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Effect of Calving Season and Parity on Productivity, Post-partum Reproductive Parameters and Disorders, and Economic Indices in Holstein Cows Kept Under Subtropical Conditions in Egypt

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Abstract

This research aimed to study the effect of calving season and parity on productivity, post-partum reproductive performance, disorders, and economic impact in Holstein cows kept under subtropical Egyptian conditions. Lactation and health records of high-yielding cows (500 records) in a commercial dairy herd covering the period between 2020 and 2021 were obtained. The studied productive parameters were average daily milk yield (DMY), dry matter intake (DMI), and feed conversion efficiency (FCE) and the reproductive measures were the number of heats, number of services per conception (NSC), days to first heat (DFH), days to first service (DFS), and days open (DO). Summer calvings were associated significantly ($P<0.05$) with a decline in DMY and DMI (31.8 kg and 22.7 kg, respectively) compared to winter calvings. Cows that calved in summer had significantly higher ($P<0.05$) NSC and longer DO (3.44, and 199.3 d, respectively) and also had a higher incidence of endometritis than winter calvings. First parity cows had significantly ($P<0.05$) lower (DMY and DMI) and higher (NSC and DO) than those in higher parities. Parity has no significant effect on the incidence of post-partum ovarian disorders. The economic losses from disease treatments recorded the highest value in summer calving (13280 LE/100 head) and primiparous cows (8218.01 LE/100 head). Revenue and profit/cost ratio were higher in winter calvings and pluriparous cows. In conclusion, good management, suitable nutrition during different parity and seasons also intensive cooling systems during the summer season should be applied for improving the productivity, fertility, and the economic impact on Holstein farms.

KEYWORDS
Calving season, Parity, Productivity, Reproductive parameters, Economic losses.

INTRODUCTION

Holstein cows are the main dairy animals in Egypt that mainly provide milk (Ghoneim *et al.*, 2018). In the last two decades, the number of Holstein herds had enlarged in the governmental or profitable farms through Europe and USA importation (Oltenacu and Broom, 2010). It is important to comprehend the physical and environmental aspects affecting the performance of the exotic Holstein dairy cows to advance their productivity. Mostly, a cow's genetic makeup determines physical factors. However, compared to physical aspects, environmental factors are more intricate and potent in cow production and reproduction (Kadzere *et al.*, 2002). The parity of calving (Cabezas-Garcia *et al.*, 2021), age at first calving (Do *et al.*, 2013), and calving season (Tao *et al.*, 2020) are just a few examples of environmental factors. Dairy cow fertility is declining globally as cows with higher milk output have the highest rates of post-partum infertility (Evans and Zeng, 2017). Reproductive parameters in dairy farms have a major role in the cost-effectiveness of a dairy project (El-Tarabany and El-Bayoumi, 2015) like days open (DO) which are days from calving to the conception or from calving to culling for those cows failing to conceive. The DO should be within the average of 80-85 days for giving a calf every year (Mohammed, 2017). Additionally, an increase in the number of services per conception (NSC), which has a detrimental effect on farm productivity and typically leads to culling from the farm (Hossein-Zadeh, 2013), is a sign that there may be issues with the cow reproductive system. The principal reproductive problem of high milk-producing cows is the number of days between calving and the first service (DFS) (López-Gatius, 2003). To have a calf every year, timely ovarian rebound and uterine involution are important. Fertility parameters are affected by ovarian and uterine disorders. Postpartum disorders lower the rate of pregnancy, which ultimately results in

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culling from the farm. High milking cows frequently experience post-partum ovarian affections such as anestrous after calving, which prolongs the calving interval (López-Gatius *et al*., 2001). This problem is attributed to either silent heat or failure of the cows to restart cycling after calving (smooth inactive ovary). A smooth inactive ovary (SIO) is associated with no estrus and no corpora lutea (Senosy and Osawa, 2013). Cows can persist acyclic due to cystic ovarian diseases (COD) (Madhuri *et al*., 2017). These ovarian disturbances may be due to the secretion of prolactin which inhibits the pituitary gland from secretion of gonadotropins, leading to delay in ovulation or disturbance in ovulation (Gossen and Hoedemaker, 2006). Fertility is mainly affected by uterine disorders such as endometritis; about 20% of cows are affected by endometritis within 21 days post-partum (El-Rheem *et al*., 2019). These variables determine whether the calving interval is shorter or longer (El-Tarabany and Nasr, 2015). Subsequently, these factors affect the cost of rearing the animals (Nor *et al*., 2015). The veterinary treatment and drugs expense, replacement costs also more or less calves being born (Oudah *et al*., 2001). Therefore, crucial information is periodically required to optimize the productive and reproductive performance of the Holstein breed in Egypt. These evaluations may improve the formulation of preventative actions to avoid financial losses. It is crucial to study factors that influence the production and reproductive performance of Holstein cows because of the dairy industry's central position in the national economy. The goal of the current study was to assess the effects of calving season and parity on the productive performance, post-partum reproductive parameters, and disorders in highly producing Holstein cows and their economic impact under subtropical Egyptian conditions

MATERIALS AND METHODS

Ethical approval

This study was approved by Alexandria university's Institutional Animal Care and Use Committee (permit # 2022/ 014/121).

Animals and farm management

Cows used in this study belonged to a commercial dairy herd (Delta Misr group) located in El-Khatatba 30°21′00″N 30°49′00″E, El Menoufia Governorate, Cairo-Alexandria desert road in the North of Egypt under subtropical conditions with humid summers and mild winters. Cows were held in free-stall shads with a concrete floor throughout the entire year. They were given a total mixed ration (TMR) twice daily. They were fed 2 different rations according to the stage of lactation, with an immediate postpartum diet (fresh ration) fed between 1 and 21 days in milk (DIM) (diet 1) and a lactating diet for the remainder of lactation (diet 2). The two rations were designed to meet National Research Council (NRC, 2001) requirements. Ingredients and Chemical Composition of the total mixed ration (on a dry matter basis) used for lactating Holstein cows are shown in Table 1. All animals had free access to water. Early rectal examination was done four weeks post-partum for clinical examination of the uterus: (normal or affected by endometritis). The ovarian examination was done twice on day 40 and day 50 post-partum for detection of COD by using B mode ultrasound 9 MHz linear array (Sonoscape-A5V, Shenzhen, China). The cows who were not observed in estrus 40 days post-partum were examined twice at 11 days apart and those

Table 1. Ingredients and chemical Composition (on dry matter basis) of the total mixed ration used for lactating Holstein cows.

Feedstuff	Diet 1 (1- 21 days postpartum) (fresh ration)	Diet 2 (21 days to remainder of lactation)
Corn silage	25	25.5
Berseem hay	9.5	10.2
Wheat straw	5.2	8.6
Yellow corn	26.2	26.6
Corn gluten feed	3.5	3.1
Dried distillers grains (DDG)	3.5	3.1
Soybean meal (SBM)	19.8	16.3
Cotton seed meal (CSM)	3.7	3.1
Protected fat	0.9	0.8
Limestone	0.8	0.8
Di-calcium-phosphate	0.2	0.2
Sodium bicarbonate	0.5	0.5
Sodium bentonite	0.5	0.5
Nacl	0.6	0.6
Vitamins and trace minerals premix*	0.1	0.1
Total	100	100
Calculated analysis**:		
TDN %	75	73.2
Crude protein %	18	16.2
Calcium %	0.7	0.7
Phosphorus %	0.4	0.4
Acid detergent fiber (ADF) %	17.5	19.1
Neutral detergent fiber (NDF) %	29.9	32.6
Non-fiber carbohydrate (NFC) %	37.2	36.5

*Containing (g/kg of mix dry matter (DM)): Zn, 24; Fe, 24; Cu, 12.8; Mn, 24; I, 1.44; Co, 0.32; Se, 0.32; 16M IU of vitamin A; 3.2M IU of vitamin D3; and 48 K IU of vitamin E. **Calculated according to the feed composition tables given in NRC (2001) showing no follicles or corpus luteum were considered SIO. Estrus detection was practiced by SCR sense Flex Neck Tag (Indira *et al*., 2020). Cows were inseminated almost 50 to 60 days postpartum. They were artificially inseminated by a veterinarian using frozen semen 12 h. from the start of the heat. Pregnancy diagnosis was done by ultrasound using a rectal probe around 27-30 days post service. Non-pregnant cows were re-inseminated according to an ovarian structure using Ovsynch synchronization (injection of gonadotropin-releasing hormone (GnRH), and prostaglandin F2α (PGF2α) 7 days later then GnRH after 48 h with timed insemination) (Hall *et al*., 2009) or by PGf2α injection then blind insemination 72 h. after injection (Abdel-Khalek *et al*., 2012).

Data and variables

The Lactation and health records for the period of September 2020 to August 2021 were obtained from the herd management software (Dairy Comp305, Valley Ag Software, Tulare, CA). Cows were divided into two groups based on how much milk they produced (high, herd average + 0.5 standard deviation (SD) and low, herd average - 0.5 SD). Only the highly producing cows (500 records) were included in the analysis and those of low milk yield were excluded. The productive parameters considered were average daily milk yield (DMY), dry matter intake (DMI), and feed conversion efficiency (FCE). Cows were milked by the DeLaval milking parlor three times/day each eight-hour intervals. The recorded daily milk yield throughout the experimental period was used to detect the average daily milk production. The amount of Total mixed ration (TMR) offered daily was adjusted to allow for 10% refusals from the previous day, amounts offered and refused were recorded each day. The daily DMI was calculated by subtracting the refused from the offered feed. FCE was calculated as milk production (kg/day) divided by DMI (kg/day) (Berry and Crowley, 2013). The studied reproductive parameters were a number of detected heats, NSC, days to first heat (DFH), DFS, and DO. The recorded data included cows positive for reproductive disorders with one or more of the following cases: endometritis, SIO, and COD. Cases with difficult calving, retained placental, abortions, and septic metritis were excluded from the study. Endometritis included any case of endometritis with abnormal secretion or pyometra. Cows affected with luteal and follicular cysts were selected and grouped in this study as COD. The independent variables affecting productive performance, and reproductive parameters and disorders were the same. The selected cows were 2-5 years of age, and the body condition score was on average 3-3.5 (scale of 1= thin to 5 = fat) (Garnsworthy and Topps, 1982).

Economic indices

A partial budget was developed for evaluating costs and revenues analysis among different calving seasons and parities by using specific inputs from each Holstein cow. Cost analysis included treatment costs (veterinary costs, drugs) and DMI costs, the remaining inputs were kept constant. Revenue analysis included milk revenue (DMY) that was calculated by multiplying DMY/cow by the average milk price. For evaluation of the economic impact of calving season and parity on DMY and DMI, the following formula was used: Daily revenue = DMY × Average milk price, Daily costs = DMI × Average ration price, Daily profit = DMY revenue- DMI costs, Profit /cost ratio = Daily profit/DMI costs. Where: DMY (Kg/cow), Average milk price (LE/Kg), DMI (Kg/cow/day), and Average ration price (LE/Kg). While the economic losses from disease incidence were calculated by the following formula: Diseases losses / 100 head= treatment costs (cow/ LE) X disease incidence %. Furthermore, total disease losses due to season and parity were calculated by the following Formula: Total losses / 100 heads = losses from endometritis + losses from SIO + losses from COD.

Statistical analyses of data

For estimating the effect of different calving seasons (CS) and different parity on the productive traits of Holstein dairy cows, statistical analysis was performed by SPSS/PC+ "version 25" based on the following linearity model: $Y_{ijk} = \mu + S_j + P_k + e_{ijk}$

Where: Yijk = dependent variables (DMY, DMI, FCE) μ = overall mean, S_j = effect of calving season (j = winter (September to February); summer (March to August), P_k = effect of Parity (k= first parity; second parity), e_{ijk} = the random error.

Furthermore, results were evaluated by SPSS/PC+ "version 25" for estimating calving season and parity effect on the reproductive performance of Holstein dairy cows based on the following linearity equation: $Y_{ijk} = \mu + S_j + P_k + e_{ijk}$

Where: Y_{ijk} = dependent variables (number of heat, NSC, DFH, DFS, DO) μ = overall mean, Sj = calving season effect (j = winter (September to February); summer (March to August), P_k = Parity effect (k= primiparous, multiparous), and e_{ijk} = the random error. Moreover, Data were analyzed for estimation of the incidence of reproductive diseases by SPSS/PC+ "version 25" (chi-square test). Differences among variable means were tested significantly using Duncan's multiple range procedure (SPSS, Version 25) at 5% probability levels.

RESULTS

Effect of calving season on the post-partum productive and reproductive parameters and disorders

Effect of calving season on the production and post-partum reproductive parameters of Holstein cows are presented in Table 2. Cows that calved in summer significantly (P < 0.05) had the lowest DMY (31.8 kg (, DMI (22.7 kg), and FCE (1.39) compared to winter calvings. Summer calvings significantly deteriorated DMY, DMI, and FCE by about 25.5%, 17.8%, and 10.3% respectively, compared to winter calvings. Cows that calved in summer were

Table 2. Effect of calving season on production parameters and post-partum reproductive performance of Holstein cows.

Calving Season	N	Productive performance			Reproductive parameters				
		DMY (kg\day)	DMI (kg\day)	FCE	heats No.	NSC	DFH	DFS	DO
Winter	322	42.8±0.28 [a]	27.6±0.36 [a]	1.55±0.04 [a]	3.53±0.17 [b]	2.76±0.11 [b]	64.5±0.99 [a]	77.7±2.69 [b]	159.9±7.07 [b]
Summer	145	31.8±0.33 [b]	22.7±0.96 [b]	1.39±0.01 [b]	4.73±0.27 [a]	3.44±0.18 [a]	66.5±2.70 [a]	94.5±5.46 [a]	199.3±9.50 [a]

*Means within the same column bearing different superscripts are significantly different at (p<0.05).
DMY: Average daily yield; FCE: Feed conversion efficiency; DMI: Dry matter intake; NSC: Number of services per conception, DFS: Days to first service, DFH: Days to first heat, DO: days open.

significantly superior (P < 0.05) in the number of detected heats till conception, NSC, DFS, and DO (4.73, 3.44, 94.5, and 199.3 respectively) compared to winter calvings. On the other hand, there was no significant difference in DFH between cows that calved in winter (64.4) and summer calvings (66.4). The economic impact of calving season on DMY, DMI, daily profit, and profit cost ratio was calculated in Table 3. Return from DMY was higher in winter calving cows (363.5 L.E./cow) compared to summer calving cows (278.6 L.E/cow). DMI costs were higher in winter calving cows (138.1 L.E./cow/day) than in summer calving (124.9 L.E./cow/day). Daily profit recorded the highest value in winter calving cows (225.4 L.E./cow). Also, the profit cost ratio was higher in winter calvings.

Table 4 demonstrates the impact of calving season on post-partum reproductive problems. The summer calvings had a significantly (P < 0.05) higher incidence of endometritis, SIO, and COD (19.4, 22.9, and 18.8%, respectively) than winter calvings (12.8, 3.12, and 11.8%, respectively). The economic losses from diseases under investigation were calculated in Table 5. Summer calving cows recorded higher losses from disease treatments (13280.23 LE/100 head) than winter calving cows (5668.7 LE/100 head).

Effect of parity on the post-partum productive and reproductive parameters and disorders

The impact of parity on the productive and reproductive performance of Holstein cows is shown in Table 6. The first parity cows significantly had the lowest (P < 0.05) DMY (32.9 kg), DMI (23.3 kg), and FCE (1.42) compared to the pluriparous cows. Multiparous cows significantly improved DMY, DMI, and FCE by about 21.2%, 10.5%, and 9.1% respectively, compared to winter calvings. The primiparous cows had a significantly higher (P<0.05) number of detected heats, NSC, and DO (4.78, 3.10, and 190.3, respectively) than those in higher parities. Meanwhile, the multiparous cows had longer DFH (68.5) compared to first parity cows (59.5). On the other hand, there was no significant difference in DFS between the primiparous and multiparous cows. The economic impact of parity on DMY, DMI, daily profit, and profit cost ratio was recorded in Table 7. Pluriparous cows reported a higher return from DMY (342.4 L.E./cow) than primiparous (282.5 L.E./cow). DMI costs were higher in pluriparous cows (134.8 L.E./cow/day) than in primiparous (122.0 L.E./cow/day). Daily profit recorded the highest value in pluriparous cows (207.5 L.E./cow). Furthermore, the Profit /cost ratio was superior in pluriparous cows (1.54).

Table 3. Economic impact of calving season on DMY, DMI, and daily profit/cow.

Item		DMY			DMI			Daily profit / LE /cow	Profit/ Cost ratio
		Amount /kg/ day	Price /kg/L.E	Return /LE/day	Amount (kg\ day)	Price /kg/L.E	Cost /LE/day/ cow		
Calving season	Winter	42.8	8.5	363.5	27.6	5	138.1	225.4	1.63
	Summer	31.8	8.75	278.6	22.7	5.5	124.9	153.8	1.23

DMY: Average daily yield; DMI: Dry matter intake

Table 4. Effect of calving season on the incidence of some post-partum reproductive disorders (endometritis, SIO, and COD) in Holstein cow.

Calving season	Diseases						Total animals no.
	Endometritis		SIO		COD		
	No.	%	No.	%	No.	%	
Winter	41	12.8[b]	10	3.12[b]	38	11.8[b]	321
Summer	28	19.4[a]	33	22.9[a]	27	18.8[a]	144
Total	69	14.8	43	9.25	65	13.9	465

X2= (2.31); * Significant at (p<0.05). SIO: Smooth inactive ovary; COD: Cystic ovarian disease.

Table 5. Effect of calving season on the economic losses of post-partum disorders in Holistein dairy cows.

Item		Endometrities		SIO		COD		Total losses (LE/100head)
		Treatment costs (LE/head)	%	Treatment costs (LE/head)	%	Treatment costs LE/head)	%	
Calving season	Winter	283	12.77[b]	207	3.12[b]	119	11.84[b]	5668.71 [b]
	Summer	305	19.4[a]	219	22.92[a]	125	18.75[a]	13280.23 [a]

SIO: Smooth inactive ovary ; COD: Cystic ovarian disease

Table 6. Effect of parity on production parameters (DMY, DMI, and FCE) and post-partum reproductive performance (heat NO., NSC, DFH, DFS, and DO) of Holstein cows (Mean±SE).

Parity	No.	Productive performance			Reproductive parameters				
		DMY (kg\day)	DMI (kg\day)	FCE	heats No.	NSC	DFH	DFS	DO
Primiparous	177	32.9±0.27 [b]	23.2±0.25 [b]	1.42 ±0.09 [b]	4.78±0.30 [a]	3.10±0.18 [a]	59.5±1.30 [b]	86.9±4.42 [a]	190.4±10.02 [a]
Multiparous	290	39.8± 0.36 [a]	25.7±0.23 [a]	1.55 ±0.05 [a]	3.36±0.13 [b]	2.88±0.11 [b]	68.5±1.49 [a]	80.4±3.05 [a]	160.5±6.90 [b]

Means within the same column bearing different superscripts are significantly different at (p<0.05).
DMY: Average daily yield; FCE: Feed conversion efficiency; DMI: Dry matter intake; NSC: Number of services per conception, DFS: Days to first service, DFH: Days to first heat, DO: days open.

The effect of parity on post-partum reproductive disorders is presented in Table 8. The pluriparous cows had a significantly lower incidence of endometritis (14.2%) compared to the first parity cow (15.8%). However, the incidence of SIO and COD wasn't significant between the primiparous (9.03 % and 14.1 %, respectively) and multiparous cows (9.4 % and 13.9 %, respectively). Economic losses from diseases presented in Table (9) show that the primiparous cows recorded the highest value (8218.01 LE / 100 head).

DISCUSSION

Climatic changes during different seasons of the year as well as nutritional management during the post-partum period might severely affect productivity and the economic impact in Holstein herds. The obtained data indicated that the DMI of summer calvings was lower than winter calvings which reflected in lower milk production in summer and, significantly harmed FCE in summer, these results agreed with Tao *et al*., (2020), and could be explained by the effect of heat stress on cows in the form of high environmental temperature; therefore, to minimize the metabolic heat production the animals' feed intake was decreased. The lower feed intake resulted in decreased mammary blood flow, indicating a limit to udder development, metabolism, milk synthesis, and decreased milk output (Rodrigues *et al*., 2019). The lower DMI is reflected in lower protein, energy, vitamins, and minerals intake and negative effects on production and reproduction. The economic analysis revealed a significant increase (P< 0.05) in DMI costs for winter calvings, which was attributed to increase average feed intake in winter season. Despite higher feed intake costs in the winter, there was a superior increase in daily profit and profit cost ratio compared to the summer calvings, though these differences may be explained by seasonal variations in milk prices and volume of milk sold. Similar results were recorded by Mohammed (2017). Hassan *et al*. (2017) found that winter calvings were superior in feed costs, net profit, and profit cost ratio to summer calvings. These fluctuations in net profit may have been caused by changes in feed material availability or cost, milk pricing, or sales volumes. It is possible that seasonal factors contributed to the fact that cows calved in winter produced more milk than those that calved in summer (Ramadan and El-Tahawy, 2014).

In this study, the average number of heats and NSC were significantly (P<0.05) higher in summer calvings than in winter calvings. This result agreed with Khodaei-Motlagh *et al*. (2011). However, Kassab and Salem (1993) found no significant difference in NSC between different seasons. The obtained result revealed that average interval of DFH in summer was longer than in winter calvings but not statistically significant. In the same line, Kornmatitsuk *et al*. (2008) reported that ovulation and ovarian resumption of lactating Holstein cows calved during the cold season were higher than cows calved during the warm season. However, Sattar *et al*. (2005) reported that the DFH of Holstein cow in the winter season was longer (136.4 days) than in summer (96.0 days) in Pakistan. On the other hand, Kassab and Salem (1993) demonstrated that the calving season had an insignificant impact on the first heat. The average interval of DFS of summer calvings was significantly (P<0.05) longer than in winter calvings. This result was consistent with the findings of Hammoud *et al*. (2010) who found that DFS was significantly longer in the spring season (91.7) than in winter (84.3). While Kassab and Salem (1993) reported that calving season had no significant effect on DFS. In the current investigation, the average DO in cows calved in the winter season was significantly (P<0.05) shorter than in summer calvings. This result was in linearity to Ozcelik and Arpacik (1996). However, Sattar *et al*. (2005) reported that the average DO was significantly higher in winter than in humid hot summer. While El-Barbary *et al*. (1992) reported that the calving season had no significant influence on DO. The incidence of endometritis was significantly (P<0.05) higher in summer calvings than in winter calvings. This finding agreed with DuBois and Williams (1980). However, Ghanem *et al*. (2002) found that the incidence of endometritis was greater in the cows calved in autumn, winter, and spring than in summer calving. Result from this study may be due

Table 7. Economic impact of parity on DMY, DMI and daily profit/cow.

Item		DMY			DMI			Daily profit / LE /cow	Profit/Cost ratio
		Amount /kg/ day	Price /kg/LE	Return/LE/day	Amount (kg\ day)	Price /kg/L.E	Cost /LE/day/ cow		
Parity	Primiparous	32.9 [b]	8.6	282.5 [b]	23.2	5.25	122.0 [b]	160.5 [b]	1.32 [b]
	Pluriparous	39.8 [a]	8.6	342.4 [a]	25.7	5.25	134.8 [a]	207.6 [a]	1.54 [a]

DMY: Average daily yield; DMI: Dry matter intake

Table 8. Effect of parity on the incidence of some post-partum reproductive disorders in Holstein cows

Parity	Diseases						Total animals No.
	Endometritis		SIO		COD		
	No.	%	No.	%	No.	%	
Primiparous	28	15.8[a]	16	9.03[a]	25	14.1[a]	177
pluriparous	41	14.2[b]	27	9.38[a]	40	13.9[a]	288
Total	69	14.8	43	9.25	65	13.9	465

X2= (8.03); * Significant at (p<0.05); SIO: Smooth inactive ovary; COD: Cystic ovarian disease

Table 9. Effect of parity on the economic losses of post-partum disorders in Holistein dairy cows.

Item		Endometrities		SIO		COD		Total losses (LE/100head)
		Treat. costs (LE/ head)	%	Treat. costs (LE/ head)	%	Treat. costs (LE/ head)	%	
Parity	Primiparous	289	15.82[a]	213	9.03[a]	122	14.12[a]	8218.01 [a]
	Pluriparous	289	14.23[b]	213	9.38[a]	122	13.88[a]	7803.77 [b]

SIO: Smooth inactive ovary; COD: Cystic ovarian disease to heat stress that impairs immunity functions in lactating cows (Dahl *et al*., 2020). Heat stress has an impact on the intrauterine environment because it causes a decrease in uterine blood flow and a rise in uterine temperature (Ealy *et al*., 1993). Summer-calving cows had a significantly (P<0.05) greater incidence of SIO than winter-calving cows. Similar findings were reported in dairy cattle (Abdoon *et al*., 2020). While Roth *et al*. (2000) reported that fertility didn't affect by seasonal variation. In the present study, summer calvings had a higher significant effect on the incidence of COD. A similar result was reported by López-Gatius *et al*. (2002). While Cattáneo *et al*. (2014) concluded that more cases of COD appeared during winter. However, Ashmawy *et al*. (1992) reported an insignificant effect of season on the incidence of COD in Guernsey and Holstein cows. Losses from reproductive diseases significantly increased (P< 0.05) in summer calving cows, which was attributed to increased incidence of post-partum reproductive diseases in summer calvings and differences in treatment costs. This was in line with Shehab-El-Deen *et al*. (2007).

Subsequently, from the current investigation, it has been found that the number of heats, SC, DFS, DO, the incidence of endometritis, SIO, COD, and economic losses from reproductive diseases were significantly higher in summer calvings than in cows calved in the winter season. This may be due to the effect of climatic variations, the differences in the photoperiod between different seasons, and feeding regimes (Morrell, 2020). The reproductive performance may potentially be significantly impacted by the rise in global temperature (Walsh *et al*., 2019). Because lactating dairy cows have high metabolic rates, their reproduction is extremely vulnerable to heat stress (Hansen, 2020)., In Egypt, the highest environmental temperature in the summer season compared with other seasons of the year. Heat stress causes failure to conceive and/or failure to maintain pregnancy so needs frequent service (Hammoud *et al*., 2010). Heat stress disrupts the release of steroid hormones from medium- and large-sized follicles (Roth *et al*., 2001). Thus, exposure to heat stress in the summer may decrease follicular function, delay ovarian resumption (Senosy and Osawa, 2013), and reduce the immunity of high lactating cows (Dahl *et al*., 2020).

Cow's parity is one of the principal factors affecting productivity, fertility parameters, and disorders. Considering the effect of parity on the productive performance of Holstein cows, the present study indicated that first parity cows significantly had the lowest (P< 0.05) DMY, DMI, and FCE compared to higher parities. These results agreed with Reshalaitihan *et al*. (2020). Subsequently, the economic evaluation showed that pluriparous cows had the highest DMY, DMI, Daily profit, and profit-to-cost ratio. The same result was concluded by Bashir *et al*. (2014) who found that high milk production often required more costly feed. This might be referred to that first-lactation heifers had smaller rumen capacity and immediately restoring this capacity after calving was difficult meanwhile, multiparous cows had higher feed intake capacity so ate higher (Jensen *et al*., 2015). According to Walter *et al*. (2022), morphological changes in primiparous cows arise from growth, the first gestation, the maturation of the mammary glands, the beginning of lactation, and competition for social dominance. Soonberg *et al*. (2021) reported that the socialization of primiparous cows with their multiparous counterparts caused a decrease in dry matter intake, which led to a lack of energy, reduced milk output, and health problems (Cabezas-Garcia *et al*., 2021).

In the current study, the number of heats and SC was significantly higher in first parity cows than in higher parities. As well as Kumar and Bhat (1979) reported that heifers required more NSC than cows. Cielava *et al*. (2017) reported that the first parity was significantly lower in NSC than the second parity of Holstein dairy cattle in the Latvia Republic. Sattar *et al*. (2005) reported a non-significant difference between the first and second parity in NSC. In the present investigation, the difference was slight but significant in DFH and not significant in DFS. These results were in agreement with Sattar *et al*. (2005) who reported no significant difference between parity in the average DFS of Holstein cows. While others found a significant effect of parity on DFS interval in crossbred cows (Rafique *et al*., 2000) and purebred Friesian cows (Hammoud *et al*., 2010). The average interval of DO in the first parity cows was significantly longer than in the higher parity cows. This result was consistent Mureda and Zeleke (2007) noted that the average interval of DO of the first parity was longer (202.3 days) than in the second parity (185.9 days) of crossbred cows in Ethiopia. While El-Barbary *et al*. (1992) and Sattar *et al*. (2005) observed that parity had no significant effect on DO. The length of DO in dairy cows was affected by many factors (such as silent or missed estrus, feeding season, and milk production (Sammad *et al*., 2020).

From the current study, the incidence of endometritis in the first parity group was significantly (P<0.05) greater than in advanced parities cows, consequently the total economic losses of the first parity were higher than the advanced parities. Finding from the current study was in agreement with Ghanem *et al*. (2002) who found that the first parity cows had the highest risk of endometritis. Others found no significant effect of parity on the incidence of endometritis (Fleischer *et al*., 2001). On contrary, Lee and Kim (2006) support the hypothesis of increasing the risk of endometritis with advancing parity. Our result may be attributed to the primiparous cows being more prone to the incidence of still-birth which considers one of the causes leading to endometritis (Markusfeld, 1984). Also, it's well known that first parity cows need birth help and interference more than advancing parity (Ghanem *et al*., 2002). Parity had no significant effect on the incidence of SIO and COD. While Lee and Kim (2006) found that first parity cows had a reduced incidence of COD than cows with advancing parities. Ashmawy *et al*. (1992) and Nelson *et al*. (2010) found that parity increased the incidence of COD.

This study approved that the post-partum reproductive performance of the higher parity cows was better than the first parity cows such as lower number of SC, shorter DO, less incidence of endometritis, and fewer economic losses. That may be due to the variations in management systems and environmental conditions among parities. Additionally, in this dairy farm, the primiparous and pluriparous cows were fed the same ration, which may not be suitable for the first parity cows' needs as they suffer from more negative energy balance (NEB) because they consume less feed and need extra energy requirements for growth in addition to lactation (De Vries *et al*., 1999). NEB in the first parity was related to delayed intervals to the first ovulation (Wathes *et al*., 2007) as NEB decreases postpartum pulsation of LH so the resumption of ovarian rebound delays (Uppal *et al*., 2021).

CONCLUSION

According to the results of the current study, summer season has a negative impact on postpartum productive and reproductive performance, and it is associated with a higher incidence of reproductive disorders and greater economic losses in high-yielding Holstein cows raised in subtropical Egypt. Multiparous cows outperform first parity cows in terms of productivity and reproduction, have a reduced incidence of post-partum reproductive disorders, and generated higher daily profits. We recommend using an effective cooling system throughout the hot summer months. To decrease the negative effects of these problems, feeding schedules must correspond with the calving season, and management strategies must be justified.

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CONFLICT OF INTEREST

There is no conflict of interest among the authors regarding the publication of this article.

REFERENCES

Abdoon, A.S., Attia, M.Z., Soliman, S.S., Kandil, O.M., El-Toukhey, N.E., Sabra, H.A., 2020. Seasonal variation in number of ovarian follicles and hormonal levels in Egyptian buffalo and cattle. Int. J. Vet. Sci. 9, 126-130.

Abdel-Khalek, A.E., El-Harairy, M.A., Darwish, S.A., Zaghloul, H.K., Farw, M.A., 2012. Effect of different hormonal treatments as therapeutic procedure on repeat breeder buffalo heifers. Egypt. J. Anim. Prod. 49, 257-266.

Ashmawy, A.A., Vogt, D.W., Garverick, H.A., Youngquist, R. S., 1992. Incidences and associations of cystic ovaries with production and reproduction traits in dairy cattle 1. J. Anim. Breed. Genet. 109, 129-135.

Bashir, M.k., Khan, M.S., Lateef, M., Mustafa, M.I., Khalid, M.F., Rehman, S., Farooq, U., 2014. Environmental factors affecting productive traits and their trends in Niliravi Buffaloes. Pak. J. Life Soc. Sci. 25, 1–7

Berry, D.P., Crowley, J.J., 2013. Genetics of feed efficiency in dairy and beef cattle. J. Anim. Sci. 91, 1594–1613.

Cabezas-Garcia, E.H., Gordon, A.W., Mulligan, F.J., Ferris, C.P., 2021. Revisiting the Relationships between Fat-to-Protein Ratio in Milk and Energy Balance in Dairy Cows of Different Parities, and at Different Stages of Lactation. Anim. 11, 3256.

Cattáneo, L., Signorini, M.L., Bertoli, J., Bartolomé, J.A., Gareis, N.C., Díaz, P.U., GA B.O., Ortega, H.H., 2014. Epidemiological description of cystic ovarian disease in argentine dairy herds: risk factors and effects on the reproductive performance of lactating cows. Reprod. Domest. Anim. 49, 1028-1033.

Cielava, L., Jonkus, D., Paura, L., 2017. Number of services per conseption and its relationship with dairy cow productive and reproductive traits. Res. Rural Dev. 2, 67-73

Dahl, G.E., Tao, S., Laporta, J. 2020. Heat stress impacts immune status in cows across the life cycle. Front. Vet. Sci. 7, 116.

De Vries, M.J., Van Der Beek, S., Kaal-Lansbergen, L.M.T.E., Ouweltjes, W., Wilmink, J.B.M., 1999. Modeling of energy balance in early lactation and the effect of energy deficits in early lactation on first detected estrus postpartum in dairy cows. J. Dairy Sci. 82, 1927-1934.

DuBois, P.R., Williams, D.J., 1980. Increased incidence of retained placenta associated with heat stress in dairy cows. Therio. 13, 115-121.

Do, C., Wasana, N., Cho, K., Choi, Y., Choi, T., Park, B., Lee, D., 2013. The effect of age at first calving and calving interval on productive life and lifetime profit in Korean Holsteins. Asian-australas. J. Anim. Sci. 26, 1511.

Ealy, A.D., Drost, M., Hansen, P.J., 1993. Developmental changes in embryonic resistance to adverse effects of maternal heat stress in cows. J. Dairy Sci. 76, 2899-2905.

El-Barbary, A.S.A., Khalil, F.F.M., Mahady, A.E., 1992. Studies on Danish Friesian cattle in Egypt. Some factors affecting reproductive traits. J. Agric. Sci. 17, 2130-2135.

El-Rheem, S.M.A, Ghallab, R.S., El-Sharkawy, S., 2019. SAT, a new approach in understanding and treatment of subclinical endometritis in dairy cows. Open J. Vet. Med. 9, 109.

El-Tarabany, M.S., El-Bayoumi, K.M., 2015. Reproductive performance of backcross Holstein× Brown Swiss and their Holstein contemporaries under subtropical environmental conditions. Therio. 83, 444- 448.

El-Tarabany, M.S., Nasr, M.A., 2015. Reproductive performance of Brown Swiss, Holstein and their crosses under subtropical environmental conditions. Therio. 84, 559-565.

Evans, A.C.O., Zeng, S., 2017. Causes, prevention and management of infertility in dairy cows. Achiev. Sustain. Prod. Milk. 3, 385-398.

Fleischer, P., Metzner, M., Beyerbach, M., Hoedemaker, M., Klee, W., 2001. The relationship between milk yield and the incidence of some diseases in dairy cows. J. Dairy Sci. 84, 2025-2035.

Garnsworthy, P.C., Topps, J.H., 1982. The effect of body condition of dairy cows at calving on their food intake and performance when given complete diets. Anim. Sci. 35, 113-119.

Ghanem, M., Shalaby, A.H., Sharawy, S., Saleh, N., 2002. Factors leading to endometritis in dairy cows in Egypt with special reference to reproductive performance. J. Reprod. Dev. 48, 371-375.

Ghoneim, E., El Kaschab, S., Omar, S., Omran, M.F., 2018. Comparative Study Among Different Dairy Production Systems In Egypt. Menoufia J. Anim. Poult. Fish Prod. 2, 39-56.

Gossen, N., Hoedemaker, M., 2006. Reproductive performance of dairy cows with relation to time of ovarian cyst formation. Bulletin of the Vet. Institute in Puławy 50, 159-161.

Hall, J. B., Whittier, W. D., Myers, J., Cline, M. A., Cuddy, D., 2009. GnRH Based Estrus Synchronization Systems for Beef Cows. Virginia Cooperative Extension (VCE). https://vtechworks.lib.vt.edu/handle/10919/50695

Hammoud, M.H., El-Zarkouny, S.Z., Oudah, E.Z.M., 2010. Effect of sire, age at first calving, season and year of calving and parity on reproductive performance of Friesian cows under semiarid conditions in Egypt. Archiva Zootech. 13, 60.

Hansen, P.J., 2020. Prospects for gene introgression or gene editing as a strategy for reduction of the impact of heat stress on production and reproduction in cattle. Therio. 154, 190-202

Hassan, F.A., Ali, M.A., El-Tarabany, M.S., 2017. Economic impacts of calving season and parity on reproduction and production traits of buffaloes in the sub-tropics. Environ. Sci. and Pollution Res. 24, 10258-10266.

Hossein-Zadeh, N.G., 2013. Effects of main reproductive and health problems on the performance of dairy cows: a review. Span. J. Agric. Res. 3, 718-735.

Indira, D., Suresh, J., Reddy, R.Y., 2020. Accurate heat detection and health monitoring of cattle by SCR sense neck collar. World J. Adv. Res. Rev. 8, 075-079.

Jensen, L.M., Nielsen, N.I., Nadeau, E., Markussen, B., Nørgaard, P., 2015. Evaluation of five models predicting feed intake by dairy cows fed total mixed rations. Livest. Sci. 176, 91–103.

Kadzere, C.T., Murphy, M.R., Silanikove, N., Maltz, E., 2002. Heat stress in lactating dairy cows: a review. Livest. Prod. Sci. 77, 59-91.

Kassab, M.S., Salem, A.Y., 1993. Some factors affecting reproductive Efficiency and its relationship with milk production in Friesian cows. Alex. J. Agric. Res. 38, 105-121.

Khodaei-Motlagh, M., Shahneh, A.Z., Masoumi, R., Derensis, F., 2011. Alterations in reproductive hormones during heat stress in dairy cattle. Afr. J. Biotechnol. 10, 5552–5558.

Kornmatitsuk, B., Chantaraprateep, P., Kornmatitsuk, S., Kindahl, H., 2008. Different types of postpartum luteal activity affected by the exposure of heat stress and subsequent reproductive performance in holstein lactating cows. Reprod. Domest. Anim. 43, 515-519.

Kumar, S., Bhat, P.N., 1979. Reproductive performance of Hariana cattle. Indian J. Anim. Sci. 49, 1001-1008

Lee, J.Y., Kim, I.H., 2006. Advancing parity is associated with high milk production at the cost of body condition and increased periparturient disorders in dairy herds. J. Vet. Sci. 7, 161-166.

López-Gatius, F., 2003. Is fertility declining in dairy cattle?: a retrospective study in northeastern Spain. Therio. 60, 89-99.

López-Gatius, F., Santolaria, P., Yániz, J., Fenech, M., López-Béjar, M., 2002. Risk factors for postpartum ovarian cysts and their spontaneous recovery or persistence in lactating dairy cows. Therio. 58, 1623-1632.

López-Gatius, F., Santolaria, P., Yániz, J., Rutlant, J., López-Béjar, M., 2001. Persistent ovarian follicles in dairy cows: a therapeutic approach. Therio. 56, 649-659.

Madhuri, G., Rajashri, M., Kesharwani, S., 2017. Post-partum anoestrus in dairy cows: A review. Int. J. Environ. Sci. Technol. 6, 1447-1452.

Markusfeld, O., 1984. Factors responsible for post parturient metritis in dairy cattle. Vet. Rec. 114, 539-542.

Mohammed, A.E.I., 2017. Evaluation of some Productive and Reproductive Traits of Local and Friesian Cross-bred Dairy Cows. Doctoral dissertation, University of Gezira. Gezira State, Sudan.

Morrell, J.M., 2020. Heat stress and bull fertility. Theriogenology 153, 62-67.

Mureda, E., Zeleke, Z.M., 2007. Reproductive performance of crossbred dairy cows in eastern lowlands of Ethiopia. Livest. Res. Rural Dev. 19, 11.

Nelson, S.T., Martin, A.D., Østerås, O., 2010. Risk factors associated with cystic ovarian disease in Norwegian dairy cattle. Acta Vet. Scand. 52, 1-10.

Nor, N.M., Steeneveld, W., Mourits, M.C.M., Hogeveen, H., 2015. The optimal number of heifer calves to be reared as dairy replacements. J. Dairy Sci. 98, 861-871.

NRC., 2001. Nutrient requirement of dairy cattle. 7th rev. ed. National Research Council, Washington, DC.: National Academy press. http://www.nap.edu/catalog/9825.htm

Oltenacu, P.A., Broom, D.M., 2010. The impact of genetic selection for increased milk yield on the welfare of dairy cows. Anim. Welf. 19, 39-49.

Oudah, E.Z.M., Nazem, A.S., Mustafa, M.A., 2001. Genetic and non-genetic factors affecting days open, number of service per conception and age at first calving in a herd of Holstein-Friesian cattle. Pak. J. Biolog. Sci. 4, 740-744.

Ozcelik, M., Arpacik, A. 1996. The effects of different seasons on milk and institute production features in holstain cows breed in central anatolia conditions (i. milk production characteristics). J. Lalahan Livest. Res. Institute. 36, 1-20.

Rafique, M., Chaudhry, M.Z., Amer, M.A., 2000. Reproductive performance of inter Se H. Friesian x Sahiwal crossbred. Pak. Vet. J. 20, 109-112.

Ramadan, E.K., El-Tahawy A.S., 2014. Effect of calving season on the economic and production efficiency of dairy production breeds. Int. Sch. Sci. Res. Innov. 8, 798–802.

Reshalaitihan, M., Wynn, S., Teramura, M., Sato, T., Hanada, M., 2020. Effect of parity number on the dry matter intake of dairy cows during the first week after calving. Anim. Sci. J. 91, 13314.

Rodrigues, O., Scaliante, J., Shangraw, E.M., Hirtz, L.K., Adkins, P.R., McFadden, T.B., 2019. Heat stress reduces total mammary blood flow and transmammary disappearance of metabolites in lactating dairy cows. J. Dairy Sci. 102, 153.

Roth, Z., Meidan, R., Braw-Tal, R., Wolfenson, D., 2000. Immediate and delayed effects of heat stress on follicular development and its association with plasma FSH and inhibin concentration in cows. J. Reprod. Fertil. 120, 8390.

Roth, Z., Arav, A., Bor, A., Zeron, Y., Braw-Tal, R., Wolfenson, D., 2001. Improvement of quality of oocytes collected in the autumn by enhanced removal of impaired follicles from previously heat-stressed cows. Reprod. Cambridge. 122, 737-744.

Sammad, A., Umer, S., Shi, R., Zhu, H., Zhao, X., Wang, Y., 2020. Dairy cow reproduction under the influence of heat stress. J. Anim. Physiol. Anim. Nutr. 104, 978-986.

Santoso, S., 2019. Menguasai SPSS versi 25. Elex Media Komputindo.

Sattar, A., Mirza, R.H., Niazi, A.A.K., Latif, M., 2005. Productive and reproductive performance of Holstein-Friesian cows in Pakistan. Pak. Vet. J. 25, 75.

Senosy, W., Osawa, T., 2013. Association among calving season and measures of energy status, resumption of ovulation and subclinical endometritis in early lactating dairy cows. Anim. Reprod. 10, 24-31.

Shehab-EL-Deen, M.A.., Leroy, J.L., Fadel, M., Saleh, S., Maes, D., Van Soom, A., 2007. Biochemical changes in the follicular fluid of the dominant follicle of high producing dairy animals exposed to heat stress early postpartum. Anim. Reprod. Sci. 101, 208-224.

Soonberg, M., Kass, M.,Kaart, T., Barraclough, R., Haskell, M.J., Arney, D.R., 2021. Effect of grouping on behaviour of dairy heifers and cows in the transition period. J. Dairy Res. 88, 45–51.

Tao, S., Rivas, R.M.O., Marins, T.N., Chen, Y.C., Gao, J., Bernard, J.K., 2020. Impact of heat stress on lactational performance of dairy cows. Therio. 150, 437-444.

Uppal, M., Awasthi, M.K., Poyam, M.R., Mishra, G.K., Parveen, K., Verma, M., 2021. Influence of Blood Metabolites on Ovarian Rebound in Postpartum Sahiwal Cows. The Indian J. Vet. Sci. Biotechnol. 17, 67-70.

Walsh, B. S., Parratt, S.R., Hoffmann, A.A., Atkinson, D., Snook, R.R., Bretman, A., Price, T.A., 2019. The impact of climate change on fertility. Trends Ecol. Evol. 34, 249-259.

Walter, L.L., Gärtner, T., Gernand, E., Wehrend, A., Donat, K., 2022. Effects of Parity and Stage of Lactation on Trend and Variability of Metabolic Markers in Dairy Cows. Anim. 12, 1008.

Wathes, D.C., Fenwick, M., Cheng, Z., Bourne, N., Llewellyn, S., Morris, D. G., Fitzpatrick, R., 2007. Influence of negative energy balance on cyclicity and fertility in the high producing dairy cow. Therio. 68, 232-241.