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# Estimation of non-genetic parameters affecting total milk yield and occurrence of mastitis in Holstein Friesian dairy cows

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**ABSTRACT**

This study was performed on 1480 productive records collected from private farm of Holstein Friesian cows. In addition, collections of 70 milk samples for the measurement of somatic cell count (SCC). This study aims to evaluate the effect of some non-genetic factors (days in milk (DIM), peak milk yield (PMY), dry period (DP), calving interval (CI), parity, and season of calving) on total milk yield (TMY), and studying the effect of305-day milk yield (305-DMY), peak milk yield (PMY), days in milk (DIM), parity and season of calving on mastitis in Holstein Friesian cows. All data were analyzed by general linear model (GLM) using SAS software ver.9.1.3. The current results revealed that DIM and parity had a significant effect on TMY, where the highest milk yield was obtained when DIM were more than 357 days and in the 3rd lactation season. Season of calving showed a significant effect on occurrence of mastitis, where the highest incidence of mastitis was recorded for spring calvers.

## 1. INTRODUCTION

The most widely used dairy cattle all over the world is the Holstein-Friesian, because of its high milk producing ability. Moreover, it is known that it can adapt hot climatic conditions (Ojango et al., 2005). In Egypt, the population of cows is continuously increasing and was recently estimated to be about 4.95 million heads (FAO, 2015). This population produces about 53.64 % of the total milk production (5.90 million tons) and 45.40 % of the total red meat production (1.04 million tons) (FAO, 2015).Ratwan et al. (2017) reported that there were many non-genetic factors affecting milk production traits as parity, season of calving and calving interval in cattle. During the last three decades, milk yield per lactation has greatly increased, whereas fertility, health and productive life have decreased (Mirhabibi et al., 2018) .

Mastitis is considered the major health and the most frequent, and serious disease of dairy cattle, because of its high economic losses and huge impact on the dairy industry via reduction in milk yield worldwide. It results in massive antibiotic use, low milk quality, and milk becomes unfit for human consumption, and finally high culling rate (Halasa et al., 2007). Tiezzi et al. (2015) defined mastitis as an inflammation of the mammary gland due to the introduction and multiplication of pathogenic microorganisms, they considered mastitis as the major infectious disease of dairy cows. Ndahetuye et al. (2019) reported that the risk of subclinical mastitis increased with advancing in age and increased parity. They attributed that to the several exposures of multiparous cows to pathogens of mastitis from suboptimum hygienic environment during milking, and due to the easy access of bacterial infection to the mammary gland because of ageing and teat canal poor integrity. The aim of this study was to evaluate the effect of some non-genetic factors days in milk (DIM), peak milk yield (PMY), dry period (DP), parity, season of calving, and calving interval (CI) on total milk yield (TMY).And the effect of days in milk (DIM), peak milk yield (PMY), 305-day milk yield (305-DMY), parity, and season of calving on mastitis disease in Holstein Friesian cows.

## 2. MATERIAL AND METHODS

### *2.1. Animals*

Productive data of 1480 records were collected from private farm of Holstein Friesian dairy cows belonged to DINA Farms for Agricultural investment, located at Km 80 in Cairo-Alexandria desert road. In addition, 70 milk samples were collected to measure somatic cell count (SCC) and somatic cell score (SCS) as followed:

$$\mathrm{SCS} = \log 2 \left(\frac{\mathrm{SCC}}{100}\right) + 3$$

### *2.2. Herd Management*

Animals were kept in open system and under open sheds all over the year. They were supported by a cool spraying system during the hot climate. The animals were fed on total mixed ration (T.M.R) all over the year with four different groups of rations for pre-freshening, freshly calved, high producing and low producing cows depending on dry matter intake (DMI).

For freshly calved cows (during 21 days after calving), the animals take about 20 kg dry matter of a ration formed from 18.19 kg Alfalfa 2nd cut, 11.01 kg Corn silage, 4.57 kg Corn, 3.00 kg Glutien feed, 3.00 kg Soya beans meal, 0.88 kg Linseed meal, 0.7 kg Magna bac, 0.22 kg Cotton

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seed meal, 0.18 kg Sodium chloride, 0.08 kg Di calcium phosphate, 0.04 kg Calcium carbonate, 0.03 kg Sodium bicarbonate.
For high producers, the animals take about 22.5 kg dry matter of a ration formed from 14.65 kg Alfalfa 2nd cut, 12.60 kg Corn silage, 6.03 kg Corn, 2.84 kg Glutien feed, 2.63 kg Linseed meal, 1.88 kg Soya beans meal, 1.23 kg Cotton seed meal, 0.50 kg Hay, 0.48 kg Magna bac, 0.20 kg Sodium bicarbonate, 0.19 kg Calcium carbonate, 0.13 kg Sodium chloride.
For low producers, the animals take about 19.58 kg dry matter of a ration formed from 25.15 kg Alfalfa 2nd cut, 11.00 kg Corn silage, 6.89 kg Corn, 3.80 kg Cotton seed meal, 2.50 kg Glutien feed, 1.19 kg Soya beans meal, 0.25 kg Molasses, 0.17 kg Calcium carbonate, 0.13 kg Sodium bicarbonate, 0.04 kg Sodium chloride.

*2.3. Ethical approval*
The Committee of Animal Care and Welfare, Benha University, Faculty of Veterinary Medicine, Egypt approved this study with an approval number of BUFVTM: 04-07-20.

*2.4. Statistical analysis*
The effect of non-genetic factors was performed using analysis of variance with days in milk, peak milk yield, dry period, calving interval, parity, and calving season as a fixed effect in a general linear model (GLM) using the SAS software ver.9.1.3 (SAS Institute Inc, Cary, NC, USA) (SAS, 2001).

*Model 1:*
To analyze the factors affecting on TMY, the following model was assumed.

$$Y_{ijklmno} = \mu + DIM_i + PMY_j + DP_k + CI_l + P_m + S_n + b(AFC) + e_{ijklmno}.$$

*Symbols in the model are defined as the following:*

$Y_{ijklmno}$: The observed value; (i.e. total milk yield).

$\mu$ : The overall mean.

$DIM_i$ :The effect of the i$^{th}$ days in milk; (i= 1, 2, 3, and 4: where 1= less than 211 days; 2= 211-357 days, and 3=more than 357 days).

$PMY_j$ : The effect of the j$^{th}$ peak milk yield; (j=1, 2, and 3: whereas 1=less than 35 kg; 2= 35-43 kg, and 3=more than 43 kg).

$DP_k$: The effect of the k$^{th}$ dry period; (k=1, 2, and 3: whereas 1=less than 54 days; 2=54- 61 days, and 3=more than 61 days).

$CI_l$: The effect of the l$^{th}$ calving interval; (l=1, 2, and 3: whereas 1= less than 13 months; 2=13 - 15 months, and 3=more than 15 months).

$P_m$: The effect of the m$^{th}$ parity; (m= 1, 2, 3, and 4: where 1=first parity; 2=second parity; 3=third parity, and 4= fourth parity or more).

$S_n$: The effect of the n$^{th}$ season of calving; (n=1, 2, 3, and 4: whereas 1= winter season; 2= spring season; 3=summer season, and 4=autumn season).

*b(AFC)*: partial linear regression coefficients of $Y_{ijklmno}$ on age at first calving.

$e_{ijklmno}$: random error.

*Model 2:*
To analyze the factors affecting on mastitis, the following model was assumed.

$$Y_{ijklmn} = \mu + L_i + PMY_j + DIM_k + P_l + S_m + e_{ijklmn}.$$

*Symbols in the model are defined as the following:*

$Y_{ijklmn}$: The observed value; (i.e somatic cell score for mastitis disease).

$\mu$ : The overall mean.

$L_i$: The effect of the i$^{th}$ level of production (305-DMY); (i=1, 2, and 3: whereas 1= less than 8643 kg; 2=8643-10440 kg, and 3=more than 10440 kg).

$PMY_j$: The effect of the j$^{th}$ peak milk yield; (j=1, 2, and 3: whereas 1=less than 35 kg; 2= 35-44 kg, and 3=more than 44 kg).

$DIM_k$: The effect of the k$^{th}$ days in milk; (k=1, 2, and 3: whereas 1=less than 156 days; 2= 156-370 days, and 3=more than 370 days).

$P_l$ : The effect of the l$^{th}$ parity; (l= 1, 2, 3, and 4: where 1=first parity; 2=second parity; 3=third parity, and 4= fourth parity or more).

$S_m$: The effect of the m$^{th}$ season of calving; (m=1, 2, 3, and 4: whereas 1= winter; 2= spring; 3=summer, and 4=autumn).

$e_{ijklmn}$: random error.

## 3. RESULTS

*3.1. Effect of non-genetic factors on total milk yield (TMY)*
The least squares means, standard errors for different factors affecting total milk yield (TMY) were shown in table 1. Days in milk had a highly significant ($P \leq 0.01$) effect on TMY. The maximum milk yield was 12052 kg when DIM was more than 357 days while the lowest yield was 7606 kg obtained when DIM was less than 211 days. Parity had a significant ($P \leq 0.05$) effect on TMY. First season of lactation showed the lowest amount of milk (9210 kg) followed by the second parity (9456 kg) then the fourth or more parity (9557 kg), and finally the third season of lactation showed the maximum yield (10792 kg). Peak milk yield, dry period, calving season, and CI showed a non-significant effect on TMY. The maximum milk yield was 9947 kg when DP more than 61 days. Calving in summer season had the highest milk production (10021kg).

*3.2. Effect of non-genetic factors on mastitis disease*
The least squares means, standard errors for different factors affecting mastitis disease were shown in table 2. Season of calving had a significant effect on the occurrence of mastitis; cows that calved in spring season had the highest somatic cell score (SCS) for mastitis (18.57) cells/ml milk. All other factors had a non-significant effect on mastitis (DIM, parity, peak milk yield, and 305-DMY).

reference value in all different affections except in cystitis. The mean value of Basophil, Eosinophil and monocyte were within the normal reference value in all different affections.

Table (1): Least-squares means (±SE) of various factors affecting total milk yield (TMY).

| Classification | N | L.S.M ± S.E |
|---|---|---|
| 1. Days in milk | | |
| <211 | 146 | 7606.42 $^{b}$±572.50 |
| 211-357 | 283 | 9604.17 $^{b}$ ±299.92 |
| >357 | 292 | 12052.26 $^{a}$ ±287.53 |
| 2. Peak milk yield (daily) | | |
| <35 | 259 | 9551.99 ±633.53 |
| 35-43 | 191 | 9472.23 ±675.36 |
| >43 | 271 | 10238.64 ±643.04 |
| 3. Dry Period (days). | | |
| <54 | 220 | 9680.71 ±665.72 |
| 54-61 | 276 | 9634.49±647.78 |
| >61 | 225 | 9947.66 ±637.82 |
| 4. Calving of interval (months) | | |
| <13 | 282 | 7992.43 ± 352.41 |
| 13-15 | 308 | 8213.48± 337.05 |
| >15 | 293 | 8577.10 ± 345.73 |
| 5. Parity. | | |
| The 1$^{st}$ lactation | 276 | 9210.27$^{b}$ ±630.19 |
| The 2$^{nd}$ lactation | 205 | 9456.89$^{b}$±662.09 |
| The 3$^{rd}$ lactation | 142 | 10792.25$^{a}$ ±694.23 |
| The 4$^{th}$ lactation and more. | 98 | 9557.73$^{ab}$ ±771.09 |
| 6. Season of Calving. | | |
| Winter | 162 | 9879.48 ±685.20 |
| Spring | 114 | 9440.93 ±743.84 |
| Summer | 217 | 10021.99 ±672.54 |
| Autumn | 228 | 9674.73±633.05 |

Within the same classification, the appearances of least square means with the different letters are significantly different ($p \leq 0.05$). Otherwise, they do not.

Table (2): Least-squares means (±SE) of various factors affecting mastitis.

| Classification | N | L.S.M ± S.E |
|---|---|---|
| 1. 305 DMY | | |
| <8643 | 22 | 17.09 ±0.78 |
| 8643-10440 | 24 | 17.16±0.71 |
| >10440 | 24 | 16.89 ±0.67 |
| 2. Peak milk yield (daily) | | |
| <35 | 22 | 17.55 ±0.75 |
| 35-44 | 28 | 16.45 ±0.66 |
| >44 | 20 | 17.14 ±0.77 |
| 3. Days in milk | | |
| <156 | 24 | 17.87 ±0.77 |
| 156-370 | 22 | 16.55 ±0.77 |
| >370 | 24 | 16.72 ±0.75 |
| 4. Parity. | | |
| The 1$^{st}$ lactation | 14 | 16.42±1.13 |
| The 2$^{nd}$ lactation | 19 | 17.65 ±0.72 |
| The 3$^{rd}$ lactation | 22 | 16.82 ±0.75 |
| The 4$^{th}$ lactation and more. | 15 | 17.300 ±0.87 |
| 5. Season of Calving. | | |
| Winter | 21 | 17.62$^{a}$ ±0.67 |
| Spring | 5 | 18.57$^{a}$±1.43 |
| Summer | 24 | 15.31$^{b}$ ±0.63 |
| Autumn | 20 | 16.68$^{ab}$ ±0.77 |

## 4. DISCUSSION

This study aimed to evaluate the effect of some non-genetic factors (days in milk (DIM), peak milk yield (PMY), dry period (DP), calving interval (CI), parity, and calving season) on total milk yield and mastitis disease. Days in milk showed a highly significant ($P \leq 0.01$) effect on TMY. In agreement to these finding, Auldist et al. (2007) who found that there was an increase in the kilograms of milk produced per cow, as lactation length increased for total yield of milk of Holstein cows. The extended lactation strategy or increase DIM leads to fewer dry days per cow and more milk production accompanied with fewer calvers and fewer replacement heifers due to diseases so that more profit to the farm (Sehested et al., 2019), while the current results disagreed with Vijayakumar et al. (2017) who reported that cow's milk yield decreased gradually as the lactation length increased in Holstein dairy cows. The significant effect of parity on TMY was similar with the reports of Getahun et al. (2020) for Holstein Friesian, Hunde et al. (2015) and Beneberu et al. (2020) for pure Jersey breed. This might be because the size of udder increased with the maturity of the cows and subsequently the milk production increased with parity (Beneberu et al., 2020). In contrast, Tadesse (2006) and Bolacali and Öztürk (2018) reported that parity did not have significant effect on TMY for Holstein Friesian and Simmental cattle .

Concerning DP, the results agreed with Kok et al. (2017) who said that dry period had a non-significant effect on TMY in Dutch dairy cow. When the DP is shortened, milk amount after calving might be reduced, remain the same, or increased. A reduction of milk yield could result from less functional epithelial cells in the mammary gland during the next lactation (Collier et al., 2012). Milk yield could stabilize or increase if cows adapt to continuous milking (Rémond and Bonnefoy, 1997) or might be due to increase of renewal mammary epithelial cells during lactation (Capuco et al., 2001). In contrast, Watters et al. (2008) showed that dry period significantly affected milk yield in Holstein cows .

Regarding CI, the obtained results were in agreement with those obtained by Remmik et al. (2020) who reported that cows with CI shorter than 12 months have an average 2345 kg lower milk yield in the first 1000 days of lifetime than those with CI between 14 and 16 months in Holstein cows. Concerning to the effect of season of calving, calving in summer season had the highest milk production in this study. This might be due to maintaining a proper summer cooling management and a proper reproductive management, which might achieve a good and professional result throughout the year in this farm. In agreement with present study, Bolacali and Öztürk (2018) and Beneberu et al. (2020) found that season of calving had a non-significant effect on TMY in pure Jersey cows and Simmental cattle, respectively. Also, Lavon (2018) stated that milk production increased in summer season than in winter in dairy farms, assumed that these farms have a better cooling system. In contrast, Mohammed and Atta (2019) found a significant increase of milk yield in winter season than in summer.

Mastitis remains one of the most common and devastating diseases affecting the dairy cow industry elsewhere in the world (De Vliegher et al., 2012). Calving season had a significant effect on the occurrence mastitis. The obtained results were in agreement with those obtained by Elghafghuf et al. (2014) who showed that in the first 13 DIM, the highest incidence of mastitis was for cows that calved in spring and summer compared with autumn and winter. This might be due to the higher bacterial counts in warmer months, so increased stress and decreased immunity that associated with hot weather. Regarding DIM, Hammer et al. (2012) did not observe an increased risk of mastitis for cows during the first 30 DIM or between 30 and 90 DIM. In contrast, Hertl et al. (2011)and Elghafghuf et al. (2014) found that parity had a significant effect on the incidence of mastitis, and hazard of mastitis tended to increase with increasing parity. This might be the result of new incidence infections during the several lactations and long exposure time to milking machines(Green et al., 2002). Also, these results were in disagreement with previous findings of where Ismail et al. (2018) who found a significant effect of peak milk yield and 305-DMY on acute and chronic mastitis.

## 5. CONCLUSION

This study revealed that the effects of non-genetic factors (DIM, parity, and season of calving) must be considered when evaluating dairy cows. The highest milk production was obtained when DIM was more than 357 days and when the cow became in the 3rd lactation. Also, calving in summer season had the highest milk production in this study. Accordingly, the proper management of the dairy farm while maintaining a proper summer cooling system and a proper reproductive management, might achieve good professional results throughout the year. Spring season was noticed for high somatic cell score of mastitis than any season of calving.

## 6. ACKNOWLEDGMENT

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### 7. CONFLICT OF INTEREST

The authors declare that they had no conflict of interest.

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