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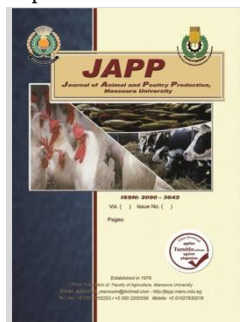
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Interactions of Year, Calving Season, and Parity on Productive and Reproductive Performance in High and Moderate Yield Friesian Herds

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ABSTRACT

This study compared the productive and reproductive performance of Friesian cows across two distinct commercial operations: The first farm (Farm 1) is classified as a large-scale, high-yield dairy operation (8,564 cows, ~9,500 kg total milk yield TMY). The second farm (Farm 2) is classified as a medium-scale, moderate-yield dairy operation (2,531 cows, ~5,500 kg TMY). The objective was to assess the interactive effects of parity, season of calving, and year on both farms. Results showed that summer calving optimizing TMY for 1st parity on both farms, while winter calving optimized TMY for 3rd parity on Farm 2. Moreover, Farm 2 maintained short, stable dry periods (DP ~60–70 d), while Farm 1 showed historical DP failures in older cows. Both farms demonstrated successful, targeted improvements in 3rd parity efficiency by year (Farm 2 days open: 63.95 d), but shared a persistent challenge: poor reproductive performance in 1st parity heifers, especially those calving in spring. The findings underscore that optimal management requires a parity-specific, season-adjusted strategy tailored to the farm's scale, prioritizing biological stability over milk yield in moderate operations.

Keywords: Farm scale, milk yielding scale, productive performance, reproductive performance, Friesian cattle

INTRODUCTION

The Friesian breed is a vital component of global and regional agriculture, dominating commercial dairy operations worldwide due to its superior genetic potential for milk production. In Egypt, Friesian cows are considered the most important and widespread foreign breed, contributing substantially to the national milk supply (El-Awady et al., 2025). Maximizing profitability in these intensive systems hinges on understanding the complex interplay of factors influencing both productive and reproductive performance. Performance is constantly affected by genetic potential, management protocols, annual changes in feed quality and health strategies, and critical non-genetic factors like the cow's parity (age or number of lactations) and the season of calving (Kamal El-den et al., 2020; Lahoul, 2021). Furthermore, the herd size introduces structural differences in management intensity, resource allocation, and environmental control, all of which directly influence performance metrics (Chanda et al., 2022; Güler and Saner, 2024).

The environmental conditions in many regions, especially periods of high ambient temperature, pose a significant threat, as Friesian cattle are highly susceptible to heat stress. This stress is known to severely reduce total milk yield (TMY) and lactation persistency (Stojnov et al., 2024), while also damaging reproductive efficiency by increasing days open (DO) and the calving interval (CI) (Lahoul, 2021). Consequently, a precise understanding of how the season of calving interacts with a cow's parity order is essential for optimizing breeding calendars and feeding regimens to mitigate seasonal declines. Generally, non-genetic factors are clearly crucial to the productive and reproductive performance of Friesian cows (Farrag et al., 2020). These significant external influences include environmental factors, herd management practices, diet, and timing-related factors such as the cow's lactation number, and the specific year and season of calving. Therefore, improving herd productivity

requires a dual focus: enhancing genetic potential and implementing effective management practices (Kamal El-Den et al., 2025).

Therefore, the primary objective of this study is to assess and compare the productive and reproductive performance of Friesian cows across different parities and calving seasons at two distinct dairy operations, characterized by significant differences in herd scale and average productivity.

MATERIALS AND METHODS

This retrospective study utilized performance data collected from two commercial Friesian dairy herds. The first herd located at Dina Dairy farm for Agricultural Investment, El- Behera governorate, west of the Nile Delta, Egypt. The second herd located at El-Shazly Farm, Gharbia governorate, north of Nile Delta, Egypt.

Description of Herds Operations

This retrospective study analyzed performance data from two commercial Friesian dairy herds, Farm 1 (Large-Scale, High-Yield) and Farm 2 (Moderate-Scale, Moderate-Yield), over the years from 2007 to 2013. Farm 1 represented a high-intensity operation (8,564 cows) with an average Total Milk Yield (TMY) of approximately 9,500 kg, characterized by specialized management for maximum output, while Farm 2 represented a more typical commercial system (2,531 cows) with a TMY of about 5,500 kg, focusing on consistent, cost-effective production. Data records were obtained from the herd management software of both farms, with only records from cows completing a full lactation period within the selected years being utilized for analysis.

Animal Management

Management practices in the two herds were almost comparable. Animal husbandry practices were precisely managed across housing, nutrition, and reproduction. The herd was housed free in shaded open yards (3.5- 4 m high

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roofs) and segregated by average daily milk production. The nutritional regimen varied seasonally: from December to April (green season), the diet comprised Egyptian clover (*Trifolium Alexandrinum*), rice straw, and a concentrate feed mixture. During the dry season (May to November), mature cows were transitioned to a ration of cotton seed cakes, barley, wheat, and rice bran, providing a minimum of 17% protein. Rice straw, water, and mineral lick salt bricks were available *ad libitum*, and the concentrates provided were individually balanced based on the animal's production and body weight.

The reproductive strategy involved Artificial Insemination (AI) using imported semen from the USA and Canada. Post-calving cows were first inseminated during the first two estrus cycles occurring after a 60-day postpartum interval. Heifers were held until they reached a minimum of 350 kg live body weight or 18–24 months of age before their initial AI, also during the first two heats. Pregnancy was confirmed via routine rectal palpation at 60 days post-service, and any non-conceiving or returning-to-estrus cows were promptly re-inseminated. Milking occurred three times daily (04:00h, 12:00h, and 19:00h) using milking machines. Calves were separated from their mothers after the colostrum phase and managed through artificial suckling until weaning.

Data Classification and Performance Parameters

The study classified performance parameters based on three fixed effects: Parity (1st, 2nd, and 3rd), Year of Calving (2007, 2010, 2013), and Calving Season (Winter, Spring, Summer, Autumn). The evaluated traits included productive parameters (Total Milk Yield, TMY, Lactation Period, LP, and Dry Period, DP) and reproductive parameters (Days Open, DO, and Calving Interval, CI).

Statistical Analysis

All collected data were subjected to statistical analysis using a General Linear Model (GLM) framework (SAS, 2014). This model was essential for assessing the influence of the main fixed effects (Year, Parity, Season) and their two-way interactions on all dependent performance variables, using the following model:

$$Y_{ijl} = \mu + T_i + S_j + TS_{ij} + e_{ijl}$$

Where, Y_{ijl} = an individual observation, μ = the overall mean, T_i = fixed effect of i^{th} year of calving, $I = (2007, 2010, 2013)$, S_j = fixed effect of j^{th} season of calving, $j = (\text{Winter, Spring, Summer, Autumn})$, TS_{ij} = interaction between year and season of calving, e_{ijl} = residual term assumed to be randomly distributed with zero mean and variance σ^2_e . The statistical significance of these effects was determined at a probability level of $P < 0.05$, ensuring robust

identification of the specific factors driving the differences observed between the two contrasting dairy operations.

RESULTS AND DISCUSION

Results

Productive performance

High yielding farm

Table 1 provided a detailed, multi-year analysis of productive performance, revealing that the year of calving significantly influences total milk yield (TMY) for younger cows and the dry period (DP) for older cows. The year had a highly significant effect on the TMY of 1st and 2nd parity cows ($P < 0.001$), with a general trend of improvement in TMY over the study period. This is best seen in the 1st parity, where the highest yields were recorded in later years, peaking at 12510.4 kg with summer calving in 2010. For 2nd parity cows, the peak TMY was in autumn 2013 (10726.9 kg). Conversely, the TMY for 3rd parity cows was not significantly affected by the year ($P = 0.5415$), with their peak yield occurring earlier in autumn 2007 (9988.3 kg), suggesting that mature cows' yield potential was less sensitive to yearly management or environmental fluctuations.

The lactation period (LP) showed remarkable stability, as the year did not exert a statistically significant overall effect on lactation length (Table 1). Despite this overall consistency, the longest LP varied by parity, with Winter calving in 2007 resulting in the longest LP for both 1st (478.8 d) and 3rd parities (463.7 d), while spring 2010 resulted in the longest LP for 2nd parity cows (449.5 d). This suggests that individual management decisions or seasonal conditions within each year, rather than a broad, yearly trend, were the dominant factors influencing lactation length.

The dry period (DP) displayed the most extreme and concerning variations, especially for older cows (Table 1). The effect of the year was highly significant for 3rd parity cows ($P < 0.0001$). In 2007 and 2010, the DP for 3rd parity cows reached abnormal lengths (up to 295.1 d for Winter 2010), far exceeding optimal dry periods and pointing to severe issues such as chronic reproductive failure, very late rebreeding, or high culling rates in these older groups. For the 1st and 2nd parities, the DP was generally more stable, though not statistically significant for the 1st parity ($P = 1.0000$).

Table 1, Interactions of calving season, parity, and year on productive performance in a large-scale, high yielding Friesian dairy herd.

Item		Total milk yield (TMY, kg)			Lactation period (LP, d)			Dry period (DP, d)		
		1 st parity	2 nd parity	3 rd parity	1 st parity	2 nd parity	3 rd parity	1 st parity	2 nd parity	3 rd parity
2007	Winter	9578.8	7513.7	8776.8	478.8	386.4	463.7	107.9	110.9	174.0
	Spring	6936.9	6248.5	9624.2	423.8	382.3	356.8	109.7	99.5	270.5
	Summer	9228.8	8286.3	9272.0	354.4	398.1	346.7	109.9	112.5	288.7
	Autumn	9154.9	9717.5	9988.3	383.7	379.9	411.6	129.4	114.7	265.7
2010	Winter	8906.5	9809.0	8652.8	408.3	391.0	418.3	85.8	107.5	295.1
	Spring	10381.1	10278.9	9461.3	453.1	449.5	385.1	103.4	118.0	223.4
	Summer	12510.4	8831.5	8701.7	395.2	399.5	405.6	96.3	100.3	156.1
	Autumn	11551.6	9397.9	9061.1	415.2	393.6	371.4	103.5	111.2	170.3
2013	Winter	10262.6	9619.2	9135.7	423.9	347.5	284.8	118.0	121.4	241.6
	Spring	10941.3	10110.6	7655.0	447.7	370.5	-	90.0	109.5	-
	Summer	11697.3	9924.0	7909.0	444.4	350.5	-	102.7	102.6	-
	Autumn	9948.1	10726.9	9441.7	436.1	331.0	-	127.5	104.7	-
SEM		592.3	730.8	767.9	34.66	31.40	33.98	19.45	20.77	36.66
P value		<0.0001	<0.0001	0.542	0.972	1.000	0.811	1.000	0.090	<0.0001

Moderate yielding farm

Table 2 showed that the TMY analysis indicates that the year of calving significantly affected milk yield for younger cows (1st parity $P = 0.0316$; 2nd parity $P = 0.0156$), but

not significantly for 3rd parity cows ($P = 0.1278$). Despite the significant effect of year, the TMY values are notably lower than those in the high yielding farm shown in previous table (Table 1), suggesting a different breed or environment.

Across all years, the highest TMY for 1st parity was recorded with summer calving in 2013 (5824.5 kg). For 2nd parity, the highest yield was achieved with Autumn calving in 2013 (5730.8 kg). The 3rd parity TMY consistently peaked in winter calving across all three years (e.g., 6134.3 kg in 2007 and 6043.2 kg in 2013), suggesting a preference for winter calving conditions in older, highly mature cows.

The LP showed a mixed significance (Table 2), the year did not significantly affect the LP for 1st and 2nd parity cows ($P=0.2861$ and $P=0.3079$, respectively). However, the

year did have a significant effect on the LP of 3rd parity cows ($P=0.0188$). The longest LP for 1st parity cows was in Spring 2010 (393.4 d), while the 3rd parity peaked in Spring 2007 (363.0 d). In contrast, the DP was not statistically affected by the year of calving across any parity. The DP values are relatively short and clustered around 60-70 days for 1st and 2nd parities, which is typical for efficient reproductive management, although the shortest DP was observed with spring calving in 2007 for the 3rd parity (64.33 d).

Table 2. Interactions of calving season, parity, and year on productive performance in a medium-scale, moderate-yielding Friesian dairy herd.

Item		Total milk yield (TMY, kg)			Lactation period (LP, d)			Dry period (DP, d)		
		1 st parity	2 nd parity	3 rd parity	1 st parity	2 nd parity	3 rd parity	1 st parity	2 nd parity	3 rd parity
2007	Winter	5036.2	5766.1	6134.3	313.7	340.5	319.1	65.92	64.83	69.46
	Spring	5611.3	5641.2	5936.3	378.3	277.8	363.0	66.50	77.60	64.33
	Summer	5021.3	5277.9	5788.5	347.9	339.0	320.9	64.43	71.08	70.00
	Autumn	5395.1	6547.5	6384.3	300.9	308.8	321.1	66.30	66.58	66.10
2010	Winter	4201.0	5945.2	6035.4	323.8	295.0	291.9	67.86	67.95	68.76
	Spring	4599.5	5192.0	6247.6	393.4	317.0	310.6	67.76	76.40	67.60
	Summer	4033.7	5559.6	6262.1	349.2	322.4	308.9	68.84	65.50	70.86
	Autumn	4485.4	5523.4	5926.9	340.6	324.7	321.3	66.09	67.33	67.16
2013	Winter	4956.3	5360.2	6043.2	296.3	281.9	273.0	66.73	68.57	69.81
	Spring	5349.4	5457.3	5685.0	342.2	291.3	310.3	73.38	74.57	68.75
	Summer	5824.5	5294.6	5669.6	334.7	324.0	294.5	66.92	70.44	66.54
	Autumn	5751.4	5730.8	5994.6	317.7	320.1	306.4	61.70	71.06	71.00
SEM		241.5	229.3	227.2	17.30	15.04	15.80	2.072	2.265	2.074
P value		0.032	0.016	0.1278	0.2861	0.308	0.019	0.568	0.533	0.000

Reproductive performance

High yielding farm

Table 3, which details the reproductive performance in terms of Calving Interval (CI) and Days Open (DO) across parities and years, showed that the year of calving had no statistically significant overall effect on these traits for most groups, despite clear numerical trends. For the Calving Interval (CI), neither the 1st nor 3rd parity cows showed a significant influence of the year ($P=1.0000$ and $P=0.5421$, respectively). However, 1st parity CI generally worsened over the years, while the 3rd parity showed a strong positive trend, achieving near-ideal intervals in Spring (369.7 d) and

Autumn (357.3 d) of 2013, a marked improvement from the extended intervals seen in 2007.

The results for DO mirrored the CI, with the year not exerting a statistically significant overall effect on any parity (Table 3). Despite the lack of overall statistical significance, the 3rd parity cows demonstrated a striking improvement in reproductive efficiency in 2013, achieving near-ideal DO values with Autumn calving (82.3 d) and Spring calving (94.7 d). In sharp contrast, the 1st parity cows consistently exhibited very poor reproductive efficiency across all years and seasons, with DO values remaining unacceptably long (e.g., 308.5 d in Winter 2007).

Table 3. Interactions of calving season, parity, and year on reproductive performance in a large-scale, high yielding Friesian dairy herd.

		Calving interval (d)			Days open (d)		
Item		1 st parity	2 nd parity	3 rd parity	1 st parity	2 nd parity	3 rd parity
2007	Winter	541.8	485.1	528.7	308.5	215.8	260.2
	Spring	474.9	469.1	492.8	218.5	155.5	254.3
	Summer	456.7	491.7	486.7	156.6	238.6	196.3
	Autumn	477.4	491.9	498.4	205.3	218.5	245.8
2010	Winter	486.8	472.5	487.0	214.5	221.8	226.0
	Spring	531.3	510.6	443.7	263.1	230.5	204.2
	Summer	463.3	474.8	492.8	208.5	219.7	238.6
	Autumn	489.2	476.0	474.3	226.2	209.7	216.4
2013	Winter	507.9	448.5	433.0	224.1	173.9	161.3
	Spring	501.3	469.8	369.7	259.2	199.7	94.7
	Summer	504.9	458.9	377.7	243.5	203.4	102.7
	Autumn	518.7	429.7	357.3	251.4	169.8	82.3
SEM		24.04	33.34	29.37	27.98	33.73	25.60
P value		1.000	0.062	0.542	1.000	0.231	0.432

Moderate-yielding farm

Table 4 presented the reproductive performance of cows, across three parities, as affected by the calving season over three different years. The CI also showed a highly significant overall effect of the year only on the 3rd parity cows ($P=0.0001$), with no significant effect on the 1st ($P=0.5228$) or 2nd parity cows ($P=0.403$). The 3rd parity CI showed the most remarkable reduction over the study period, moving from a long 427.3 d in Spring 2007 down to a near-ideal 342.9 d in winter 2013. This

reduction confirms the improving reproductive efficiency in the oldest group. The 1st parity cows consistently maintained CI values well above the ideal 365 days, with the shortest interval being 363.0 d (Winter 2013) and the longest being 461.1 d (Spring 2010). The 2nd parity cows also showed overall improvement, with the shortest CI achieved with winter calving in 2013 (350.5 d).

Similar to the CI, the DO analysis revealed that the year of calving had a highly significant overall effect only on

the 3rd parity cows ($P=0.0039$), but not on the 1st ($P=0.4877$) or 2nd parity cows ($P=0.2465$) (Table 4). The most striking trend is the dramatic and continuous improvement in reproductive efficiency for older cows (3rd parity) over the years. The DO for 3rd parity cows was 123.69 d in Winter 2007, but decreased to the highly efficient value of 63.95 d in

winter 2013, achieving near-ideal conception timing. For 1st parity cows, the DO remained high across all years, peaking with spring calving (e.g., 181.71 d in 2010), while autumn calving was consistently better (e.g., 88.65 d in 2007). The 2nd parity cows achieved the shortest DO with spring calving in 2007 (77.6 d) and winter calving in 2013 (71.2 d).

Table 4, Interactions of calving season, parity, and year on reproductive performance in a medium-scale, moderate-yielding Friesian dairy herd.

Item		Calving interval (CI, d)			Days open (DO, d)		
		1 st parity	2 nd parity	3 rd parity	1 st parity	2 nd parity	3 rd parity
2007	Winter	379.6	405.3	388.5	101.2	126.8	123.7
	Spring	444.8	355.4	427.3	167.0	77.60	141.3
	Summer	412.4	404.8	385.5	133.3	129.8	111.6
	Autumn	367.2	375.3	387.2	88.65	96.80	108.1
2010	Winter	391.7	363.0	357.3	113.6	83.10	81.90
	Spring	461.1	393.4	378.2	181.7	113.6	99.00
	Summer	418.1	387.9	379.7	140.9	109.3	104.6
	Autumn	406.7	392.1	388.5	128.5	113.4	110.1
2013	Winter	363.0	350.5	342.9	84.96	71.20	63.95
	Spring	415.6	365.9	379.0	135.9	87.90	99.75
	Summer	401.6	394.4	361.1	121.9	116.7	80.92
	Autumn	370.5	391.2	377.0	114.9	111.3	95.63
SEM		17.18	15.49	16.16	17.01	14.55	16.05
P value		0.523	0.403	<0.0001	0.488	0.247	0.004

Discussion

The analysis of productive performance, total milk yield (TMY), lactation period (LP), and dry period (DP), provides crucial insights into the management priorities and success of the large-scale, high-yielding Farm 1 (~9,500 kg TMY) versus the moderate-scale, moderate-yielding Farm 2 (~5,500 kg TMY), largely supporting and contextualizing the observed performance differences within published literature for Friesian cattle under similar conditions.

Productive performance

The fundamental 4,000 kg difference in average TMY between the two farms is immediately striking. When placed in the context of published Egyptian TMY data, Farm 1's average (~9,500 kg) aligns with the highest-performing commercial herds reported (e.g., 8,315 kg to 8,750 kg by Osman et al., 2013; Faid-Allah, 2015; Salem and Hammoud, 2016). Conversely, Farm 2's average (~5,500 kg) falls within the upper-middle range of typical Egyptian Friesian TMY (e.g., 5,387 kg by Sanad and Hassanane, 2017 and 5,778.15 kg by Lahoul, 2021). This comparison confirms that Farm 1's high TMY is achieved due to superior genetic potential and optimal environmental/nutritional management, echoing the literature's consensus that farm category/scale significantly affects milk yield due to differences in management and feeding (Chanda et al., 2022; Güler and Saner, 2024).

The finding that younger cows (1st and 2nd parity) were highly sensitive to yearly changes (TMY: $P<0.05$) on both farms supports the literature (Tadesse et al., 2010; Gamaniel et al., 2019; Lahoul, 2021) that calving year significantly affects TMY, reflecting the impact of changing managerial or nutritional conditions, which primarily benefit animals in their developmental stage. The stability of 3rd parity TMY against annual fluctuation on both farms aligns with the finding that mature cows' potential is more fixed.

The study's seasonal TMY optimization strategies align with and specify the generalized effects of heat stress reported in the literature. Heifer Advantage in Summer, the finding that summer calving was optimal for TMY in 1st parity cows on both farms (Farm 1: 12510.4 kg; Farm 2: 5824.5 kg) is notable. While many studies generally report

lower daily or total milk yield in summer (Mohamed et al., 2017; Abd El-Rheem et al., 2022), the benefit observed here is likely linked to the subsequent peak lactation period avoiding the intense heat of late summer and falling instead into milder conditions, allowing heifers to maximize their initial yield. This is a critical seasonal management distinction for young cows. Mature cow stress mitigation, the preference for winter calving in 3rd parity cows on the moderate-yield Farm 2 (6134.3 kg) strongly suggests a strategy to mitigate the negative effects of heat stress on older, potentially less resilient cows, where milk yield is known to decrease by 10% to 30% under heat stress conditions (Sacido et al., 2001; Segnalini et al., 2011). Conversely, the shift to autumn calving for 2nd parity TMY peak on Farm 1 suggests that the high-yield operation's superior cooling and feeding management allows them to strategically use autumn/winter for maximal production. The literature widely confirms the significant effect of calving season on TMY (Kamal El-den et al., 2020; Lahoul, 2021), driven by ambient temperature and feed availability (Amasaib et al., 2011).

The LP across both farms showed notable stability, with the year effect being non-significant. This contrasts with several reports finding a significant effect of calving year on LP length (Gamaniel et al., 2019) but aligns with other studies showing a non-significant effect of calving season on LP (Kaleri et al., 2017). Current LP values (e.g., Farm 1 1st parity 478.8 d) exceed many Egyptian averages reported in the literature (e.g., 308.5 d to 358.25 d, Kamal El-den et al., 2020; Lahoul, 2021), indicating a focus on maintaining long persistency.

The DP, however, revealed a critical management divergence. The DP values of Farm were consistently short (clustered around 60–70 d), aligning with optimal industry standards and well within reported Egyptian averages (e.g., 63.0 d by Salem et al., 2006 and 68.39 d by Lahoul, 2021). This indicates consistent, high-quality management of the dry-off and re-breeding process. The abnormally long DP for 3rd parity cows on Farm 1 in 2007 and 2010 (up to 295.1 d) represents a severe management failure. While the literature confirms that the year of calving can significantly affect DP (Cilek and Tekin, 2005; Lahoul, 2021), these extreme values far exceed normal biological ranges and signal a major

breakdown in reproductive efficiency for those years, confirming the concept that high-volume operations may sometimes sacrifice reproductive consistency in the pursuit of maximum yield, as also noted by Shalaby et al. (2013).

Reproductive performance

The analysis of Days Open (DO) and Calving Interval (CI) in our study, comparing the large-scale, high-yield Farm 1 with the moderate-scale, moderate-yield Farm 2, reveals performance trends that are partially supported by existing literature, particularly concerning the effects of parity, management intensity, and season of calving.

Current findings confirm the well-established principle that parity significantly affects reproductive performance. The literature, citing authors like Faïd-Allah (2015), Rushdi (2015), and Lahoul (2021), indicates that both DO and CI tend to increase with advancing parity order. While our study's detailed tables are required to confirm if the 2nd parity followed this exact trend numerically, the observation that 3rd parity cows (older cows) demonstrated the most dramatic improvement in efficiency by year 2013 on both farms supports the concept that mature cows are highly responsive to targeted management strategies due to their established physiological state.

A key finding was the statistically significant improvement in the reproductive efficiency of 3rd parity cows on Farm 2 ($P \leq 0.0039$ for DO and CI) and the strong numerical improvement on Farm 1 by year 2013, achieving near-ideal CI (342.9 d on Farm 2) and DO (63.95 d on Farm 2). These year 2013 figures represent performance at the elite end of the spectrum, especially for Farm 2. The general reported mean CI for Friesian cows in Egypt is often much higher, ranging from 377.4 d (Lahoul, 2021) to over 450 d (Farag et al., 2017). Similarly, DO in commercial Egyptian herds is commonly reported between 99.56 d (Lahoul, 2021) and 159 d (Zahed et al., 2020), with some governmental herds exceeding 190 d. The 63.95 d DO achieved by Farm 2 in winter 2013 is substantially better than most published Egyptian averages, confirming that the management intervention for their mature herd segment was exceptionally successful.

Present finding that 1st parity cows consistently exhibited poor reproductive efficiency (long CI/DO) on both farms, regardless of scale, highlights a universal challenge in Friesian herd management. The literature strongly correlates DO variation with the accuracy of heat observation and herd management (Gabr, 2005; Tadesse et al., 2010). The persistently poor performance of heifers suggests that the energy demands of establishing the first high lactation, combined with insufficient focus on heat detection or inadequate post-calving recovery protocols, are not being sufficiently managed. This challenge is present even on farms like Farm 1, which has otherwise achieved high TMY, suggesting that the drive for high initial yield may compromise reproductive timing in the younger animals.

Current study found that the optimal season for achieving peak reproductive efficiency differed by farm scale, supporting the literature's assertion that season significantly affects DO and CI, but with varying trends reported across studies (Sanad, 2016; Lahoul, 2021). Generally, the literature widely attributes poor reproductive performance in summer to heat stress, which negatively affects DO and NSC (Lahoul, 2021; Abd El-Rheem et al., 2022). Our finding that the poor reproductive efficiency in 1st parity cows was often worst with spring calving (leading to peak re-breeding efforts in the summer heat) is consistent with this known effect. Conversely, the literature suggests that DO is often shortest in winter and autumn (Lahoul, 2021). However, Farm 2 achieved its best 3rd parity efficiency with Winter calving

(DO 63.95 d). This aligns with reports showing improved DO in winter (Abd El-Rheem et al., 2022) and suggests that Farm 2 successfully leveraged the cooler, controlled winter environment for maximal mature cow fertility. Farm 1, however, achieved its best 3rd parity results with autumn and spring calving, suggesting that the superior cooling facilities or management on the high-yield operation allows them to find optimal windows outside of deep winter.

Current results reflect the high variability in reproductive traits observed across different Egyptian herds, driven by management, environmental factors, and genetics (Sanad and Hassanane, 2017; Kamal El-den et al., 2020). The study provides compelling evidence of the success of modern, targeted management in mature cows (3rd parity) on both scales, while simultaneously highlighting the universal and unresolved challenge of improving reproductive metrics in 1st parity heifers, demanding focused research and protocol adjustments for this vulnerable group.

CONCLUSION

This comparative, multi-year study of two distinct Friesian dairy operations, a large-scale, high-yielding farm (Farm 1) and a moderate-scale, moderate-yielding farm (Farm 2), concludes that optimal performance and management consistency are highly dependent on the interaction of farm scale, parity, and season of calving. While Farm 1's superior total milk yield affirms the benefits of high genetic potential and intensive investment, the data reveals significant trade-offs in management stability. The dry period analysis clearly exposed historical management crises on Farm 1 (abnormally long DP in 3rd parity), a vulnerability absent on the moderate-scale Farm 2, which demonstrated superior consistency in this key biological metric.

Both farms successfully implemented strategic interventions that led to dramatic reproductive efficiency improvements in their mature (3rd parity) cows, achieving near-ideal days open and calving interval values, though through different seasonal windows (winter calving for Farm 2; autumn/spring for Farm 1). Critically, both operations shared a universal and persistent reproductive failure in 1st parity heifers, characterized by unacceptably long CI and DO values, particularly when calving in Spring. This highlights an across-the-board weakness in managing the high energy demands and re-breeding protocols for young cows, irrespective of farm scale. Ultimately, the study confirms that success is not merely measured by TMY volume, but by the resilience and stability of fundamental biological processes across all segments of the herd.

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تأثير التداخل بين السنة وموسم الولادة وموسم الحليب على الأداء الإنتاجي والتناسلي في قطعان الأبقار الفريزيان عالية ومتوسطة الإنتاج

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الملخص

أجريت هذه الدراسة لمقارنة الأداء الإنتاجي والتناسلي للأبقار الفريزيان لمزرتين تجاريتين: المزرة الأولى (المزرة ١) تُصنف على أنها مزرعة إنتاج ألبان عالية الكثافة العددية والإنتاج (عدد ٨٥٦٤ بقرة، بمتوسط إنتاج لبن كلي حوالي ٩٥٠٠ كجم في الموسم). بينما صنفت المزرة الثانية (المزرة ٢) على أنها مزرعة إنتاج ألبان متوسطة الحجم والإنتاج (عدد ٢٥٣١ بقرة، بمتوسط إنتاج لبن كلي حوالي ٥٥٠٠ كجم في الموسم). كان الهدف من الدراسة هو تقييم الأداء ودراسة تأثير التداخل بين كل من موسم الولادة والسنة في كلتا المزرتين خلال الثلاث مواسم الحليب الأولى من الإنتاج. أظهرت النتائج أن الولادات الصيفية أدت إلى تحقيق الأداء الأمثل لإنتاج اللبن الكلي في أبقار موسم الحليب الأول في كلتا المزرتين، في حين حققت الولادات الشتوية الأداء الأمثل لإنتاج اللبن الكلي في أبقار الموسم الثالث في المزرة ٢. علاوة على ذلك، حافظت المزرة ٢ على فترات جفاف قصيرة ومستقرة (٦٠-٧٠ يوم)، بينما أظهرت المزرة ١ زيادة ملحوظة في فترة الجفاف، خاصة في أبقار مواسم الحليب الثانية والثالثة. كما أظهرت كلتا المزرتين تحسناً ملحوظاً في متوسط الأيام المفتوحة مع المواسم المتقدمة، خاصة في المزرة ٢ لأبقار الموسم الثالث (٦٣،٩٥ يوم). لكن كلا المزرتين واجهتا تحدياً مشتركاً تمثل في ضعف الأداء التناسلي لمجالات الموسم الأول، خاصة تلك التي تلد في الربيع. تؤكد النتائج أن تحقيق الكفاءة الإنتاجية والتناسلية المثلى للأبقار يتطلب استراتيجيات رعاية خاصة لكل موسم حليب، وتكون مناسبة لاختلافات موسم الولادة، وملائمة لحجم الإنتاج بالمزرة، مع ضرورة إعطاء الأولوية للحفاظ على الإنتاج المعتدل من الحليب من أجل الحفاظ على الكفاءة التناسلية للأبقار.