

## Associations between Peak Yield and Peak Day with Productive and Reproductive Traits of Holstein-Friesian Dairy Cows in Egypt

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### ABSTRACT

Data of 3251 lactation records for the first five lactations of 1022 Holstein-Friesian dairy cows at Alex-Kobenhagen farm during the period from 2000 to 2010 were used to determine the associations between levels of peak yield and peak day with some productive and reproductive traits. The data of peak yield (PY) was categorized as {PY1 (<33.4 kg), PY2 (33.4-<43.03 kg), PY3 (43.03-<52.6 kg) and PY4 ( $\geq$ 52.6 kg)} and the peak day (PD) was expressed as {PD1 (<23.8 d), PD2 (23.8-<77 d), PD3 (77-<131 d) and PD4 ( $\geq$ 131 d)}. The reproductive and productive traits studied were; service per conception (SC), days open (DO), calving interval (CI), total milk yield (TMY), 305-d milk yield (305-MY), lactation period (LP), dry period (DP), fat yield (FatY) and protein yield (ProY). The results revealed that the cows with intermediate peak yield in the first lactation (PY3) tended to stay longer in the herd, on close level of TMY and in intermediate DO value during the five tested lactations, compared with other peak milk yield groups. Moreover, it could be noticed that the PD3 group obtained high TMY and intermediate DO values by the five tested lactations. Insignificant differences have been detected among groups PD1, PD2 and PD3 for all tested traits, except that for SC of group PD3 which was the lowest value. Group PD3 was significantly higher ( $p < 0.05$ ) than group PD4 in TMY, 305-MY, FatY and ProY, while insignificant differences for the reproductive tested traits were detected. The results indicated that regardless of high productive performance, the reproductive performance of cows had early peak milk and delayed DO (PD < DO) was significantly lower ( $p < 0.05$ ) than those had early DO and delayed peak milk. Generally, the present study revealed that cows maintaining peak milk from 77 to <131 day and intermediate peak yield from 43.03 to <52.6 kg could be considered as the most profitable cow.

**keywords:** peak yield, peak day, reproductive and productive performance

### INTRODUCTION

The lactation curve has three important components namely milk yield at peak lactation, days to attain peak yield and persistency, whose study provides insight into lactation physiology (Wasike *et al.*, 2014). The peak milk production is considered an indication of how well the cow responded to feeding and management during the dry period (Chen *et al.*, 2016), calving and early lactation periods. Moreover, peak milk and when it occurs affords a realistic window to how well the manager handles these cows. Additionally, the lactation persistency is an economically important trait for dairy cattle, since improving persistency is considered a good alternative method for increasing overall milk production (Do *et al.*, 2017). However, in a broader view, reaching peak milk yield and persistency encompasses the ability of lactating cows to rebound from effects of adverse events such as illness and climatic stress as well as feed shortages, thus providing a gauge for adaptability of the dairy cow (Kamidi, 2005).

Generally, peak yield and peak day has a high correlation with total milk yield, therefore selection based on peak yield and peak day would reduce the generation interval (Patond *et al.*, 2013). Additionally, several studies found relationships between the lactation curve parameters, such as peak day, peak yield, persistency, and milk productivity, affected by selection for higher milk yield (Nemeckova *et al.*, 2015). Therefore, the reasons for being interested in a peak day at a given level of production include the reduction in stress due to high peak production, and the possibility of improving reproductive performance.

On the other hand, reproductive efficiency is one of the most important determinants of profitability in dairy (Kumar *et al.*, 2017). In this aspect, the days open and services per conception traits are responsible for either shorter or longer calving interval and thus it has a significant relationship with the milk yield (El-

Tarabany and Nasr, 2015) and the peak yield respectively inversely with peak day (Lopez-Villalobos *et al.*, 2005).

Hence, search for suitable peak yield and peak day are of great importance for both management decisions and genetic evaluations, especially for assessing an economically convenient asymptotic level of production. Therefore, the objective of this work was to determine the associations between levels of peak yield and peak day with some productive and reproductive traits of Holstein-Friesian dairy cows.

### MATERIALS AND METHODS

The dairy herd of Alex-Kobenhagen was used in the present study. The data represent 3251 records collected for the first five lactations of 1022 Holstein-Friesian dairy cows during the period from 2000 to 2010. The data of peak yield (PY) was categorized as {PY1 (<33.4 kg), PY2 (33.4-<43.03 kg), PY3 (43.03-<52.6 kg) and PY4 ( $\geq$ 52.6 kg)} and the peak day (PD) was expressed as {PD1 (<23.8 d), PD2 (23.8-<77 d), PD3 (77-<131 d) and PD4 ( $\geq$ 131 d)}. The herd of the farm was divided into groups according to their productive and reproductive status. The groups were housed free separately in open yards with half-shaded pens. The cows were fed, ad libitum of total mixed ration (TMR) constant around the year. The offered feed was calculated daily at morning based on the weight of refusals during the previous day (approximately 5% of the offered feed). Equal portions of the rations were fed at 0800, 1400 and 1700 h., and water was offered freely.

Cows were machine milked three times daily at 0600, 1300 and 1800 h. in herringbone parlor. The computer program (Dairy cattle Comp.) was used for recording. Milk yield was individually recorded at each milking for each cow separately. The cows were dried at two months before the next calving. Estrus was detected by visually monitoring cows for thirty minutes a.m and p.m near predicted estrus. Artificial insemination took place approximately 12 h after a cow was first observed standing

for mounting. Pregnancy diagnosis via rectal palpation was performed on day 40 after the last service.

The traits studied were; service per conception (SC), days open (DO), calving interval (CI), total milk yield (TMY), 305-d milk yield (305-MY), lactation period (LP), dry period (DP), fat yield (Fat Y) and protein yield (Pro Y).

Statistical analysis was performed by the least squares method using the GLM procedure of the SAS computational program (Statistical Analysis System, 2008). The significant differences among means were assigned using Duncan (1955) multiple range test method according to the following model;

$$Y_{ijklmn} = \mu + Yr_i + Sea_j + Lac_k + PY_l + PD_m + e_{ijklmn}$$

**Where:**  $Y_{ijklmn}$  is the observation productive and reproductive traits,  $\mu$  is the mean value of the dependent variables,  $Yr_i$  is the effect of year of calving  $i=11$ ,  $Sea_j$  is the effect of season of calving  $j=4$ ,  $Lac_k$  is the effect of lactations order  $k=5$ ,  $PY_l$  is the effect of peak yield levels  $l=4$ ,  $PD_m$  is the effect of peak days from calving levels  $m=4$ , and  $e_{ijklmn}$  is the random residual error.

### RESULTS

The distribution of cows by peak milk levels during the lactations are reported in Table (1). At the 1<sup>st</sup> lactation, the most cows were observed in the intermediate peak milk groups PY2 and PY3 (40% and 33%, respectively). It could be noticed that more than 25% of the total cows were culled after the second lactation and most of them were recorded from the low peak milk groups (PY1 and PY2). Moreover, only about 12.8% of the cows reached the 5<sup>th</sup> lactation, 47% of them were recorded in group PY3. The percentages of groups PY1 and PY2 were decreased by lactations, while the percentage of PY3 group clearly was increased. In other words, the cows with intermediate peak yield in the first lactation (group PY3, from 43.03 to < 52.6 kg) tended to stay longer in the herd than cows produced low (< 33.4 kg) and high ( $\geq 52.6$  kg) peak milk yield. These findings could be explained by the low production in the first case or culling for reasons other than production (e.g. health disorders and unsatisfactory reproductive performances) in the second case, which caused more cows culling in both cases.

As for peak day (Table 2), the results cleared that the vast majority of cows were maintained their peak milk at 23.8 to < 77 days (group PD2) followed by those maintained peak at 77 to < 131 days (group PD3), however, this trend was stable in all lactations. As a result, the rate of cows culling was lower for early peak yield

maintained (group PD1) than for delayed ones (group PD4).

Figure (1) presented the values of TMY and DO by peak milk levels during the five tested lactations. At the 1<sup>st</sup> lactation, the increase in PY levels did not cause obvious differences in the TMY, but increased the DO values specially cows of group PY4 ( $\geq 52.6$  kg). However, in the subsequent lactations the TMY increased by the PY levels, while, the DO values decreased in subsequent lactations compared with the 1<sup>st</sup> lactation. The DO values for groups PY1, PY2 and PY3 were almost convergent. In general, group PY3 (43.03 to < 52.6 Kg) was tended to stay on close level of TMY and in intermediate DO values by the five tested lactations.

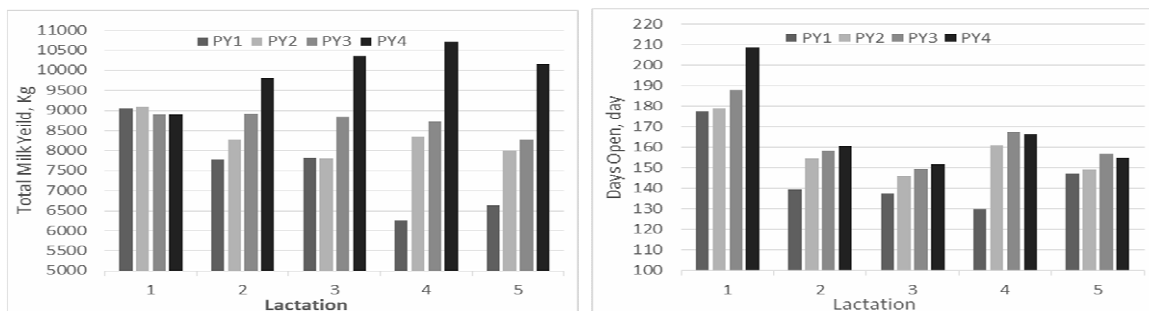
Results obtained in Figure (2) indicated that, at the 1<sup>st</sup> lactation, the groups of cows maintained peak milk earlier than 23.8 days (PD1) and from 77 to < 131 days (PD3) recorded higher TMY values. Otherwise, the group PD1 showed the highest DO value, while the lowest DO value was given by group PD3. In the 2<sup>nd</sup> and 3<sup>rd</sup> lactations, no differences were detected for TMY and DO values among the tested groups, except of group PD4 ( $\geq 131$  days) observed a decrease in TMY. At the 4<sup>th</sup> and 5<sup>th</sup> lactations, both groups PD2 and PD3 showed higher TMY values, compared with groups PD1 and PD4. However, there were no differences in the DO values at the 4<sup>th</sup> lactation between the groups PD1 and PD2, but were differ with groups PD3 and PD4. At the 5<sup>th</sup> lactation, the DO values increased by the peak day levels. Generally, it could be noticed that group PD3 (77 to < 131 days) had high TMY and intermediate DO values during the five tested lactations.

**Table 1. The distribution of Holstein-Friesian cows (%) by peak yield (PY) levels during the first five lactations.**

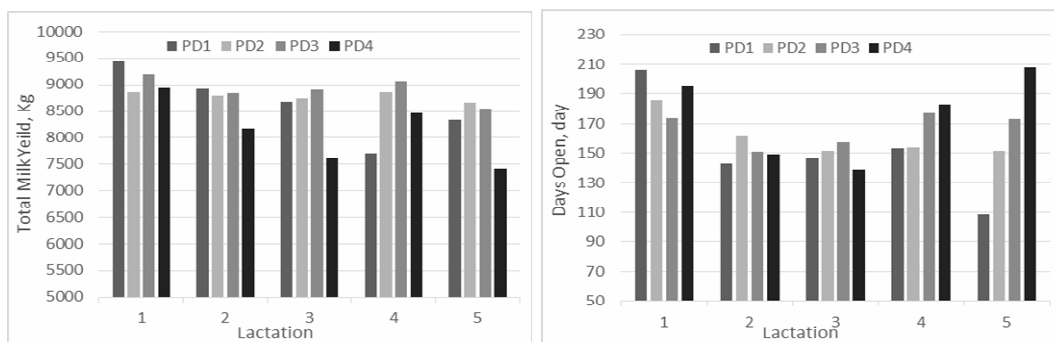
Lactatio n	No.	Peak Yield (kg)			
		PY1 ( $< 33.4$ )	PY2 ( $33.4 - < 43.03$ )	PY3 ( $43.03 - < 52.6$ )	PY4 ( $\geq 52.6$ )
1 <sup>st</sup>	1022	14	40	33	13
2 <sup>nd</sup>	1022	11	35	36	18
3 <sup>rd</sup>	764	10	33	37	20
4 <sup>th</sup>	312	10	32	37	21
5 <sup>th</sup>	131	8	24	47	21

**Table 2. The distribution of Holstein-Friesian cows (%) by peak day (PD) levels during the first five lactations.**

Lactatio n	No.	Peak Day (day)			
		PD1 ( $< 23.8$ )	PD2 ( $23.8 - < 77$ )	PD3 ( $77 - < 131$ )	PD4 ( $\geq 131$ )
1 <sup>st</sup>	1022	8	53	24	15
2 <sup>nd</sup>	1022	11	53	22	14
3 <sup>rd</sup>	764	10	55	22	13
4 <sup>th</sup>	312	7	61	20	12
5 <sup>th</sup>	131	4	55	30	11



**Figure 1. least squares means of total milk yield and days open traits by peak yield (PY) levels during the five tested lactations for Holstein-Friesian cows.**



**Figure 2.** least squares means of total milk yield and days open traits by peak day (PD) levels during the five tested lactations for Holstein-Friesian cows.

Data in Table (3) illustrated that the increasing in peak milk yield resulted in an increasing in CI, DO, LP, TMY, 305-MY, FatY and ProY. However, significant differences were detected among all tested groups in TMY, FatY and ProY. Otherwise, significant differences were mostly clear between the lowest peak yield group PY1 and the highest group PY4. Therefore, from the economic point, since no significant difference among PY2, PY3 and PY4 for all the reproductive tested traits, while the TMY, ProY and FatY were significantly higher ( $p < 0.05$ ) in group PY4. Thus, cows of group PY4 ( $\geq 52.6$  Kg) could be considered the more profit cows followed by group PY3 (43.03 to  $< 52.6$  Kg), compared with other tested groups.

Table (4) showed that there is no significant differences have been detected among groups PD1, PD2

and PD3 for all tested traits, except that for SC which was the lowest value for group PD3. Insignificant differences were detected between groups PD3 and PD4 for all the reproductive tested traits. However, group PD3 was significantly higher ( $p < 0.05$ ) than group PD4 in TMY, 305-MY, FatY and ProY. It is obvious that, the maintaining of peak milk earlier than 77 days did not affect cows' productive traits, but showed higher SC value, compared with cows maintaining peak milk later than 77 days. On the other hand, maintaining the peak milk later than 131 days showed low SC value, but significantly decreased the cows TMY, FatY and ProY, compared with other tested groups. Consequently, the group PD3 (77 -  $< 131$  day) could be considered as the better time for cows to maintain peak milk yield.

**Table 3.** Least squares means ( $\pm$ SE) of productive and reproductive traits according to the peak yield (PY) levels of Holstein-Friesian cows.

	Peak Yield (kg)			
	PY1 ( $< 33.4$ )	PY2 ( $33.4 - < 43.03$ )	PY3 ( $43.03 - < 52.6$ )	PY4 ( $\geq 52.6$ )
No.	370	1152	1157	572
SC	2.72 $\pm$ 0.17	2.86 $\pm$ 0.11	2.96 $\pm$ 0.11	2.87 $\pm$ 0.13
CI, day	433.00 $\pm$ 9.70 <sup>b</sup>	440.25 $\pm$ 6.36 <sup>ab</sup>	444.25 $\pm$ 5.93 <sup>ab</sup>	454.73 $\pm$ 7.48 <sup>a</sup>
DO, day	158.39 $\pm$ 10.20 <sup>b</sup>	170.38 $\pm$ 6.70 <sup>ab</sup>	183.75 $\pm$ 6.25 <sup>a</sup>	188.31 $\pm$ 7.87 <sup>a</sup>
LP, day	343.47 $\pm$ 9.38 <sup>c</sup>	354.07 $\pm$ 6.16 <sup>bc</sup>	367.46 $\pm$ 5.74 <sup>ba</sup>	384.72 $\pm$ 7.24 <sup>a</sup>
TMY, kg	7062.63 $\pm$ 280.58 <sup>d</sup>	8101.77 $\pm$ 184.11 <sup>c</sup>	8560.79 $\pm$ 171.73 <sup>b</sup>	9831.83 $\pm$ 216.53 <sup>a</sup>
305-MY, kg	7290.01 $\pm$ 199.80 <sup>d</sup>	8018.39 $\pm$ 131.10 <sup>c</sup>	8368.63 $\pm$ 122.29 <sup>b</sup>	8840.92 $\pm$ 154.19 <sup>a</sup>
DP, day	81.60 $\pm$ 6.08	76.96 $\pm$ 3.99	82.15 $\pm$ 3.72	72.35 $\pm$ 4.70
FatY, kg	216.57 $\pm$ 8.76 <sup>d</sup>	251.20 $\pm$ 5.75 <sup>c</sup>	266.96 $\pm$ 5.36 <sup>b</sup>	301.93 $\pm$ 6.76 <sup>a</sup>
ProY, kg	177.64 $\pm$ 7.25 <sup>d</sup>	203.74 $\pm$ 4.76 <sup>c</sup>	217.74 $\pm$ 4.44 <sup>b</sup>	245.75 $\pm$ 5.59 <sup>a</sup>

a-d: Means in the same row with different superscripts are significantly different at  $p < 0.05$

**Table 4.** Least squares means ( $\pm$ SE) of productive and reproductive traits according to the peak day (PD) levels of Holstein-Friesian cows.

	Peak Day			
	PD1 ( $< 23.8$ )	PD2 ( $23.8 - < 77$ )	PD3 ( $77 - < 131$ )	PD4 ( $\geq 131$ )
No.	296	1776	734	445
SC	3.00 $\pm$ 0.23 <sup>a</sup>	3.05 $\pm$ 0.09 <sup>a</sup>	2.67 $\pm$ 0.12 <sup>b</sup>	2.69 $\pm$ 0.15 <sup>b</sup>
CI, day	441.98 $\pm$ 12.59	442.78 $\pm$ 4.83	446.69 $\pm$ 6.43	440.77 $\pm$ 8.51
DO, day	170.46 $\pm$ 13.25	173.95 $\pm$ 5.09	175.75 $\pm$ 6.77	180.68 $\pm$ 8.96
LP, day	375.15 $\pm$ 12.19	361.17 $\pm$ 4.68	361.70 $\pm$ 6.23	351.70 $\pm$ 8.24
TMY, kg	8701.94 $\pm$ 364.35 <sup>a</sup>	8459.99 $\pm$ 139.91 <sup>a</sup>	8458.59 $\pm$ 186.19 <sup>a</sup>	7936.48 $\pm$ 246.28 <sup>b</sup>
305-MY, kg	8218.81 $\pm$ 259.45 <sup>ab</sup>	8174.42 $\pm$ 99.63 <sup>ab</sup>	8242.98 $\pm$ 132.58 <sup>a</sup>	7881.75 $\pm$ 175.37 <sup>b</sup>
DP, day	79.21 $\pm$ 7.90	84.48 $\pm$ 3.03	74.59 $\pm$ 4.04	74.79 $\pm$ 5.34
FatY, kg	274.18 $\pm$ 11.38 <sup>a</sup>	264.21 $\pm$ 4.37 <sup>a</sup>	257.04 $\pm$ 5.81 <sup>a</sup>	241.22 $\pm$ 7.69 <sup>b</sup>
ProY, kg	217.12 $\pm$ 9.41 <sup>a</sup>	219.99 $\pm$ 3.61 <sup>a</sup>	210.82 $\pm$ 4.81 <sup>a</sup>	196.95 $\pm$ 6.36 <sup>b</sup>

a-d: Means in the same row with different superscripts are significantly different at  $p < 0.05$

According to the statistical analysis of data in Table (5), it could be noticed that the reproductive performance of cows attended early peak milk and delayed DO (PD  $<$  DO) was significantly lower ( $p < 0.05$ ) than those had early DO and delayed peak

milk (PD  $>$  DO). The reverse trend was detected for tested productive traits (LP, TMY, FatY and ProY). However, no significant deference was detected for 305-MY between the two groups. Accordingly, regardless of high productive performance, the early maintaining of

peak milk (62.86±37.81 day) caused an increase in cows' SC value and that subsequently increased its DO and CI.

**Table 5. Least squares means (±SE) of productive and reproductive traits at peak day before days open (PD<DO) and peak day after days open (PD>DO) of Holstein-Friesian cows.**

	PD < DO	PD > DO
No.	2589	662
SC	3.065±2.105 <sup>a</sup>	2.595±1.791 <sup>b</sup>
CI, day	444.89±117.13 <sup>a</sup>	402.59±94.48 <sup>b</sup>
DO, day	185.34±127.38 <sup>a</sup>	84.14±34.67 <sup>b</sup>
LP, day	379.53±117.97 <sup>a</sup>	310.34±68.60 <sup>b</sup>
TMY, kg	9044.55±3455.03 <sup>a</sup>	7806.85±2767.30 <sup>b</sup>
305-MY, kg	8441.84±2372.06	8334.05±2346.35
DP, day	76.99±75.05 <sup>a</sup>	65.47±44.84 <sup>b</sup>
FatY, kg	275.05±107.73 <sup>a</sup>	239.14±92.74 <sup>b</sup>
ProY, kg	226.96±89.36 <sup>a</sup>	196.13±76.79 <sup>b</sup>
PD, day	62.86±37.81 <sup>b</sup>	133.99±62.47 <sup>a</sup>

a-b: Means in the same row with different superscripts are significantly different at  $p < 0.05$

## DISCUSSION

This study was performed to clarify the associations between levels of peak yield and peak day with productive and reproductive performance during the first five lactations studied of Holstein dairy cows. Generally, results showed that the cows with peak yield from 43.03 to < 52.6 kg and maintaining peak milk from 77 to < 131 day were tended to stay longer in the herd and showed intermediate productive and reproductive performance by the five tested lactations. While, cows had higher peak yield and earlier peak day, in spite of produced high TMY, it showed unfavorable reproductive performance as well.

However, unfortunately, a high milk yield is often associated with deteriorated cow health and fertility and, consequently, with an increased culling rate (Adamczyk *et al.*, 2017). Moreover, in the period between calving and peak yield, incidences of most health problems, including mastitis are high (Strapakova *et al.*, 2016), and that had a detrimental impact on cows reproductive and milk peak performance (Boujenane *et al.*, 2015). Hence, the high milk production is connected with high peak yield, higher number of services per conception and especially significantly longer days open period (Nemeckova *et al.*, 2015). However, Wasike *et al.* (2014) detected negative genetic correlations between peak day and peak yield, peak yield and persistency, and peak day and total milk yield. Accordingly, as total milk yield increased, the peak day and persistency increased as well (Muir *et al.*, 2004).

Increased peak milk yield in early stages of lactation would lead to high energy demand and consequently aggravating the condition of negative energy balance (NEB) (Wasike *et al.*, 2014) especially during the first 4 wk after calving (Chen *et al.*, 2016). Therefore, cows usually use their own body condition for about 12 weeks after calving, to provide energy in addition to that consumed (Moran, 2009). Simultaneously, the main reason of poor fertility is assumed to be NEB (Duchacek *et al.*, 2014), evoking body reserves mobilization to meet the increased nutrient demand for milk yield (Beran *et al.*, 2012). In

this aspect, several studies showed an association between the energy balance and lactation curve shape, which correspond with DO length (Andersen *et al.*, 2011). Pollot (2011) explained that long lactation with high peak yield and early maintain of peak yield is typical for cows with deep negative energy balance which cause decrease in conception rate and calving interval prolongation over 365 days. However, Atashi *et al.* (2013) documented that the lower peak yield and higher persistency improves cows' robustness to the stress of lactation and metabolic disorders, as a consequence of shallower energy imbalance, followed by less body reserves mobilization to meet the nutrient demand for lower milk production. Generally, under tropical environment conditions, lactation curves with lower peaks and typical peak day, subsequently higher persistency, might be desirable from both an economical and a physiological point of view (Tullo *et al.*, 2014).

## CONCLUSION

The present results cleared that the high reproductive performance is associated with a slow rate of increase in milk production, whereas low reproductive performance is associated with early maintaining of peak yield. Moreover, the total milk yield of cows could be predicted based on peak yield and peak day at early lactation and seems appropriate that both traits could be factored into animals management and selection decisions. Generally, the present study revealed that cows maintaining peak milk from 77 to <131 day with intermediate peak yield from 43.03 to <52.6 kg could be considered the most profitable and typical lactation cow.

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## العلاقة بين قمة انتاج اللبن ويوم الوصول لقمة الإنتاج مع الصفات الإنتاجية والتناسلية لأبقار الهولشتين فريزيان الحلابة في مصر

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قسم إنتاج الحيوان ، كلية الزراعة ، جامعة المنصورة ، مصر

استخدم في الدراسة البيانات الخاصة بخمسة مواسم حلابة لعدد ١٠٢٢ من أبقار هولشتين فريزيان (٣٢٥١ سجل) بمزرعة اسكندرية كوربينهاجن في مصر عن الفترة من ٢٠٠٠ وحتى ٢٠١٠. تهدف الدراسة لتحديد العلاقة بين مستويات مختلفة من قمة انتاج اللبن ويوم الوصول لقمة الانتاج مع بعض الصفات الإنتاجية والتناسلية. قسمت بيانات قمة الإنتاج (PY) إلى أربعة مجموعات وهي PY1 (<33.4 kg) و PY2 (33.4-43.03 kg) و PY3 (43.03-52.6 kg) و PY4 (≥52.6 kg) ، وكذلك تم تقسيم البيانات الخاصة بيوم الوصول لقمة الإنتاج (PD) إلى أربعة مجموعات وهي PD1 (<23.8 d) و PD2 (23.8-77 d) و PD3 (77-131 d) و PD4 (≥131 d). كانت الصفات الإنتاجية والتناسلية التي تم دراستها هي: عدد التلقيحات اللازمة للإخصاب ، فترة الأيام المفتوحة ، الفترة بين ولادتين ، إنتاج اللبن الكلي ، إنتاج اللبن عند ٣٠٥ يوم ، طول موسم الحليب ، فترة الجفاف ، محصول إنتاج الدهن و محصول إنتاج البروتين. أشارت النتائج إلى أن مجموعة الأبقار PY3 استمرت داخل القطيع لفترة أطول وكانت قيم مستويات إنتاج اللبن الكلي لها متقاربة وكذلك طول فترة الأيام المفتوحة وذلك على مدار المواسم المختلفة بالدراسة. أوضحت النتائج كذلك أن مجموعة الأبقار PD3 تميزت بمستوى عالي من إنتاج اللبن الكلي ومستوى متوسط من فترة الأيام المفتوحة خلال المواسم المختلفة. لوحظ أيضاً، انه لا يوجد فروق معنوية بين المجموعات PD1 و PD2 و PD3 للصفات قيد الدراسة فيما عدا صفة عدد التلقيحات اللازمة للإخصاب حيث كانت اقل قيمة للمجموعة PD3. بغض النظر عن مستوى الإنتاج العالي ، أظهرت النتائج انخفاض معنوي في الكفاءة التناسلية للأبقار التي وصلت لقمة الإنتاج من اللبن قبل الوصول للتلقيح المخصب. يستخلص من الدراسة أن الوصول لقمة الإنتاج خلال الفترة من ٧٧ يوم وحتى 131 يوم والتي قمة إنتاجها من اللبن من ٤٣.٠٣ كجم وحتى 52.6 كجم تعتبر الحيوانات الأكثر ربحية تحت ظروف الدراسة الحالية. وتوصي الدراسة بأهمية صفات قمة الإنتاج ويوم الوصول لقمة الإنتاج في اتخاذ قرارات الرعاية والانتخاب الخاصة بالحيوانات.