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Evaluation of some economic traits in Holstein dairy cattle under Egyptian conditions

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ABSTRACT

The objectives of this study were to estimate heritability and breeding value for some economic traits and the impact of some environmental factors on these traits in Holstein dairy cattle in Egypt. The data of 10034 records for 3295 Holstein cows were studied during the period from 1998 to 2021 in El-Alamia farm which is belonging to Universal Company for Agricultural Development and Soil Reclamation and has a commercial dairy herd located at Nubaria region in the K 90 Alex - Cairo desert road. The traits under study were: Total milk yield (TMY, kg), 305-day milk yield (305-dMY, kg), Lactation length (LL, day), Dry period (DP, day), Days open (DO, day), Calving interval (CI, month) and Gestation length (GL, day). The results showed that all traits under study were significantly influenced by parity. Also, the calving year has a significant effect on the studied traits except for gestation length. In the same trend, the effect of calving season was significant in all traits except lactation length and gestation length. Heritability estimates were 0.265, 0.393, 0.488, 0.238, 0.12, 0.138 and 0.57 for TMY, 305-dMY, LL, DP, DO, CI and GL, respectively. Cow breeding values for TMY, 305-dMY, LL, DP, DO, CI and GL ranged from -957 to 2170.5 kg, from -2432.75 to 2713.75 kg, from -266.25 to 340 days, from -114 to 100.25, from -105.75 to 164 days, from -13.9 to 13.18 months and from -0.33 to 0.45 days, respectively. Dams breeding values ranged from -823.5 to 1364.25 kg, from -1076.75 to 1531.75 kg, from -139.75 to 186.5 days, from -79.75 to 46.5, from -58.25 to 82 days, from -8.23 to 8.63 months and from -0.28 to 0.53 days, respectively. Sires breeding values ranged from -1057.75 to 1082 kg, from -1458 to 1549.25 kg, from -219.25 to 292.75 days, from -79.5 to 85.25 days, from -75.5 to 89 days, from -8.7 to 7.08 months and from -0.58 to 0.60 days, respectively. In conclusion, heritability values for all traits under study were low to moderate except for gestation length was a high value, so the most useful way to improve the traits under the study would be by improving the management level. Also, an estimated cow's breeding value has a wide range than sires' or dams' breeding value revealing a higher genetic variance and a good chance of selecting superior cows.

Introduction

The dairy industry in Egypt has undergone substantial changes during the last two decades (Rushdi *et al*., 2014). The efficiency of the dairy farming system depends largely on the productive and reproductive performance of the herd (Ayalew *et al*., 2018). Milk production and reproductive traits are the most important economic traits as sources of income for dairy farmers where high-producing and fertile cows are usually profitable (Cervo *et al*., 2017). Breeding and selection programs in dairy herds have focused on the improvement of milk production and fertility traits (Muller *et al*., 2014). Productive and reproductive traits are affected by genetic and non-genetic factors. Evaluation of these factors provides the basic information for establishing good breeding programs for the genetic improvement of dairy herds (Goshu *et al*., 2014; Ramadan, 2018). Estimation of genetic parameters for these traits in dairy cattle is very important to determine the optimal breeding strategies (Pantelic *et al*., 2011; Zink *et al*., 2012; Hammoud, 2013). Moreover, evaluate the breeding plan as well as predict the breeding values of the animals (Sahin *et al*., 2012).

Our study aimed to estimate heritability and breeding value for some economic traits and the impact of some environmental factors on these traits in Holstein dairy cattle in Egypt.

Materials and methods

This experimental protocol was approved by the Ethics Committee of Damanhur University under approval number DUFA-2023-1.

Data collection

The data of 10034 productive records for 3295 Holstein cows were studied during the period from 1998 to 2021 in El-Alamia farm which is belonging to Universal Company for Agricultural Development and Soil Reclamation and has a commercial dairy herd located at Nubaria region in the K 90 Alex - Cairo desert road. Abnormal records of cows which were affected by udder troubles or reproductive disorders were excluded. Also, milk production records for cows which produced milk for less than 100 days were excluded from the study. Animals were housed in open barns with shades. Animals were fed according to the NRC requirements and were housed freely in open partly shaded yards. Animals were machine-milked twice a day at 7 a.m. and 4 p.m. and milk yield was recorded weekly in a fixed test day. The traits under study were: Total milk yield (TMY, kg), 305 day milk yield (305-dMY, kg), Lactation length (LL, day), Dry period (DP, day), Days open (DO, day), Calving interval (CI, month) and Gestation length (GL, day). Traits were classified according to sire, year of calving, season of calving and parity. Year of calving was divided into four categories; before 2000, 2000-2004, 2005-2010 and after 2010. The season of calving was classified into four seasons; winter, spring, summer and autumn. Cows were grouped according to parity into five parities; 1, 2, 3, 4, 5 and over.

Statistical analysis

Data were analyzed by using linear mixed model least squares analysis with unequal subclass numbers using the PROC MIXED procedure of

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SAS (SAS, 2009). The following model was used to analyse milk productive and reproductive traits

$$Y_{ijklmn} = \mu + S_i + P_j + D_k + C_l + b_m (x - \bar{x}) + e_{ijklmn}$$

Where: Y_{ijklmn} = the individual observation of productive and reproductive traits under study, μ = the overall mean, S_i = the random effect of ith sire, P_j = the fixed effect of jth parity, D_k= the fixed effect of k^{th} year of calving, C_l = the fixed effect of lth season of calving, bm = a regression coefficient of the trait on age at first calving (AFC), x = the independent continuous variant for (AFC) and = the respective mean, and e_{ijklmn} = the error term, assumed to be randomly and independently distributed with a mean equal to 0 and variance equal to δ^2e.

Heritability and Breeding values were estimated using Multiple Traits Derivative Free Restricted Maximum Likelihood (MTDFREML) according to Boldman *et al*. (1995) by using Animal Model. The Mixed Model Equations (MME) for the Best Linear Unbiased Estimate (BLUE) to estimate the Function for the (BLUP) was as follows:

$$\begin{bmatrix} X'X & X'Z & X'W \\ Z'X & Z'Z+A^{-1}\alpha_1 & Z'W \\ W'X & W'Z & W'W+I\alpha_2 \end{bmatrix} \begin{bmatrix} b' \\ a' \\ Pe \end{bmatrix} = \begin{bmatrix} Xy' \\ Zy' \\ Wy' \end{bmatrix}$$

Where; $\alpha_1 = \sigma^2e / \sigma^2a$ and $\alpha^2 = \sigma^2e / \sigma^2p$

And to estimate the heritability, the following equation was used;

$h^2 = \sigma^2a / (\sigma^2a + \sigma^2pe + \sigma^2e)$

Where; σ^2a = addition genetic variance, σ^2pe = permanent environmental variance and σ^2e = the random residual effect.

Results

Effect of parity

In the present study our results showed that the parity has a significant effect on all traits under study (Table 1). The highest total milk yield and 305-day milk yield were found in the third lactation (8067.83 and 6237.59 kg, respectively) and the lowest values were observed in the first lactation (6630.5 and 4471.24 kg, respectively). While, the longest lactation length (435.75 days) was showed in the first lactation, but the shortest lactation length (374.42 days) recorded in the fourth lactation. Our result obtained that the dry period was significantly increased with advanced parities and the highest dry period (88.58 days) found in the fifth lactation and the lowest dry period (68.53 days) was scored in the first lactation. In contrast, the longest days open (245.68 days) was showed in the first parity and it scored low values with advanced parities. In the same trend with days open, the calving interval was decreased with increased lactation number and the longest calving interval was 506.15 days in the first lactation, but the shortest calving interval was 205.71 days in the fourth lactation. But, the longest gestation length (296.08 days) found in the second parity, but the shortest gestation length (277.98 days) observed in the first parity.

Effect of calving year

Our results reported that the calving year has a significant effect on all studied traits except gestation length (Table 2). The highest total milk yield was showed in the year ≥2010 (8248.26 kg) then the year 2005-2010 (8206.89 kg) and the lowest total milk yield was scored in the year 2000> (6379.15 kg). Also, the highest 305-day milk yield was found in the year ≥2010 (6427.11 kg) then the year 2005-2010 (5952.53 kg) and the lowest value was showed in the year 2000-2004 (4877.54 kg). The lowest value of lactation length (385.68 days) was recorded in the year ≥2010 and the longest lactation length (420.62 days) was found in the year 2000-2004. In the present investigation, days open and calving interval increased in the same trend during the year of calving, the longest days open and calving interval (232.6 days and 495.65 days) found in the year 2000-2004 but the shortest days open and calving interval (200.28 days and 454.63 days) obtained in the year 2000>. The highest value of gestation length (311.77 days) was showed in the year ≥2010 followed by the year 2005-2010 (284.50 days) and the shortest gestation length (279.48 and 279.82 days) was scored in the year 2000-2004 and the year 2000>, respectively.

Table 1. Effect of parity on traits under study in Holstein dairy cattle.

Traits	Parity					SEM	P-Value
	1	2	3	4	≥5		
TMY, kg	6630.50[d]	8025.00[a]	8067.83[a]	7700.70[b]	7337.99[c]	458.77	0.00
305-dMY, kg	4471.24[d]	6094.79[a]	6237.59[a]	5971.39[b]	5519.86[c]	286.2	0.00
LL, d	435.75[a]	415.86[ab]	382.42[cd]	374.42[d]	398.10[bc]	33.63	0.00
DP, d	68.53[d]	71.69[cd]	75.00[c]	80.72[b]	88.58[a]	8.45	0.00
DO, d	245.68[a]	216.52[b]	210.94[b]	205.71[b]	224.67[b]	25.18	0.00
CI, d	506.15[a]	470.17[bc]	459.77[c]	467.70[bc]	482.99[b]	21.18	0.00
GL, d	277.98[b]	296.08[a]	278.36[b]	278.13[b]	292.54[a]	17.14	0.00

Table 2. Effect of the calving year on traits under study in Holstein dairy cattle.

Traits	Calving year				SEM	P-Value
	2000>	2000-2004	2005-2010	>2010		
TMY, kg	6379.15[c]	6746.91[b]	8206.89[a]	8248.26[a]	361.45	0.00
305-dMY, kg	4930.69[c]	4877.54[c]	5952.53[b]	6427.11[a]	233.76	0.00
LL, d	386.33[b]	420.62[a]	418.37[a]	385.68[b]	32.8	0.02
DP, d	70.09[b]	68.43[b]	72.64[b]	112.25[a]	7.51	0.00
DO, d	200.28[b]	232.60[a]	231.06[a]	224.55[a]	18.61	0.00
CI, d	454.63[b]	495.65[a]	485.38[a]	493.35[a]	17.28	0.00
GL, d	279.82	279.48	284.5	311.77	24.39	0.22

Effect of calving season

Calving season had a significant effect on all studied traits except lactation length and gestation length (Table 3). The cows were calved during autumn season scored the highest total milk yield (7626.1 kg), however the cows were calved in the spring season gave the lowest total milk yield (7348.73 kg). Additionally, the highest value of 305-day milk yield (5897.72 kg) was recorded in the autumn and the lowest 305-day milk yield (5109.77 kg) was found in the spring. The highest value of dry period (77.06 days) was recorded in the winter season and the shortest value (70.22 days) was showed in the summer season. Also, our results reported that there were no significant changes in the lactation length between different calving seasons, the highest value of lactation length (423.49 days) was found in the spring season and the lowest value of lactation length (391.92 kg) was scored in the autumn season. While, days open recorded the longest length (238.84 days) in spring and the shortest length (212.37 and 213.56 days) was scored in summer and autumn, respectively. Subsequently, days open and calving interval recorded the highest value (500.08 days) in the spring season and the lowest value (460.40 kg) in the autumn season. In contrary, Gestation length had non-significant changes between different calving seasons, the shortest gestation length (277.58 days) was found in the spring season and the longest period was obtained in the other seasons.

Heritability and breeding values

The values of heritability and breeding value for all studied traits showed in Table 4.

Heritability

The values of heritability for all traits under study were showed in Table 4. The values of heritability for TMY, 305-dMY, LL, DP, DO, CI and GL were 0.265, 0.393, 0.488, 0.238, 0.120, 0.138 and 0.570, respectively.

Breeding value

Minimum, and maximum cow, sire and dam breeding values for traits under study were presented in Table 2.

Cows breeding value

From the results presented in Table 4, cow breeding values for TMY, 305-dMY, LL, DP, DO, CI and GL ranged from -957.0 to 2170.5 kg, from -2432.75 to 2713.75 kg, from -266.25 to 340 days, from -114 to 100.25, from -105.75 to 164 days, from -13.9 to 13.18 months and from -0.33 to 0.45 days, respectively.

Dams breeding value

From the same table (Table 4), the breeding values of dams for TMY, 305-dMY, LL, DP, DO, CI and GL ranged from -823.5 to 1364.25 kg, from -1076.75 to 1531.75 kg, from -139.5 to 186.5 days, from -79.75 to 46.5, from -58.25 to 82 days, from -8.23 to 8.63 months and from -0.28 to 0.53 days, respectively.

Sires breeding value

Sires breeding values for TMY, 305-dMY, LL, DP, DO, CI and GL ranged from -1057.75 to 1082 kg, from -1458 to 1549.25 kg, from -219.25 to 292.75 days, from -79.5 to 85.25 days, from -75.5 to 89 days, from -8.7 to 7.08 months and from -0.58 to 0.60 days, respectively.

Discussion

The current investigation presented that parity has a significant effect on all studied traits (Table 1). The highest values of total milk yield and 305-day milk yield were observed in the third lactation (8067.83 and 6237.59 kg, respectively) and the lowest values were found in the first lactation (6630.5 and 4471.24 kg, respectively). These results agreed with Hussein (2000) who found that the highest total milk yield in the third lactation

Table 3. Effect of calving season on traits under study in Holstein dairy cattle.

Traits	Calving season				SEM	P-Value
	Winter	Spring	Summer	Autumn		
TMY, kg	7424.59^{ab}	7348.73^{b}	7405.32^{ab}	7626.11^{a}	326.59	0.00
305-dMY, kg	5424.38^{b}	5109.77^{c}	5529.54^{b}	5897.72^{a}	204.92	0.01
LL, d	413.92	423.49	409.04	391.92	24.15	0.06
DP, d	77.06^{a}	72.42^{b}	70.22^{b}	75.09^{a}	5.27	0.00
DO, d	233.04^{a}	238.84^{a}	212.37^{b}	213.56^{b}	18.65	0.00
CI, d	489.14^{b}	500.08^{a}	478.37^{c}	460.40^{d}	14.46	0.00
GL, d	286.94	277.58	284.91	285.62	14.62	0.52

Table 4. Estimates of heritability and breeding values (Sire, dam and cow) for traits under study in Holstein dairy cattle.

Trait	h^2	Breeding values					
		Sire (no=415)		Dam (no=1010)		Cow (no=3295)	
		Min.	Max.	Min.	Max.	Min.	Max.
TMY, kg	0.27	-1057.75	1082	-823.5	1364.25	-957.0	2170.5
305-dMY, kg	0.39	-1458	1549.25	-1076.75	1531.75	-2432.75	2713.75
LL, d	0.49	-219.25	292.75	-139.75	186.5	-266.25	340.0
DP, d	0.24	-79.5	85.25	-79.75	46.5	-114.0	100.25
DO, d	0.12	-75.5	89.0	-58.25	82.0	-105.75	164.0
CI, d	0.14	-8.7	7.08	-8.23	8.63	-13.9	13.18
GL, d	0.57	-0.58	0.6	-0.28	0.53	-0.33	0.45

(4823.9 kg) for Friesian cows in Egypt, while, Sanad *et al*. (2020) found the highest value (3823.55 kg) in the fifth lactation. In the same trend, El-Arian *et al*. (2001) reported that Holstein cattle in Egypt produced the highest 305-dMY in the third parity; but, Sanad *et al*. (2020) recorded that the highest 305-day milk yield (3505.49 kg) in the fifth lactation. They explained that by the full development of body size and secretory tissues of the udder. In the present study, the longest lactation length (435.75 days) was found in the first lactation, but the shortest lactation length (374.42 days) showed in the fourth lactation. A similar result was reported by Haress (2005) who found that the longest lactation length (398 days) was scored in the first parity. On the other hand, Sanad *et al*. (2020) observed that the longest lactation length (351.44 days) was recorded in the fourth parity in Friesian cows in Egypt. Our result obtained that the dry period was significantly increased with advanced parities and the highest dry period (88.58 days) scored in the fifth lactation and the lowest dry period (68.53 days) was found in the first lactation. The current results disagreed with M'hamdi *et al*. (2012) who observed that the longest dry period (113.28 days) was in the fifth parity and the shortest dry period (87.23 days) was in the third parity in Tunisian Holstein cows. On the contrary, the longest days open (245.68 days) was observed in the first parity and it scored low values with advanced parities. A similar result was found by Goshu *et al*. (2007) who reported that the longest days open was scored in the first parity (212 days). In contrast, Sanad *et al*. (2020) found the longest days open (154.57 days) in the fourth parity. These results may be due to the changes in managerial systems and environmental conditions among parities. In the same trend with days open, the calving interval was decreased with increased lactation number and the longest calving interval was 506.15 days in the first lactation, but the shortest calving interval was 205.71 days in the fourth lactation. Similar results were obtained by Goshu *et al*. (2007) who observed that the calving interval decreased with advanced parities in Friesian cows in Ethiopia. While Sanad *et al*. (2020) recorded the longest calving interval (457.27 days) in the third lactation. Our result may be due to the longest days open in the first lactation. On the contrary, the longest gestation length (296.08 days) scored in the second parity, but the shortest gestation length (277.98 days) scored in the first parity. A similar result was observed by Carvalho *et al*. (2020) who reported that the shortest gestation length (274.7 days) scored in the first parity. In contrast, our result disagreed with Kumar *et al*. (2016) who observed that the longest gestation length (281.31) was in the fourth parity and the shortest gestation length (279.45 days) was in the fifth parity in Jersey crossbred cattle.

In general, the effect of parity was due to the changes in managerial systems, environmental conditions among parities and milk production of the cow among parities.

The current results showed that the calving year has a significant effect on the studied traits except for gestation length (Table 2). The highest total milk yield was during the year ≥2010 (8248.26 kg) followed by the year 2005-2010 (8206.89 kg) and the lowest value was during the year 2000> (6379.15 kg). In the same trend, the highest 305-dMY was during the year ≥2010 (6427.11 kg) followed by the year 2005-2010 (5952.53 kg) and the lowest value was during the year 2000-2004 (4877.54 kg). While, Sanad *et al*. (2020) studied the effect of calving year on some traits in Friesian cows in Egypt during the period from the year 2007 to the year 2018 and they found the highest total milk yield and 305-dMY (3837.9 and 3465.7 kg, respectively) in the year 2018 and the lowest value (2598.8 and 2160.6 kg, respectively) in the year 2017. In our results, the differences in total milk yield and 305-day milk yield between the calving years could be attributed to climatic, nutritional, and management practices changing from one year to another. The shortest lactation length (385.68 days) was scored in the year ≥2010 and the longest lactation length (420.62 days) was observed in the year 2000-2004. Sanad *et al*. (2020) found the longest lactation length (322.40 days) in the year 2013, but the shortest value (294.58 days) in the year 2018. Besides, the longest dry period (112.25 kg) was observed in the year ≥2010 and the shortest dry period (68.43) was found in the year 2000-2004. Radu *et al*. (2021) found the longest dry period (67.3 days) in the year 2017 and the shortest value (64.35 days) in the year 2017 in Simmental cattle. In the present work, days open and calving interval increased in the same trend during the year of calving, the longest days open and calving interval (232.6 days and 495.65 days) scored in the year 2000-2004 but the shortest days open and calving interval (200.28 days and 454.63 days) found in the year 2000>. Sanad *et al*. (2020) observed that the longest days open (174.69 days) in the year but the shortest days open (131.15 days) showed in the year. In contrast, there are no significant differences in gestation length during calving years. The longest gestation length (311.77 days) was observed in the year ≥2010 followed by the year 2005-2010 (284.50 days) and the shortest gestation length (279.48 and 279.82 days) was found in the year 2000-2004 and the year 2000>, respectively. Sanad *et al*. (2020) found the longest calving interval (482.30 days) in the year 2011, but the shortest value (402.63 days) in the year 2017.

Our results showed that calving season had a significant effect on studied traits except lactation length and gestation length (Table 3). The cows which calve during autumn gave the highest total milk yield (7626.1 kg), whereas those which calve in spring gave the lowest total milk yield (7348.73 kg). Similar results were obtained by Sanad *et al*. (2020) who recorded the highest total milk yield (3610.83 kg) in autumn. On the other hand, this result disagreed with El-Attar (2009) who observed that cows calving during spring gave the highest total milk yield (8215.51 kg), whereas those calving in summer gave the lowest total milk yield (7519.21 kg). In the same trend, the highest 305-day milk yield (5897.72 kg) was observed in the autumn season and the lowest 305-day milk yield (5109.77 kg) was found in the spring season. The current results agreed with the result observed by Sanad *et al*. (2020) who showed that the highest 305-day milk yield (3211.04 kg) was in autumn. In contrast, the obtained results disagreed with Cilek and Tekin (2004) who reported that winter scored the highest 305-day milk yield (4819 kg) and the lowest 305-day milk yield (4477 kg) scored in summer for Simmental cows in Turkey. The highest dry period (77.06 days) was recorded in winter and the shortest value (70.22 days) was shown in summer. This result was agreed with the result obtained by Radu *et al*. (2021) who reported that the longest dry period (66.42 days) was in winter and the shortest dry period (65.89 days) was in summer in Simmental cattle. On the contrary, M'hamdi *et al*. (2012) reported that the longest dry period (104 days) was in spring and the shortest dry period (87.56 days) was in winter in Tunisian Holstein cows. There were no significant changes in lactation length between calving seasons, the longest lactation length (423.49 days) was observed in spring but the shortest lactation length (391.92 kg) was found in the autumn season. These results agreed with Cilek and Tekin (2004) who noticed that the longest lactation length in the spring season (301.7 days) and the shortest lactation length in the autumn season (295.1 days) for Simmental cows in Turkey. On the other hand, Sanad *et al*. (2020) showed that the longest lactation length (319.41 days) was in winter and the shortest lactation length (301.98 days) was in summer. Moreover, days open recorded the longest length (238.84 days) in spring and the shortest length (212.37 and 213.56 days) was recorded in summer and autumn. The current results agreed with the results obtained by Hammoud *et al*. (2010) who reported that the spring season scored the highest days open (137.8 days) and the lowest period (122.6 days) scored in the autumn season for Friesian cows in Egypt. But, these results disagreed with Sanad *et al*. (2020) who found the longest days open (151.32 days) in winter. In the same trend with days open, the calving interval scored the longest value (500.08 days) in spring and the shortest value (460.40 kg) found in autumn. This result disagreed with the result obtained by Haress (2005) and Hammoud *et al*. (2010) they observed that the longest calving interval (460.5 and 409.4 days, respectively) seen in the spring season and the shortest calving interval scored in the autumn season (400.7 and 394.3 days, respectively). Also, Sanad *et al*. (2020) found the longest calving interval (454.78 days) in winter and the shortest calving interval (447.03 days) scored in summer. Gestation length had non-significant changes between different seasons of calving, the shortest period (277.58 days) was shown in the spring season and the longest period was obtained in the other seasons. Kumar *et al*. (2016) found that the longest gestation length (281.16 days) in winter and the shortest gestation length (279.31 days) were in the rainy season in Jersey crossbred cattle.

In general, the effect of the calving season was due to the changes in climatic conditions and seasonal differences in nutrition and/or housing systems.

Heritability estimates of all traits under study were summarized in Table 4. The values of heritability for TMY, 305-dMY, LL, DP, DO, CI and GL were 0.265, 0.393, 0.488, 0.238, 0.120, 0.138 and 0.570, respectively.

For total milk yield, the obtained value (0.265) was higher than that estimated by Sanad and Hassanane (2017) who found a lower value (0.17) of heritability in Friesian cows in Egypt. While, the same value was lower than that estimated by El-Bayoumi *et al*. (2015) who recorded a medium heritability for total milk yield (0.34), also, Abd El-Moez (2007) observed that the value of heritability for total milk yield was 0.29. Moreover, Sanad *et al*. (2020) found a heritability value of 0.31 for TMY. In the present study, heritability value of 305-day milk yield was 0.393, the obtained result was higher than that estimated as 0.17 by Amira Mohamed (2006), 0.24 by El–Awady *et al*. (2017), 0.25 by Sanad and Hassanane (2017), 0.32 by El-Bayoumi *et al*. (2015), 0.17 by Al-Juwari and Al-Salam (2018) and 0.34 by Sanad *et al*. (2020). In the same trend, the heritability estimate for lactation length was 0.488, the obtained value was higher than that found by many researchers, 0.172 by Abd El-Gader *et al*. (2007), 0.19 by El-Attar (2009), 0.17 by Sanad and Hassanane (2017), 0.24 by Al-Juwari and Al-Salam (2018) and 0.31 by Sanad *et al*. (2020). In addition, the heritability value for the dry period was 0.238, this result was higher than the result recorded as 0.12 by El-Bayoumi *et al*. (2015). On the contrary, our result was lower than the result (0.24) observed by Abdel-Hamid *et al*. (2017) and 0.24 by Al-Juwari and Al-Salam (2018). Besides, in the same table the heritability value for days open was 0.120, this result was higher than the results estimated as 0.07 by El-Bayoumi *et al*. (2015), 0.05 by Al-Juwari and Al-Salam (2018) and 0.03 by Sanad *et al*. (2020). While, the same result was lower than the results observed as 0.57 by Mohamed Atia (2002), 0.023 by Shah *et al*. (2005), 0.51 by Abd El-Gader *et al*. (2007), 0.20 by Shalaby *et al*. (2012) and 0.17 by El–Awady *et al*. (2017). In the same trend, the heritability value for the calving interval was 0.138, this result was higher than those obtained by different authors such as 0.047 by Abdel-Gader *et al*. (2007) and 0.03 by Makgahlela *et al*. (2008). In contrast, the same result was lower than many results estimated as 0.002 by El-Bayoumi *et al*. (2015), 0.16 by El–Awady *et al*. (2017), 0.03 by Al-Juwari and Al-Salam (2018) and 0.04 by Sanad *et al*. (2020). The heritability value for gestation length was 0.570. This result was higher than the obtained result as 0.33 by Norman *et al*. (2009), 0.062 by Nogalski and Piwczyński (2012), 0.06 by Sahin *et al*. (2014), 0.02 by Al-Juwari and Al-Salam (2018), 0.48 by Kašná *et al*. (2020) and 0.44 by Galluzzo *et al*. (2022). The differences among the heritability estimates may be attributed to the differences in herd size, ages of cows, method of estimation and number of records.

In general, heritability values for all traits under study were low to moderate except gestation length was high value, so the most useful way to improve the most traits under the study would be by improving the management level.

Cow breeding values for TMY, 305-dMY, LL, DP, DO, CI and GL ranged from -957.0 to 2170.5 kg, from -2432.75 to 2713.75 kg, from -266.25 to 340 days, from -114 to 100.25, from -105.75 to 164 days, from -13.9 to 13.18 months and from -0.33 to 0.45 days, respectively.

The current study showed that the cows' breeding values for TMY ranged from -957.00 to 2170.50 kg. The obtained results were higher than the results observed by However; El-Attar (2009) found that the value ranged from -160.602 to 764.672 for TMY. In contrast, this result was lower than the results obtained by Hammoud (2013); Salem and Hammoud (2016) and Abdel-Hamid *et al*. (2017) who reported that it ranged from -3474.0 to 4416.7, from -2737 to 3285 and from -4463 to 4969 kg, respectively. In the present study, the cows' breeding values for 305-dMY ranged from -2432.75 to 2713.75 kg. The obtained results were higher than the results showed by Zahed *et al*. (2003); El-Attar (2009); Hammoud (2013) and Sanad *et al*. (2020) who found that cow breeding values for 305-dMY ranged from -1841 to 1791, from -238.118 to 178.496 kg, from -2567.2 to 2332.0 kg and from -931 to 1795 kg, respectively. On the contrary, this result was lower than the result obtained by Abdel-Hamid *et al*. (2017) who observed that it ranged from -3854 to 3086 kg. From the same table, the cows' breeding values estimates for LL ranged from -266.25 to 340 days and it was higher than those obtained by Afifi *et al*. (2002) which ranged from -13.0 to 11.2 days, El-Attar (2009) which ranged from -80.95 to 121.79 day and Hammoud (2013) which ranged from -59.1 to 109.7 day. Also, Salem and Hammoud, 2016 found that it ranged from -45.0 to 71.1 kg. The current investigation showed that the cows' breeding value for DP ranged from -114 to 100.25. The obtained result was higher than the result shown by El-Bayoumi *et al*. (2015) and Abdel-Hamid *et al*. (2017) who reported that it ranged from -36.63 to 53.71 and from -22.22 to 123.91 days, respectively. In the present study, the cows breeding values estimates for DO ranged from -105.75 to 164. This result was higher than the results found by Hammoud, (2013); El-Bayoumi *et al*. (2015); Salem and Hammoud (2016); Abdel-Hamid *et al*. (2017) and Sanad *et al*. (2020) who found that the value ranged from -48.0 to 33.7, from -50.13 to 144.30 and from -37.9 to 64.8, from -27.27 to 37.49 and from -5.22 to 5.027 days, respectively. In the same table, the cows' breeding value for CI ranged from -13.9 to 13.18 months. This result was higher than the result obtained by El-Bayoumi *et al*. (2015) who found it ranged from -1.00 to 1.03 days. While the current results were lower than the result observed by Easa (2011); Abdel-Hamid *et al*. (2017) and Sanad *et al*. (2020) reported that it ranged from -825.06 to 1047.45, -14.43 to 15.58 and from -18.53 to 28.79 days, respectively. In the present study, the cows' breeding value estimates for GL ranged from -0.33 to 0.45 days. This result was lower than the result obtained by Haile-Mariam and Pryce (2019) who found that the cows' breeding value for GL ranged from -10.81 to 8.16 days.

From the results presented in Table 4, dams breeding values for TMY, 305-dMY, LL, DP, DO, CI and GL ranged from -823.5 to 1364.25 kg, from -1076.75 to 1531.75 kg, from -139.5 to 186.5 days, from -79.75 to 46.5, from -58.25 to 82 days, from -8.23 to 8.63 months and from -0.28 to 0.53 days, respectively.

The results indicated that the breeding values of dams for TMY ranged from -823.5 to 1364.25 kg. The obtained result was higher than the result found by Afifi *et al*. (2002) who reported that the value ranged from -728 to 874 kg. Also, El-Attar (2009) found that the dam's breeding value ranged from -91.055 to 960.969 kg. While, our result was lower than the observed result by Hammoud (2013); Salem and Hammoud (2016) and Abdel-Hamid *et al*. (2017) who recorded that it ranged from -3582.2 and 5088.1, from -2835 to 2979 and from -2535 to 3034 kg, respectively. In the present study, the dams breeding value for 305-dMY ranged from -1076.75 to 1531.75 kg, this result was higher than those calculated by El-Attar (2009) and Sanad *et al*. (2020) who found it ranged from -136.683 to 102.234 kg and from -1066 to 748 kg, respectively. But, these results were lower than the result found by Hammoud (2013) and Abdel-Hamid *et al*. (2017) who found that dam breeding values ranged from -2964.8 to 2368.5 and from -2598 to 1709 kg, respectively. Also, the breeding value for LL ranged from -139.5 to 186.5 days in this study. Our result was higher than the results found by Afifi *et al*. (2002); El-Attar (2009); Hammoud (2013) and Salem and Hammoud (2016) who reported that it ranged from -7.2 to 6.2, from -47.9 to 75.02, from -74.7 to 99.3 and from -9.9 to 44.0 day, respectively. From the same table, the dams' breeding value for DP ranged from -79.75 to 46.50 days. This result was higher than the result obtained by El-Bayoumi *et al*. (2015) and Abdel-Hamid *et al*. (2017) who found the dam breeding value for DP ranged from -18.36 to 29.35 and from -15.92 to 57.13 days, respectively. In addition, it ranged from -58.25 to 82.00 days for DO. These results were higher than the results obtained by Hammoud (2013); El-Bayoumi *et al*. (2015); Salem and Hammoud (2016); Abdel-Hamid *et al*. (2017) and Sanad *et al*. (2020) who reported that the dams breeding value was ranged from -27.4 to 16.0, from -24.42 to 66.3, from -38.1 to 53.7, -16.05 to 21.11 and from -4.082 to 4.014 days, respectively. While the obtained results were lower than the results calculated by El-Attar (2009) who found the dams' breeding value ranged from -163.4 to 512.7 days for DO. Besides, dams' breeding values ranged from -8.23 to 8.63 months for CI. This result was higher than the results obtained by El-Bayoumi *et al*. (2015) and Abdel-Hamid *et al*. (2017) who showed that it ranged from -0.54 to 0.59 and -5.92 to 10.56 days, respectively. In contrast, our result was lower than the result obtained by Easa (2011) and Sanad *et al*. (2020) who found that it ranged from -508 to 508.82 and from -16.32 to 15.63 days, respectively. Our result showed that the dams' breeding value for GL ranged from -0.28 to 0.53 days.

Sires breeding values for TMY, 305-dMY, LL, DP, DO, CI and GL ranged from -1057.75 to 1082 kg, from -1458 to 1549.25 kg, from -219.25 to 292.75 days, from -79.5 to 85.25 days, from -75.5 to 89 days, from -8.7 to 7.08 months and from -0.58 to 0.60 days, respectively.

In the present study, the sires' breeding values for TMY ranged from -1057.75 to 1082 kg. The obtained results were higher than the results observed by Afifi *et al*. (2002), El-Attar (2009) and Salem and Hammoud (2016) who found it ranged from -780 to 922, from -80.997 to 350.291 and from -1057 to 659 kg, respectively. While, our results were lower than the results obtained by Hammoud (2013) and Abdel-Hamid *et al*. (2017) who reported that the sire breeding values ranged from -4012.3 to 2824 and from -4754 to 3972 Kg, respectively. Also, sires breeding values for 305-dMY ranged from -1458 to 1549.25 kg. This result was higher than the result calculated by Abdel-Glil (2004) and Sanad *et al*. (2020) who found that sires breeding value ranged from -936 to 1912 kg and from -493 to 895 kg, respectively. In contrast, our result was lower than the result obtained by Hammoud (2013) and Abdel-Hamid *et al*. (2017) who found that the sire breeding value for 305-dMY ranged from -3069.0 to 1536.5 and from -3736 to 2151 kg, respectively. The sires' breeding values for LL ranged from -219.25 to 292.75 days and it was higher than those shown by El-Attar (2009), Hammoud (2013) and Salem and Hammoud (2016) who reported that it ranged from -164.44 to 67.9, from -80.7 and 80.3 and from -23.6 to 18.6 days, respectively. From the same table, sires breeding value for DP ranged from -79.5 to 85.25 days. Our result was higher than the results found by El-Bayoumi *et al*. (2015) and Abdel-Hamid *et al*. (2017) who reported that it ranged from -44.58 to 34.62 and from -24.08 to 110.01day, respectively. In addition, sires breeding values estimated for DO ranged from -75.5 to 89 days. This result was higher than the obtained results by Hammoud (2013) and Abdel-Hamid *et al*. (2017) who observed that the value ranged from -14.7 and 19.9 and from -16.05 to 21.11 days, respectively. But, this result was lower than the results obtained by El-Attar (2009); El-Bayoumi *et al* (2015); Salem and Hammoud (2016) and Sanad *et al*. (2020) who reported that it ranged from -117.5 to 149.6, from -37.59 to 170.46 and -11.2 to 13.5 and from -2.60 to 2.60 days, respectively. The sire breeding values for CI ranged from -8.7 to 7.08 months. The result was higher than that observed by El-Bayoumi *et al*. (2015) and Abdel-Hamid *et al*. (2017) who showed that it ranged from -1.23 to 0.95 and from -5.92 to 10.56 days, respectively. In contrast, our result was lower than the result found by Easa (2011) and Sanad *et al*. (2020) who reported that it ranged from -515.73 to 421.07 and from -18.92 to 16.11 days, respectively. In the present study, the sires' breeding value estimates for GL ranged from -0.58 to 0.60 days. Our result was lower than the result calculated by Haile-Mariam and Pryce (2019) who found that the sires' breeding value for GL ranged from -12.45 to 11.67 days.

In general, the range of breeding values for cows was higher than those for dams or sires for all traits under study except for gestation length it was higher for sires than dams or cows, so, the higher range for cows' breeding values revealed a higher genetic variation and a good chance for selecting superior cows.

Conclusion

The main results of this study were concluded the significant effect of parity on all traits, calving year has a significant effect on the studied traits except gestation length and the effect of calving season was significant in all traits except lactation length and gestation length. Also, heritability estimated for most traits had a low to moderate value, this refers to the minor effect of genetics on these traits, so the most useful way to improve the most traits under the study would be by improving the management level. In addition, these results refer to the major effect of cows' breeding value for these traits compared with their sires and dams' breeding value.

Conflict of interest

The authors declare that they have no conflict of interest.

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