. Das D, Goswami RN, Deka D. Genetic and Non-Genetic Factors Affecting the Lactation Milk Yield and Lactation Length of Jersey and Red Dane Cattle. *Indian*

Journal of Animal Health. 2002; 41(2): 137–140p.

62. Singh VK, Singh CV, Kumar D, *et al.* Genetic Evaluation of Some Economic Traits in Sahiwal and its Crossbreds. *Indian J Dairy Sci*. 2005; 58(3): 206–210p.

63. Singh NP, Yadav MC, Kushwaha BP, *et al.* Factors Affecting Milk Production Efficiency Traits in Holstein × Sahiwal Crosses. *Indian J Dairy Sci.* 2006; 59(3): 172–176p.

64. Verma N, Thakur YP. Effect of Genetic and Non-Genetic Factors on Production Efficiency Traits of Red Sindhi x Jersey Crossbred Cows Maintained Under Sub-Temperate Indian Conditions. *Livestock Research International*. 2013; 1: 58–60p.

65. Ratwan P, Mandal A, Kumar M, *et al.* Genetic Analysis of Milk Production Efficiency Traits in Jersey Crossbred Cattle. *Indian J Ani Res.* 2015. DOI:10.18805/ijar.7076.

66. Deshpande KS, Bonde HS. Genetic Aspect of Milk Yield Per Day of Age at Second Calving in Friesian × Sahiwal Crossbreds. *Indian J Anim Sci*. 1983; 53: 189p.

67. Baruah DK, Sarker AB, Bora NN. Performance of Jersey Grade Cows in Operation Flood Areas of Assam. *Indian Vet J.* 1997; 74(11): 947–950p.

68. Javed K, Mohiuddin G, Akhtar P. Heritability Estimates of Some Productive Traits in Sahiwal Cattle. *Pakistan Vet J*. 2001; 21(3): 114–117p.

69. Das PK, Ali SZ, Islam AB, *et al.* A Comparative Study of Productive and Reproductive Performance and Estimates of Heritability for Economic Traits in Different Genetic Groups of Cattle Available at Baghabarighat Milk Pocket Area of Bangladesh. *Online J Biol Sci.* 2003; 3: 726–740p.

70. Singh, V. K., Singh, C.V., Kumar, D. and Kumar, A. (2005). Genetic evaluation of some economic traits in Sahiwal and its crossbreds. Indian J. Dairy Sci. 58(3): 206-210.

71. Singh VK, Singh CV, Kumar D. Genetic Analysis of Milk Producing Efficiency Traits in Crossbred Cattle. *Indian J Anim Sci*. 2005; 75(1): 37–40p.

72. Kumar S, Singh YP, Kumar D. Genetic Studies on Performance Traits in Frieswal Cattle. *Indian J Anim Sci*. 2008; 78(1): 107–110p.

73. Thomas N, Anilkumar K. Evaluation of Ten Sire Families of Crossbred Dairy Cattle of Kerala Based on Milk Production and Milk Composition Traits. *Vet World*. 2009; 2(1): 10–12p.

74. Hashemi A, Bernousi I, Zadeh SR, *et al.* Estimates of Genetic Parameters of Productive Traits in Holstein-Native Crossbreeds in W. Azerbaijan Province-Iran. *J Anim Vet Adv*. 2009; 8: 917–919p.

75. Dandapat A, Banerjee D, Chakraborty D. Genetic Studies on Various Production and Reproduction Traits of Sahiwal and Crossbred Cattle (HF × Jersey × Sahiwal) of an Organised Farm. *Vet World*. 2010; 3: 4p.

76. Badri TM, Atta M, Ibrahim MT, *et al.* Genetic and Non-Genetic Factors Affecting Production Potential of Butana Dairy Cows at Atbara Research Station, Sudan. *Res Opin Anim Vet Sci*. 2011; 1(7): 429–433p.

77. Usman T, Guo G, Suhail SM, *et al.* Performance Trait Study of Holstein Friesian Cattle Under Subtropical Conditions. *J Anim Plant Sci.* 2011; 22: 92–95p.

78. Hassan F, Khan MS. Performance of Crossbred Dairy Cattle at Military Dairy Farms in Pakistan. *J Anim Plant Sci*. 2013; 23(3): 705–714p.

79. Gacula Jr. MC, Gaunt SN, Damon Jr. RA. Genetic and Environmental Parameters of Milk Constituents for Five Breeds. II. Some Genetic Parameters. *J Dairy Sci.* 1968; 51: 438–444p.

80. Wilcox CJ, Miller LH, White JM, *et al.* Methods and Procedures. In: *Genetic Methods of Improving Dairy Cattle for the South*. Minutes of the Annual Meeting of the Southern Regional Tech. Comm. Agricultural Library, Betsville, MD, USA. 1972; 7–10p.

81. Benya EG, Wilcox CJ, Martin FG, *et al.* Parametrosgeneticos para peso corporal, composicion y produccion de leche de unrebanolocalizadoen Florida. *Asoc Latinoam Prod Anim Men.* 1976; 11: 163–169p.

82. Sharma AK, Rodriguez LA, Mekonnen G, *et al.* Climatological and Genetic Effects on Milk Composition and Yield. *J Dairy Sci*. 1983; 66: 119–126p.

83. Moya J, Wilcox CJ, Bachman KC, *et al.* Genetic Trends in Milk Yield and Composition in a Subtropical Dairy Herd. *Rev Bras Genet.* 1985; 8: 509–521p.

84. Albuquerque LG, Dimov G, Keown F, *et al.* Estimates Using an Animal Model of (Co) variances for Yields of Milk, Fat, and Protein for the First Lactation of Holstein Cows in California and New York. *Faculty Papers and Publications in Animal Science.* Paper 144. 1995.

85. Rekaya R, Carabano MJ, Toro MA. Bayesian Analysis of Lactation Curves of Holstein-Friesian Cattle. *J Dairy Sci*. 2000; 83: 2691–2701p.

86. Roman RM, Wilcox CJ, Martin FG. Estimates of Repeatability and Heritability of Productive and Reproductive Traits in a Herd of Jersey Cattle. *Genet Mol Biol.* 2000; 23(1): 113–119p.

87. Ojango JMK, Pollot GE. Genetics of Milk Yield and Fertility Traits in Holstein-Friesian Cattle on Large Scale Kenyan Farms. *J An Sci.* 2001; 79: 1742–1750p.

88. Boujenane I. Estimates of Genetic and Phenotypic Parameters for Milk Production in Moroccan Holstein-Friesian Cows. *Revue Elev Med Vet Pays Trop*. 2002; 55(1): 63–67p.

89. Lee DH, Han KJ. Genetic Parameters of Milk Yield and Milk Fat Percentage Test Day Records of Iranian Holstein Cows. *Asian-Aust J Anim Sci.* 2004; 17(2): 153–158p.

90. Khattab AS, Atil H, Badawy L. Variances of Direct and Maternal Genetic Effects for Milk Yield and Age at First Calving in a Herd of Friesian Cattle in Egypt. *Arch Tierz, Dummerstorf.* 2005; 48(1): 24–31p.

91. Edriss MA, Nilforooshan MA, Sadeghi JM. Estimation of Direct Genetic and Maternal Effects for Production Traits of Iranian Holstein Cows using Different Animal Models. *Pak J Biol Sci.* 2006; 9(4): 636–640p.

92. Filho AEV, Madalena FE, Albuquerque LG, *et al*. Genetic Relationships between Milk Traits, Weight Traits and Age at First Calving in Crossbreed Dairy Cattle (Bostaurus × Bosindicus). *8th World Congress on Genetics Applied to Livestock Production*. 2006.

93. Cilek S, Tekin ME. Calculation of Adjustment Factors for Standardizing Lactations to Mature Age and 305-Day and Estimation of Heritability and Repeatability of Standardized Milk Yield of Simmental Cattle Reared on Kazova State Farm. *Turk J Vet Anim Sci*. 2006; 30: 283–289p.

94. Haile A, Joshi BK, Ayalew W, *et al.* Genetic Evaluation of Ethiopian Boran Cattle and their Crosses with Holstein Friesian in Central Ethiopia: Milk Production Traits. *Animal*. 2009; 3(4): 486–493p.

95. Deb GK, Mufti MM, Mostari MP, *et al.* Genetic Evaluation of Bangladesh Livestock Research Institute Cattle Breed-1: Heritability and Genetic Correlation. *Bang J Anim Sci*. 2008; 37(2): 25–33p.

96. Banik S, Gandhi RS. Estimation of Genetic Parameters in Sahiwal Cattle Using Single and Multi-Trait Restricted Maximum Likelihood Method. *Indian J Anim Sci.* 2010; 80(3): 266–268p.

97. Hossein-Zadeh NG. Genetic Parameters and Trends for Lactation Length in the First Three Lactations of Holstein Cows. *Archiv Tierzucht.* 2012; 55(6): 533–539p.

98. Zavadilova L, Zink V. Genetic Relationship of Functional Longevity with Female Fertility and Milk Production Traits in Czech Holsteins. *Czech J Anim Sci*. 2013; 58(12): 554–565p.

99. Rehman, S. U., Ahmad, M. and Shafiq, M. (2006). Comparative performance of Sahiwal cows at LES Bahadurnagar Vs Patadar’s herd. Pakistan Vet. J. 26(4): 179-183.

100. Habib, M. A., Bhuiyan, A. K. F. H., Bhuiyan, M. S. A. and Khan, A. A. (2003). Performance of Red Chittagong Cattle in Bangladesh Agricultural University Dairy Farm. Bangladesh J. Anim. Sci. 32: 101-108.

101. Thakur, Y. P. and Singh, B. P. (2001). Performance evaluation of Jersey × Sindhi crossbred cows. Indian Vet. J. 78(1): 62-63.

102. Singh, M., Tomar, S. P. S., Singh, R. and Manglik, V. P. (1997). Influence of exotic germplasm on Sahiwal to increase milk production under the foothills of

Uttar Pradesh. Indian Journal of Dairy Science. 49: 163-166.

103. Singh, M. K. and Gurnani, M. (2004). Performance Evaluation of Karan Fries and Karan Swiss Cattle under closed Breeding System. Asian-Aust. J. Anim. Sci. 17(1): 1-6.

104. Singh, N. P., Yadav, M. C., Kushwaha, B. P. and Sachan, C. B. (2007). Factors affecting milk production efficiency traits in Holstein × Sahiwal crosses. Indian Journal of Dairy Science. 59(3): 172-176.

Cite this Article

Poonam Ratwan, Manoj Kumar, Ajoy Mandal. Influence of Genetic and Non-Genetic Factors on Lactation Traits in Dairy Cattle: A Review. *Research & Reviews: Journal of Dairy Science and Technology*. 2016; 5(3): 7–22p.