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THE IMPACT OF AGE AT FIRST CALVING ON PRODUCTIVITY AND PROFITABILITY IN FRIESIAN COWS UNDER EGYPTIAN CONDITIONS

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SUMMARY

The aim of this study was to estimate the effect of age at first calving (AFC) on first lactation traits (FLMY, FLP, FDO, FDP, and FCI), lifetime milk yield (LTMY), number of lactations complete (NLC), and profitability in Friesian cows under Egyptian conditions. Additionally, the study aimed to assess genetic parameters and breeding values to aid in genetic selection and improve dairy herd performance. Data were collected over 23 years from 1767 first lactation cows. A General Linear Model (GLM) in SAS was used to assess significant fixed effects, and restricted maximum likelihood (REML) procedures were applied to estimate genetic parameters and breeding values.

AFC significantly influenced productivity and reproductive traits. Cows with early AFC (≤25 -35 months) had higher LTMY (19881.25 ± 1248.6 kg) and NLC (4.58 ± 0.15) compared to cows with late AFC (≥46 months) (LTMY: 15343.5 ± 1430.55 kg, NLC: 2.87 ± 0.15). Profitability was highest in early AFC cows (39518.24 ± 2268.06 EGP), decreasing with delayed AFC. Heritability estimates ranged from 0.14 to 0.26 indicating potential for genetic improvement.

Breeding values were estimated for sires, cows, and dams with high accuracy. These values can guide genetic selection to enhance desired traits in Friesian cows, contributing to improved lifetime milk production and the number of lactations complete.

Keywords: Friesian cows, lifetime milk yield, age at first calving, breeding values

INTRODUCTION

Friesian cows play a crucial role in improving the productive performance of Egyptian Baladi cows, contributing significantly to the profitability of the dairy industry. Over the past three decades, the importance of Friesian cows for both milk and meat production in Egypt has been well recognized. Reducing the age at first calving (AFC) in Friesian cows led to enhanced lifetime milk production and increased lactations number. This reduction not only improved lifetime milk production and lactation numbers but also resulted in substantial cost savings in heifer rearing, accounting for approximately 26% of total expenses throughout the lifespan of dairy cows (Abu El-Naser, 2019).

Eastham *et al*. (2018) reported that Holstein and Holstein-Friesian cows with lower AFC had improved reproductive performance, higher survivability, and greater lifetime daily milk production, although their first-lactation milk yield was lower. Similarly, a study on Australian Holsteins found that cows with the highest lifetime production had an optimal AFC between 24 and 30 months, whereas excessive first-lactation milk production negatively impacted lifetime production (Haworth *et al*., 2008). In Holstein cattle, a higher AFC has been associated with reduced fertility (Zavadilová and Štípková, 2013).

Tefera *et al*. (2021) reported moderate heritability estimates for lifetime milk production in Ethiopian Borana×Friesian dairy crossbreds, indicating the potential of genetic improvement through selection program. Similarly, El-Awady *et al.* (2021) emphasized that reducing AFC enhances profitability by increasing annual and lifetime milk yield, whereas delayed AFC leads to reduced economic returns. Additionally, on Holstein cattle have identified an optimal AFC range of 22.5–23.5 months to maximize lifetime profit (Do *et al*., 2013). Research on Turkish Holsteins has further confirmed the optimal AFC for maximizing milk production in Turkish Holstein cows was two years minus one month, and age at first calving significantly affected lifetime milk yield (Teke and Murat, 2013).

Despite these findings, questions remain regarding the optimal AFC that balances high lifetime production with long-term health and reproductive performance. Understanding this balance is critical for maximizing genetic potential while ensuring economic sustainability.

This study aims to investigate the impact of AFC on first lactation traits, as first lactation milk yield (FLMY), first lactation period (FLP), first lactation days open (FDO), first lactation dry period (FDP), and first lactation calving interval (FCI). Additionally, we assess lifetime milk yield (LTMY), the number of lactations complete (NLC), and profitability in Friesian cows under Egyptian conditions. The study also estimated the genetic parameters and breeding values for these traits.

MATERIALS AND METHODS

Data Collection and Management:

This research received ethical approval from the Research Ethics Committee of the Faculty of Agriculture at Suez Canal University (reference number 06/2024). Extensive data for this study were gathered from two experimental farms, Sakha and El-Karada, affiliated to the Animal Production Research Institute under the Ministry of Agriculture and Land Reclamation (MALR), located in Kafr El-Sheikh governorate, Egypt.

The dataset covered a continuous 23-year period (1998–2020) and included records from 1767 first-lactating cows. These cows were the progeny of 193 sires and 548 dams. To ensure data quality, rigorous measures were implemented during the data editing process, involving the exclusion of abnormal records of cows affected by diseases, disorders, or abortions from the analysis.

Cows on both farms were housed in open sheds and subjected to uniform management, feeding, and housing practices. Their diet strictly adhered to the recommended requirements of the Animal Production Research Institute (APRI), based on guidelines provided by the NRC (2001). The feeding regimen varied according to the seasons. From December to May, the cows were fed a combination of Egyptian clover (*Trifolium alexandrinum*), a concentrate mixture, and rice straw. From June to November, their diet consisted of a concentrated mixture, rice straw, and a limited amount of clover hay or silage. Water was consistently provided to the cows at all times while housed in a loose housing system. Heifers, reaching a body weight exceeding 350 kg or 18 months of age, were artificially inseminated using locally prepared frozen semen. Pregnancy in heifers was confirmed through rectal palpation within 60 days after the last insemination, following routine procedures. After calving, the cows were milked twice a day using milking machines, and milk production was recorded daily throughout the lactation period, as detailed by El-Awady (2013b).

The traits examined in this study included first lactation milk yield (FLMY, in kilograms), first lactation period (FLP, in days), first lactation dry period (FLDP, in days), first lactation days open (FDO, in days), first lactation calving interval (FCI, in days), lifetime milk yield (LTMY, in kilograms), and the number of lactations complete (NLC) indicating the parity of the cows. The recorded data of AFC were classified into three levels, early (≤25 to 35 months), medium (36 to 45 months), and late (≥46 month). The costs of raising, managing, and nutrition of heifers from birth to first calving were calculated to determine the effect of that period on the profitability from animals. The prices and the costs were based on market and farm gate prices adopted as the mean of that period. Profitability is one of the key measures of farm effectiveness El-Awady (2013a). Thus, to compare between the three AFC levels (groups), profitability for each cow was calculated as follows; Profitability =Total Revenues (Income) - Total Cost (Outcome), as described by Abu El-Naser (2019) and El-Awady *et al*. (2021).

Statistical Analysis:

The data were analyzed using the General Linear Model (GLM) procedure in SAS (2002) to evaluate the effects of fixed factors on the studied traits. The statistical model used was:

$$\mathbf{Y_{ijklm}} = \mu + S_i + P_j + F_k + AFC_l + e_{ijklm}$$

Where: Y_{ijklm} represents the individual observation of the studied traits, μ is the overall mean, S_i is the fixed effect of the season of first calving (i=1,2,3 and 4), classified as winter (December–February), spring (March–May), summer (June–August), and autumn (September–November). P_j represents the fixed effect of the period of first calving (j=1, 2, 3, and 4), divided into four periods: 1998–2002, 2003–2007, 2008–2012, and 2013–2020. F_k denotes the fixed effect of the farm (Sakha and El-Karada), while AFC_l represents the fixed effect of age at first calving (AFC), categorized into three levels: early (≤25 to 35 months), medium (36 to 45 months), and late (≥46 months), and the e_{ijklm} represents random error, assumed to be normally and independently distributed with mean zero and constant variance, NID (0, σ^2_e) .In addition, genetic and phenotypic parameters for the studied traits were estimated using the derivative-free restricted maximum likelihood (REML) procedures. The MTDFREML program developed by Boldman *et al*. (1995) was used for this analysis. The following multiple traits animal model was employed:

$$Y = X\beta + Za + e$$

Where: Y, β, a, and e are vectors representing the observations, fixed effects, direct genetic effects, and residual effects, respectively. X and Z are incidence matrices that relate the records to fixed and direct genetic effects, respectively.

Furthermore, the estimated breeding values were calculated using the MTDFREML program to obtain the best linear unbiased predictions (BLUP) for all animals in the pedigree file for multi-trait analysis.

RESULTS AND DISCUSSION

General Description:

The mean values for first lactation milk yield (FLMY), first lactation period (FLP), first lactation dry period (FDP), lifetime milk yield (LTMY), first lactation days open (FDO), first lactation calving interval (FCI), and number of lactations complete (NLC) are presented in Table 1. The coefficient of variation (CV%) for these traits ranged from 36.13% to 58.97%, with LTMY showing the highest CV%, indicating substantial variation among individual cows. This finding is consistent with previous studies by Khattab *et al*. (2009), El-Awady (2013b), El–Awady and Abu El-Naser (2017), Abu El-Naser (2020).

The mean NLC observed in this study (3.83 lactations) was higher than the 3.34 lactations reported by Sadek *et al*. (2009) for Holstein cattle. However, the mean of LTMY (17515.86 kg) in the present study was lower than the 35741 kg reported by Alhammad (2008) for Holstein cows. The LTMY and NLC values in this study exceeded those reported by Khattab *et al*. (2009) for Friesian cattle (9670 kg and 2.48 lactations, respectively). Additionally, Farrag *et al*. (2017) reported first lactation mean values of 6173.5 kg for total milk yield (TMY), 359.2 days for lactation period (LP), 174.4 days for days open (DO), and 472 days for calving interval (CI) in Friesian cattle.

The FLMY and FLP values recorded in the present study were lower than those reported by Abu El-Naser (2020) for Friesian cows (2425 kg and 304 days, respectively). Conversely, the mean FDP and CI in this study were shorter than the values reported by Abu El-Naser *et al*. (2020) (170 days and 474 days, respectively). These variations suggest differences in genetic and environmental factors influencing these traits across studies.

Overall, these findings highlight significant variability in milk production and reproductive traits, reinforcing the importance of genetic improvement and management in optimizing dairy performance.

Table 1. Least square means (±SE) of season and period of first calving and farm affecting the studied traits

Variable	No.	Traits						
		FLMY, kg	**FLP, d**	**FDP, d**	**LTMY, kg**	**FDO, d**	**FCI, d**	**NLC, l**
Mean		3439.63	307.87	95.96	17515.86	105.27	394.84	3.83
SD	1767	1375.27	111.23	40.98	10329.1	39.67	176.51	1.87
CV%		39.98	36.13	42.71	58.97	39.67	44.70	48.75
Factor levels		**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**	**Mean±SE**
Season of Calving								
Winter	686	3064.25^{b}±60.60	309.49^{b}±3.98	105.78^{a}±3.24	13573.53^{b}±440.87	123.48^{a}±2.17	420.22^{a}±3.26	3.36^{b}±0.06
Spring	405	3688.74^{a}±81.50	315.11^{a}±5.33	86.39^{b}±2.91	20708.45^{a}±650.09	98.87^{b}±2.35	382.68^{b}±2.73	4.11^{a}±0.07
Summer	353	3604.56^{a}±80.28	304.65^{b}±5.18	87.35^{b}±3.29	20399.49^{a}±771.10	87.25^{c}±2.02	371.41^{c}±2.50	4.15^{a}±0.09
Autumn	323	3765.29^{a}±87.22	308.45^{b}±5.44	95.63^{a}±31.51	19082.16^{a}±684.12	92.24^{bc}±2.46	373.85^{bc}±2.99	2.66^{c}±0.06
Period of first calving								
1998-2002	823	4040.51^{a}±57.13	323.17^{a}±57.13	83.52^{b}±1.99	19735.27^{a}±397.80	97.08^{b}±1.64	378.92^{b}±1.93	4.79^{a}±0.06
2003-2007	310	3142.90^{c}±76.29	300.53^{b}±5.57	88.21^{b}±3.20	20523.47^{a}±847.23	84.33^{c}±1.66	370.91^{b}±2.11	3.10^{b}±0.08
2009-2012	226	3474.01^{b}±88.79	306.59^{b}±6.49	89.55^{b}±4.06	19540.32^{a}±979.95	88.95^{bc}±2.27	376.24^{b}±2.79	3.26^{b}±0.09
2013 to 2020	408	2297.60^{d}±67.59	283.67^{c}±5.29	131.11^{a}±4.93	9618.56^{b}±512.90	146.35^{a}±3.16	452.76^{a}±4.88	2.65^{c}±0.05
Farm								
Sakha	1074	3590.42^{a}±46.92	306.78±2.90	98.05^{a}±2.21	16384.35^{b}±363.17	105.19±1.42	395.11±2.05	3.49^{b}±0.04
El-Karada	693	3132.56^{b}±63.96	310.48±4.48	91.83^{b}±2.68	19817.47^{a}±558.06	104.61±2.23	391.75±2.86	4.42^{a}±0.09

First lactation milk yield (FLMY), first lactation period (FLP), first lactation dry period (FDP), lifetime milk yield (LTMY), first lactation days open (FDO), first lactation calving interval (FCI), and number of lactation complete (NLC). Means within the same column with different superscript letters (a, b, c, etc.) differ significantly at $p < 0.05$. Overall means, standard deviation (SD) and coefficients of variations (CV).

Moreover, these results emphasize the need to consider specific study contexts and populations when comparing mean values of traits such as FLMY, FLP, FDP, and FCI.

Table 2 presents the analysis of variance results for the effects of season, period of first calving, farm, and age at first calving levels (AFC) on the studied traits.

Table 2. Analysis of variance for effect season and period of first calving, farm and age at first calving levels on studied traits

Factors	**Season**	**Period (years)**	**Farm**	**AFC**
Traits	**F**	**F**	**F**	**F**
FLMY, kg	1.51^{ns}	66.57**	4.62*	9.47**
FLP, d	2.03^{ns}	16.91**	1.05^{ns}	12.2**
FDP, d	1.62^{ns}	42.08**	6.18*	2.89*
LTMY, kg	6.82**	30.33**	14.29**	19.63**
FDO, d	7.87**	51.85**	0.06^{ns}	1.48^{ns}
FCI, d	10.72**	78.32**	1.04^{ns}	1.52^{ns}
NLC, l	2.36^{ns}	153.69**	94.86**	114.15**

* Significant differences ($P < 0.05$); ** Highly significant differences ($P < 0.01$) and (ns) non-significant; first lactation milk yield (FLMY), first lactation period (FLP), first lactation dry period (FDP), lifetime milk yield (LTMY), first lactation days open (FDO), first lactation calving interval (FCI), and number of lactation complete (NLC).Season of the first calving (1, 2, 3 and 4), 1: winter (December through February), 2: spring (March through May), 3: summer (June through August), and 4: autumn (September through November); Period= period of first calving (1, 2, 3, and 4), where, 1: 1998-2002, 2: 2003-2007, 3: 2008-2012, and 2013 -2020 and age at first calving level (AFC) were classified into three levels, early (≤25 to 35 months), medium (36 to 45 months), and late (≥46 month).

The results indicated that the season of first calving had no significant effect on FLMY, FLP, FDP, and NLC, but highly significantly affected LTMY, FDO and FCI ($P < 0.01$). In contrast, the period of first calving had highly significant effects ($P<0.01$) on all traits studied, including FLMY, FLP, FDP, LTMY, FDO, FCI, and NLC. The farm also significantly influenced FLMY, FDP, LTMY, and NLC, but had no significant effect on FLP, FDO and FCI (Table 2).

The effects of season, period of first calving, and farm on various productive and reproductive traits are presented in Table 1. Significant differences ($P<0.05$) were observed among seasons of calving for most traits. Animals were calved in autumn and summer had significantly higher FLMY (3765.29±87.22) compared to those calved in winter (3064.25±60.60). Notably, spring-calving animals exhibited the highest LTMY (20708.45 ± 650.09 kg), while winter-calving ones had the lowest (13573.53 ± 440.87 kg).

Regarding the period of first calving, animals that calved between "1998 – 2002" showed superior performance in FLMY and NLC compared to more recent periods, with a marked decline observed in animals calving from 2013 to 2020. This group had significantly lower FLMY (2297.60 ± 67.59 kg), LTMY (9618.56 ± 512.90 kg) and NLC (2.65 lactations), alongside a significantly longer FDP (131.11±4.93), and (146.35±3.16) FDO.

Also, the current results (Table 1) showed significant differences between the means of the studied traits between the two farms. Animals from El-Karada farm showed higher LTMY and NLC, while those from Sakha farm had superior FLMY and the longest of FDP, FDO and FCI were (98.05, 105.19 and 395.11 days, respectively in Sakha, while the opposite was true for the other traits. The differences between herds may be due to difference in management practices between herds, the variation in the proper reproduction and health care and fluctuation in the herd size, also the genetic differences between individuals which effect on the culling rates in herds (Rakhshani Nejad *et al*., 2021).

The age at first calving (AFC) had a highly significant effect ($P< 0.01$) on first lactation milk yield (FLMY), lifetime milk yield (LTMY), first lactation period (FLP), and numbers of lactations complete (NLC). The effect of AFC on first lactation dry period (FDP) was marginally significant ($P<0.05$), while no significant effect was observed on first lactation days open (FDO) and first calving interval (FCI) (Table 2). These results align with previous studies, such as El-Awady (2013a), who reported significant effects of the year of calving and farm on milk yield and lactation period.

Alhammad *et al*. (2008) reported significant month and year of calving effects on lifetime milk yield (LTMY) and calving interval (CI). Similar findings were observed by Sung *et al*. (2016), Abu El-Naser *et al*. (2019), and El-Awady *et al*. (2021), regarding the effect of AFC on LTMY in different breeds. Furthermore, Almasri *et al*. (2020) reported that both AFC and year of calving (periods) had significant effects on lifetime milk production and lactations number in Syrian Shami cows, while the season of calving had no effect.

Table 3 classifies animals based on age at first calving (AFC) into three groups: early (≤25–35 months; 36% of cows), moderate (36–45 months; 43%), and late (≥46 months; 21%). First lactation milk yield (FLMY) was significantly higher in the late AFC group (3980.40 ± 264.1 kg), followed by the moderate (3500.1 ± 119.6 kg), and early (2932.6 ± 134.5 kg) groups.

Furthermore, the early AFC group exhibited the highest values for lifetime milk yield (LTMY) and number of lactations complete (NLC), recorded 19881±1249 kg and 4.58 lactations, respectively, which were significantly higher than those observed in the moderate group (17319±855 kg and 3.80 lactations) and the late group (15344±1431 kg and 2.87 lactations). Conversely, cows in the early group had shorter FLP, FDP, FDO, and FCI, with values of 296.05 ± 10.6, 86.21 ± 7.3, 89.58 ± 5.7 and 372.65 ± 13.4 days, respectively. In contrast, the late AFC group exhibited longer FLP, FDP, FDO, and FCI, measuring 317.70 ± 22.3, 100.2 ± 11.3, 122.94 ± 5.1, and 408.75 ± 25.1 days, respectively.

Almasri *et al*. (2020) found that cows with an AFC of ≤25.4 months had the highest NLC (4.9) and lifetime milk production (7610 kg), whereas cows with an AFC of ≥34.8 months had the lowest NLC (3.8) and lifetime milk production (5761 kg) in Syrian Shami cows. Pytlewski and Antkowiak (2021) also reported that primiparous Jersey cows calving at 26–28 months achieved the highest milk production. Furthermore, Atashi *et al*. (2021) highlighted that AFC significantly affected the first calving interval in Holstein cows, with a longer AFC being associated with an extended first calving interval.

Furthermore, profitability was significantly higher for cows with an early AFC (39518 ± 2268 EGP) compared to those with a late AFC (17244 ± 2996 EGP). This indicates that early calving not only improves lifetime milk yield but also enhances the overall profitability of dairy farming. These findings are consistent with those of El-Awady *et al*. (2021), reinforcing the economic advantage of an earlier AFC in dairy cattle production.

Table 3. Effect of age at first calving levels on studied traits and profitability in Friesian cows

Levels of age at first calving	%	FLMY (kg)	FLP (d)	FDP (d)	LTMY (kg)	FDO (d)	FCI (d)	NLC (l)	Profitability (EGP)
		Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE
Early (≤25-35)	36	2932.6[c] ±134.5	296.05[b] ±10.6	86.21[b] ±7.3	19881[a] ±1249	89.58[c] ±5.7	372.65[c] ±13.4	4.58[a] ±0.15	39518 ±2268
Medium (36-45)	43	3500.1[b] ±119.6	301.45[b] ±16.2	93.6[b] ±5.7	17319[b] ±855	100.65[b] ±3.25	385.58[b] ±18.40	3.80[b] ±0.1	28802 ±1223
Late ≥46	21	3890.40[a] ±264.1	317.70[a] ±22.3	100.2[a] ±11.3	15344[c] ±1431	122.94[a] ±5.1	408.75[a] ±25.1	2.87[c] ±0.15	17244 ±2996

The Egyptian pound (EGP) is the current legal currency of Egypt. The pound is divided into 100 piasters (qirsh) or 1000 milliemes (malleem). The ISO 4217 code for the Egyptian pound is EGP. First lactation milk yield (FLMY), first lactation period (FLP), first lactation dry period (FDP), lifetime milk yield (LTMY), first lactation days open (FDO), first lactation calving interval (FCI), and number of lactation complete (NLC). Values are presented as means ± standard error (SE). Means within each column with different superscripts (a, b, c) differ significantly ($P<0.05$). Profitability is expressed in Egyptian pounds (EGP).

Genetic parameters:

The heritability (h^2) estimates for the studied traits-including first lactation milk yield (FLMY), first lactation period (FLP), first lactation dry period (FDP), lifetime milk yield (LTMY), first lactation days open (FDO), first lactation calving interval (FCI), and number of lactations complete (NLC)-were found to be moderate, with values of 0.26, 0.23, 0.17, 0.21, 0.16, 0.14, and 0.22, respectively (Table 4).

These estimates are consistent with findings from El-Awady and Abu El-Naser (2017), Abu El-Naser *et al*. (2019 and 2020) in Friesian cows, and El-Awady *et al*. (2021) in buffaloes. However, the h^2 estimate for LTMY in this study was slightly lower than the 0.24 reported by Khattab *et al*. (2009) for Friesian cattle. Conversely, the h^2 estimate for NLC (0.22) was higher than that they found (0.12). Additionally, Sadek *et al*. (2009) reported heritability estimates of 0.21, 0.29, and 0.25 for FLMY, LTMY, and NLC, respectively, in Holstein cattle, which are slightly different from the present findings.

Table 4. Heritability (h^2) estimates (on the diagonal), genetic correlations (r_g, above the diagonal), and phenotypic correlations (r_p, below the diagonal) of the studied traits

Items	FLMY	FLP	FDP	LTMY	FDO	FCI	NLC
FLMY	0.26	0.69	-0.39	0.36	0.48	-0.18	-0.38
FLP	0.65	0.23	-0.44	-0.39	0.21	0.20	-0.53
FDP	-0.21	-0.49	0.17	-0.80	0.17	0.79	-0.57
LTMY	0.15	0.41	-0.49	0.21	-0.53	-0.36	0.79
FDO	0. 52	0.18	0.41	-0.38	0.16	0.63	-0.34
FCI	0.14	0.42	0.14	-0.17	0.58	0.14	-0.68
NLC	-0.36	-0.48	-0.39	0.49	-0.36	-0.54	0.22

First lactation milk yield (FLMY), first lactation period (FLP), first lactation dry period (FDP), lifetime milk yield (LTMY), first lactation days open (FDO), first lactation calving interval (FCI), and number of lactation complete (NLC).

The genetic correlations (r_g) among the studied traits ranged from -0.80 to 0.79 (Table 4). The strongest genetic relationship was a highly negative correlation between first lactation dry period (FDP) and lifetime milk yield (LTMY) (-0.80), indicating that longer dry periods were genetically associated with reduced lifetime milk production.

In contrast, the highest positive genetic correlation (0.79) was observed between FDP and first lactation calving interval (FCI), suggesting that animals with longer dry periods also tended to have longer calving intervals. Another strong positive correlation (0.79) was found between LTMY and number of lactations complete (NLC), in agreement with previous findings by Khattab *et al*. (2009) and Salem and Hammoud (2019), who reported values of 0.50 and 0.264, respectively.

Moderate to high positive genetic correlations were also noted among first lactation milk yield (FLMY), first lactation period (FLP), and first lactation days open (FDO), with values ranging from 0.21 to 0.69, consistent with the findings of Abu El-Naser *et al*. (2020) in Friesian cows.

Conversely, negative genetic correlations were detected between FDP and each of FLMY (-0.39), FLP (-0.44), and NLC (-0.57), which contrasts with the results of El-Awady *et al*. (2021). Similarly, Sahin *et al*. (2014) reported a different pattern in Brown Swiss cattle, with genetic correlations between FDP and FLMY, FLP, and FCI were 0.10, -0.31, and 0.44, respectively. Moreover, Goshu *et al*. (2014) documented negative genetic correlations of -0.15 and -0.84 between FDP and FLMY and FLP, respectively, in Holstein-Friesian cows.

The phenotypic correlations (r_p) among the studied traits ranged from -0.54 to 0.65 (Table 4). The phenotypic correlation between LTMY and NLC was 0.49, suggesting that cows completing more lactations tend to achieve higher lifetime milk production. This correlation is lower than those reported by Salem and Hammoud (2019) in Friesian cows (0.597) and Sadek *et al*. (2009) in Holstein cattle (0.90) but closer to the 0.30 estimated by Khattab *et al*. (2009) in Friesian cows. However, Abu El-Naser *et al*. (2019) reported a much lower phenotypic correlation (0.03) between LTMY and NLC in Friesian cows.

The phenotypic correlations among early lactation traits offer valuable insights into the dynamics of milk production during first lactation. For example, the negative correlations between FDP and both FLMY (-0.21) and FLP (-0.49) indicate that cows exhibiting longer dry periods tend to show lower milk yield and shorter lactation durations during first lactation, consistent with the results of Abu El-Naser *et al*. (2020) in Friesian cows. Furthermore, positive phenotypic correlations were observed among FLMY, FLP, and FCI, ranging from 0.14 to 0.65, while negative correlations were noted between FDP and each of FLMY, FLP, and NLC (-0.21 to -0.49). In Brown Swiss cattle, Şahin *et al*. (2014) found positive phenotypic correlations of 0.55 and 0.20 between FLP and FLMY and FCI, respectively, along with a strong correlation of 0.73 between FCI and FDP.

These findings emphasize the importance of selecting key traits such as LTMY and FLMY to enhance productivity. Moreover, the relationships between early lactation traits underscore the need for balanced breeding and management strategies that improve performance without compromising lactation efficiency.

Breeding values:

Breeding values provide assessments of an animal's genetic merit for specific traits and are used to guide selection decisions. The accuracy of breeding values in this study ranged from 0.67 to 0.93 for sires, 0.67 to 0.91 for cows with recorded performance data, and 0.64 to 0.85 for dams based on progeny records, indicating reliable estimates for genetic selection.

The estimated breeding values (EBVs) for sires varied significantly across traits, as shown in Table 5. For first lactation milk yield (FLMY), the EBVs ranged from-1055.47 ± 83.01 kg to 927.22 ± 74.01 kg, with an accuracy of 0.87–0.93. Similarly, for first lactation period (FLP), the EBVs ranged from -70.95 ± 1.81 days to 63.56 ± 1.35 days, with an accuracy of 0.79–0.91. The EBVs for FDP were ranged from -45.18 ± 0.70 to 58.61 ± 0.76 with accuracy of 0.78-0.87. The EBVs for lifetime milk yield (LTMY) showed a wide range, from -5492.36 ± 229.10 kg to 6339.90 ± 250.13 kg, with an accuracy of 0.74–0.78. Other traits, such as days open (FDO) and calving interval (FCI), also exhibited significant variation, with EBVs ranging from -38.20 ± 0.48 days to 32.64 ± 0.85 days (accuracy: 0.74–0.79) and -37.52 ± 1.10 days to 56.88 ± 1.38 days (accuracy: 0.71–0.77), respectively. While, the EBVs of NLC ranged from (-1.25 to 1.52) lactation with accuracy was 0.72 – 0.83.

The EBVs for cows also demonstrated considerable variation. For FLMY, the values ranged from -1009.96 ± 73.0 kg to 1239.65 ± 76.02 kg, with an accuracy of 0.87–0.88. For FLP, the EBVs ranged from -87.60 ± 0.87 days to 88.02 ± 1.01 days, with an accuracy of 0.90–0.91. The EBVs for FDP were ranged from -47.96 ± 0.61 to 64.68 ± 0.68 with accuracy of 0.80-0.85. The EBVs for LTMY ranged from -5345.50 ± 142.02 kg to 6145.57 ± 120.02 kg, with an accuracy of 0.78–0.90. Traits such as FDO and FCI also showed significant variation, with EBVs ranging from -39.59 ± 0.86 days to 31.47 ± 0.75 days (accuracy: 0.77–0.81) and -59.31 ± 1.25 days to 40.85 ± 1.34 days (accuracy: 0.80–0.83), respectively. Whereas, the EBVs of NLC ranged from (-1.7 to 1.50) lactation with an accuracy was 0.68 – 0.81.

The EBVs for dams exhibited a wide range across traits. For FLMY, the values ranged from -801.31 ± 106.02 kg to 858.38 ± 91.02 kg, with an accuracy of 0.72–0.80. For FLP, the EBVs ranged from -64.10 ± 1.94 days to 67.34 ± 1.25 days, with an accuracy of 0.64–0.80. The EBVs for FDP were ranged from -56.39±0.86 to 63.47±0.98 with accuracy of 0.67-0.75. The EBVs for LTMY ranged from -5490.38 ± 229 kg to 8834.30 ± 208 kg, with an accuracy of 0.71–0.77. Traits such as FDO and FCI also showed significant variation, with EBVs ranging from -53.24 ± 0.49 days to 44.98 ± 0.58 days (accuracy: 0.68–0.76) and -63.96 ± 0.88 days to 113.07 ± 1.83 days (accuracy: 0.78–0.80), respectively.

The results clearly demonstrate the potential for genetic improvement through the selection of sires, cows, and dams with high breeding values and accuracy. The wide range of breeding values across traits indicates significant genetic diversity within the herd. For example, sires exhibited EBVs ranging from -1055.47 kg to 927.22 kg for FLMY and from -5492.36 kg to 6339.90 kg for LTMY. Similarly, cows had EBVs ranging from -1009.96 kg to 1239.65 kg for FLMY and from -5345.50 kg to 6145.57 kg for LTMY. Dams showed EBVs ranging from -801.31 kg to 858.38 kg for FLMY and from -5490.38 kg to 8834.30 kg for LTMY. Whereas, the EBVs of NLC ranged from (-1.5 to 1.9) lactation with accuracy was 0.72 – 0.83.

These findings align with previous studies. For instance, Awady *et al*. (2016) and El-Awady and Abu El-Naser (2017) emphasized the importance of breeding values for genetic improvement in Friesian cows. Similarly, Khattab *et al*. (2009) reported higher breeding value ranges for LTMY and NLC in cows and sires. The results highlight the importance of selecting animals based on breeding values to enhance genetic merit within the herd. By focusing on sires, cows, and dams with high EBVs for key traits such as FLMY, LTMY, and NLC, breeders can achieve significant genetic progress in Friesian cows.

Table 5. Estimated breeding values for studied traits in Friesian cows

Variable Traits	Estimated breeding value (EBV's) Minimum±SE	Maximum±SE	Accuracy
Estimated of sire breeding values (EBV's)			
FLMY, kg	-1055.47 ± 83.01	927.22± 74.01	0.87-0.93
FLP, d	-70.95 ±1.81	63.56 ±1.35	0.79-0.91
FDP, d	-45.18 ± 0.70	58.61 ± 0.76	0.78-0.87
LTMY, kg	-5492.36 ± 229.10	6339.90 ± 250.13	0.74-0.78
FDO, d	-38.20 ± 0.48	32.64 ± 0.85	0.74-0.79
FCI, d	-37.52 ± 1.10	56.88 ± 1.38	0.71-0.77
NLC, l	-1.25 ± 0.66	1.52 ± 0.60	0.67-0.75
Estimated of cows breeding values (EBV's)			
FLMY, kg	-1009.96±73.0	1239.65±76.02	0.87-0.88
FLP, d	-87.60±0.87	88.02±1.01	0.90-0.91
FDP, d	-56.39±0.86	63.47±0.98	0.67-0.75
LTMY, kg	-5345.50±142.02	6145.57±120.02	0.78-0.90
FDO, d	-39.59±0.86	31.47±0.75	0.77-0.81
FCI, d	-59.31±1.25	40.85±1.34	0.80-0.83
NLC, l	-1.7±0.65	1.5±0.61	0.68-0.81
Estimated of dams breeding values (EBV's)			
FLMY, kg	-801.31 ± 106.02	858.38 ± 91.02	0.72-0.80
FLP, d	-64.10.55 ± 1.94	67.34 ± 1.25	0.64-0.80
FDP, d	-47.96 ± 0.61	64.68 ± 0.68	0.80-0.85
LTMY, kg	-5490.38 ± 229	8834.30 ± 208	0.71-0.77
FDO, d	-53.24 ± 0.49	44.98 ± 0.58	0.68-0.76
FCI, d	-63.96 ± 0.88	113.07 ± 1.83	0.78-0.80
NLC, l	-1.5 ± 0.86	1.9 ± 0.92	0.72-0.83

First lactation milk yield (FLMY), first lactation period (FLP), first lactation dry period (FDP), lifetime milk yield (LTMY), first lactation days open (FDO), first lactation calving interval (FCI), and number of lactation complete (NLC).

CONCLUSION

In conclusion, our current results emphasize the positive impact of the early Age at First Calving (AFC) on the lifetime milk production of Friesian cows. These findings underscore the significance of considering AFC in breeding programs aimed at enhancing lifetime milk production. By selecting animals with early AFC, dairy farmers can effectively boost the productivity and profitability of their herds. Furthermore, the moderate heritability estimates for these traits suggest that the performance can be improved through genetic improvement and good management at the same time. The high accuracy and range of breeding values of sires, cows, and dams reinforces informed decision-making for the full possibility of genetic improvement in the herds.

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تأثير العمر عند أول ولادة على الإنتاجية والربحية في أبقار الفريزيان تحت الظروف المصرية

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يهدف هذا البحث إلى تقدير تأثير العمر عند أول ولادة (AFC) على صفات الموسم الأول، بما في ذلك إنتاج اللبن في الموسم الأول (FLMY)، طول أول موسم حليب (FLP)، فترة الجفاف للموسم الأول (FDP)، عدد الأيام المفتوحة للموسم الأول (FDO)، والفترة بين الولادتين في الموسم الأول (FCI) بالإضافة إلى ذلك، تم تقييم إنتاج اللبن للحياة الانتاجية (LTMY)، وعدد مواسم الحليب الكلية (NLC)، والربحية في أبقار الفريزيان تحت الظروف المصرية. كما هدفت الدراسة إلى تقدير المعالم الوراثية والقيم التربوية لهذه الصفات لدعم الانتخاب الوراثي وتحسين أداء القطيع. وشملت الدراسة على تحليل للبيانات التى تم جمعها على مدار ٢٣ عامًا من ١٧٦٧ بقرة في الموسم الأول للحليب. تم إستخدام النموذج الخطي العام (GLM) في برنامج SAS لتقييم التأثيرات الثابتة، كما تم تطبيق free restricted maximum likelihood (REML)لتقدير المعالم الوراثية والقيم التربوية. أظهر العمر عند أول ولادة (AFC) تأثر كبير على الصفات الإنتاجية والتناسلية في أبقار الفريزيان. أظهرت الأبقار ذات العمر المبكر عند أول ولادة (≤٢٥–٣٥ شهرًا) إنتاجية من اللبن للحياة الإنتاجية (LTMY) ١٩٨٨١,٢٥ ± ١٢٤٨,٦ كجم وعدد مواسم حليب الكلية (NLC) ٤,٥٨ ± ٠,١٥ مقارنةً بالأبقار ذات العمر المتأخر عند أول ولادة (≤٤٦ شهرًا) إنتاجية أعلى من اللبن للحياة الإنتاجية (LTMY) ١٥٣٤٣,٥ ± ١٤٣٠,٥٥ كجم، وعدد مواسم حليب الكلية (NLC) ٢,٨٧ ± ٠,١٥. كما أظهرت النتائج أن الربحية كانت الأعلى في الأبقار ذات العمر المبكر عند أول ولادة (٣٩٥١٨,٢٤ ± ٢٢٦٨,٠٦ جنيهًا مصريًا) وإنخفضت مع تأخر عمر أول ولادة، حيث بلغت (٢٨٨٠١,٩٩ ± ١٢٢٣,١٧ جنيهًا مصريًا) للأبقار ذات العمر المتوسط عند أول ولادة (٣٦–٤٥ شهرًا) و(١٧٢٤٤,١٠ ± ٢٩٩٦,٤٢ جنيهًا مصريًا) للأبقار ذات العمر المتأخر عند أول ولادة (≤٤٦ شهرًا). تراوحت تقديرات المكافئ الوراثي للصفات المدروسة بين ٠,١٦ و٠,٢٦، مما يشير إلى إمكانية تحسين هذه الصفات وراثيًا من خلال الإنتخاب. تم تقدير القيم التربوية للآباء والأمهات والإناث بدقة عالية . وتبرز هذه القيم إمكانية تحقيق الانتخاب الوراثي لتحسين الصفات المرغوبة في أبقار الفريزيان. مما يسهم في تحسين إنتاج اللبن للحياة الإنتاجية وزيادة عدد مواسم الحليب الكلية.

الكلمات المفتاحية: أبقار الفريزيان، إنتاج الحليب للحياة الإنتاجية، العمرعند أول ولادة، القيم التربوية