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Effect of calving season and parity on the productivity and profitability of Holstein Friesian dairy farms

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ABSTRACT

The aim of this study is to evaluate the effect of calving season and parity on the productivity and profitability of private and governmental dairy farms in Egypt. The data of this study were estimated from 1353 lactation records of Friesian dairy cows. The data were classified according to calving season into winter and summer calvers, and according to parity into six lactation orders from 1st to 6th, then the data were analyzed statistically by using the computer programs SPSS/PC+ version 23. Total milk yield (305MY) and net profit (NP) differed significantly between calving season and parity within production sector, private sector for winter calvers and 3rd parity had the highest 305MY and NP (9759.5Kg - 40960.9 EGP and 10304.3 kg, 44546.1 EGP, respectively), while governmental sector for summer calvers and 6th parity had the lowest 305MY and NP (5028.4Kg-12117.1EGP and 4460.1kg, 10027.3 EGP, respectively). Total cost (TC) differed significantly within parity and sector, it was the highest for the private sector at 4th parity (34849.1EGp), while 6th parity for governmental sector had the lowest value (27657.5 EGP). Finally, we concluded that winter calvers and 3rd parity achieve the highest profitability for dairy farms.

1. INTRODUCTION

Productive and reproductive efficiency of dairy cows affected by different non-genetic factors such as calving season, parity, and management. The productive efficiency indices are days in milk (DIM) and 305MY, while the reproductive indices are service per conception (S/C), days open (DO), and calving interval (CI) (Amene et al., 2011). In general, economic traits are controlled by genetic factors, but environmental factors like calving season, and parity have a significant effect on milk yield (Pirzada, 2011). These environmental factors might suppress the animal's true genetic ability and lead to a bias in the selection of animals, so these environmental effects have to be taken into account to estimate the genetic ability of animals in milk yield (Djemali and Berger, 1992). Several researchers revealed that an increase in the parity resulted in an increase in the milk yield up to the 4th then declining (Hatungumukama et al., 2007; Badri et al., 2011). Also, Yilmaz and Koc (2013) and Al-Samarai et al. (2015) confirmed that the parity had a significant effect on 305MY of several breeds. Season of calving has an important impact on productive traits, as the high temperature severely depresses feed intake and milk yield (Amasaib et al., 2011). 305MY was observed to be higher during the rainy season due to higher levels of protein, energy, and minerals available to the lactating animals during this period (Gimbi, 2006). Several studies showed a significant effect of season of calving on milk yield of cows (Chegini et al., 2015; Faid-Allah, 2015; Petrović et al., 2015; Mikó et al., 2016). Atallah et al. (2015) showed that winter season and special sectors had the significant lead of milk production, also Mohamed et al. (2017) concluded that, the winter calving and first three parties were more profitable for Holstein dairy producers. However, other studies stated that there were no significant effects of calving season on milk yield (Badri et al., 2011; Usman et al., 2012; Mikó et al., 2016). In responding to the production sector, several studies showed that, the dairy production sector affects milk yield significantly (Rehman et al., 2008; Petrović et al., 2015). It might be due to variations in the level of management (Hadad, 2020). Improving the level of management is required for optimal reproduction performance (Mengistu and Wondimagegn, 2018). So, to improve the productivity and profitability of dairy cows, it is necessary to study variables affecting the animal's performance and farm economy. Therefore, our current study was planned to evaluate the effect of calving season and parity on the productivity and profitability of governmental and private dairy cow farms under subtropical Egyptian conditions.

2. MATERIAL AND METHODS

This study was carried out through field surveys in different regions of dairy cow farms (Cairo and Sharkia provinces) during the period extended from summer 2016 to winter

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2019 on random samples of private and governmental production sectors.
The current work was approved by the Committee of Animal Care and Welfare, Benha University, Faculty of Veterinary Medicine, Egypt (BUFVTM:03-07-20).

2.1. Animals and management
Data used in this study were estimated from 1353 lactation records of Friesian dairy cows. All animals on the farm were housed in a free stall shaded open yards bedded with a sand floor, supplied with a cool spraying system during the summer season. Animals were grouped according to average daily milk yield (DMY) into fresh (from calving day till 60 days post-partum), high, medium, and low milk producing cows, all groups of cows were fed a balanced total mixed ration, although the diet composition differed according to the region, sector and management. Water was freely available at all times. Lactating cows were machine-milked two times per day with milk production was recorded at each milking. The collected data were milk production records and reproduction records.

2.2. Productive traits:
They included 305MY, DIM, DMY, and DPL. 305MY = 305 ×total milk yield/DIM (El-Tahaway, 2007 and Ahmed, 2011). DMY = Total milk yield per cow per lactation/ DIM. DPL (defined as the number of days between the dry-off date and the subsequent parturition date) (Capuco et al., 1997; Melendez and Pinedo, 2007).

2.3. Reproductive traits:
They included S/C (number of insemination doses till conception) calculated individually for each cow and DO.

2.4. Economic indices:
Calculations of costs and returns:
2.4.1. Fixed costs = Depreciation cost of building + Depreciation cost of animal + Depreciation cost of parlor (Ahmed, 2011).
2.4.2. Variable costs = Feed cost + Veterinary cost+ Labor cost + Fuel cost (Ahmed, 2011).
2.4.3. Total costs = Fixed costs + Variable costs (Kavoi et al., 2010).
2.4.4. Total returns = Returns from milk sales (amount of kg milk produced X price of kg milk) + Value of calves sold (price of one day old calf) + Fecal matter (amount of fecal matter produced m^3 X price of m^3) (Ahmed, 2011).
2.4.5. Net profit = Total returns –Total costs (Ribeiro et al., 2008).

2.5. Data classification
The data were classified according to (production sector, lactation order (parity), and calving season) into two production sectors private and governmental (El-Tahawy, 2007), six lactation orders from 1^{st} to 6^{th} , two calving seasons (summer and winter) on basis of atmospheric temperature, humidity and rainfall into two seasons. Summer season extended from (21 March to 20 September) and winter season extended from (21 September to 20 March) (Attalla, 1997).

2.6. Statistical analysis
All statistical procedures were performed using the computer programs SPSS/PC$^+$ "version 23"(SPSS, 2015). Preliminary Levene's test was performed to ensure the homogeneity of variances among groups. The general linear model (GLM) procedure was used to analyze the productive, reproductive and economic measures for each animal according to fixed variables (Production sector, Calving season and Parity order) Duncan's Multiple Range-Test (Duncan, 1955) was used to test differences among means. Statistical significance between mean values was set at ($P \leq 0.05$). Results were reported as means and standard error. This statistical model was constructed to determine the effect of interaction between fixed variables (Production sector, Calving season and Parity order) on some productive and reproductive variables and their costs and returns according to the following equation

$$V_{jkn} = \mu + S_j + Se_k + P_n + (Se \times S)_{kj} + (Se \times P)_{kn} + e_{jkn}$$

Where:
V_{jkn} =the response variable.
μ = the overall mean of population.
S_j= effect of j^{th} calving seasons (summer and winter).
Se_k= effect of k^{th} sector (private and governmental).
P_n = effect of n^{th} parity (1^{st} to 6^{th} parity order).
$(Se \times S)_{kj}$ = effect of the interaction between k^{th} sector and j^{th} calving season.
$(Se \times P)_{kn}$ = effect of the interaction between k^{th} sector and n^{th} parity.
e_{jkn}= un-explained error term.

3. RESULTS

3.1. Effect of calving season within production sector on some productive and reproductive traits of Holstein-Friesian dairy cows
Data summarizing results for the effect of calving seasons within the production sector on DIM, DMY, Milk yield, Dry period, S/C, and DO are presented in Tables (1 and 2).
DIM showed non-significant ($P > 0.05$) increase for summer season calvers (374.3d) than winter calvers, it was (371.8 d), on the other side DIM increased significantly ($P < 0.05$) within governmental sector than a private one, governmental sector for summer season calvers had the highest lactation length (387.0d), while private sector for summer calvers had the shortest lactation length (361.6d). DMY and 305MY were differed significantly ($P < 0.05$) between calving seasons within the production sector, the private sector for winter calvers had the highest values (32 and 9759.5kg, respectively), while governmental sector for summer season calvers had the lowest values (16.5 and 5028.4 kg, respectively). DP showed a significant increase in cows calved in summer season (75.2d) than in winter (70.8d), with non-significant effect within production sectors in the same season, either winter or summer. S/C and DO showed a non-significant increase for summer season calvers (4.1 and 222.5d, respectively) than in the winter season (4.0 and 217.3d, respectively).

3.2. Effect of calving season within sectors on collective efficiency measurements of Holstein-Friesian dairy cows.
Data summarizing results for the effect of calving season within the production sector on economic indices are presented in Table (3). Calving season showed a non-significant increase on total production cost for winter season calvers (32100.8EGP) compared with the summer season (32004.5EGP). In responding to the production sector, TC showed a significant increase for the private sector than governmental one within both Calving season. Private sector cows that calved in winter season had the highest TC value (34609.7EGP), while governmental sector summer calving cows had the lowest value (29486.0 EGP).

Calving season within the production sector had a significant effect on milk return, TR and NP, regarding winter season calvers they were (52390.7, 59242.3 and 27141.4EGP, respectively), while summer season calvers were (50916.7, 57766.3 and 25761.8 EGP, respectively). Private sector cows that calved in winter season had the highest values (68316.2, 75570.6 and 40960.9 EGP, respectively), governmental sector summer calving cows had the lowest values (35198.6, 41642.4 and 12117.1 EGP, respectively).

Table 1 Effect of calving season within sectors on some productive traits of Holstein-Friesian dairy cows.

Calving season	Sector	NO.	DIM	DMY	305 MY	DPL
			Mean ± S.E	Mean ± S.E	Mean ± S.E	Mean ± S.E
Winter	Private	989	363.0^{b}±3.8	32.0^{a}±0.3	9759.5^{a}±83.0	70.5^{b}±1.0
	Gov.	753	380.6^{a}±4.4	17.1^{b}±0.3	5209.3^{b}±95.1	71.2^{b}±1.1
	Total	1742	371.8^{A}±2.9	24.5^{A}±0.2	7484.4^{A}±63.1	70.8^{B}±0.7
Summer	Private	751	361.6^{b}±4.4	31.2^{a}±0.3	9519.2^{a}±95.3	75.5^{a}±1.1
	Gov.	602	387.0^{a}±4.9	16.5^{b}±0.3	5028.4^{b}±106.4	74.8^{a}±1.2
	Total	1353	374.3^{A}±3.3	23.8^{B}±0.2	7273.8^{B}±71.4	75.2^{A}±0.8

Means within the same column carrying different superscripts (small letters) are significantly different ($P < 0.05$). Means within the same column carrying different superscripts (capital letters) are significantly different ($P < 0.05$). (Gov.): Governmental – (NO.): Number - (DIM): Days in milk - (DMY): Daily milk yield – 305MY: Total milk yield within 305 days- (DPL): Dry period length.

Table 2 Effect of calving season within sectors on some reproductive traits of Holstein-Friesian dairy cows.

Calving season	Sector	NO.	Service/ conception (S/C)	Current days open (DO)
			Mean ± S.E	Mean ± S.E
Winter	Private	989	4.2^{ab}±0.1	183.8^{b}±4.5
	Gov.	753	4.0^{b}±0.1	250.7^{a}±5.1
	Total	1742	4.0^{A}±0.1	217.3^{A}±3.4
Summer	Private	751	4.3^{a}±0.1	188.9^{b}±5.1
	Gov.	602	3.9^{b}±0.1	256.1^{a}±5.7
	Total	1353	4.1^{A}±0.1	222.5^{A}±3.8

Means within the same column carrying different superscripts (small letters) are significantly different ($P < 0.05$). Means within the same column carrying different superscripts (capital letters) are significantly different ($P < 0.05$) - (Gov.): Governmental - (NO.): Number.

Table 3 Effect of calving season within sectors on collective efficiency measurements of Holstein-Friesian dairy cows.

Calving season	Sector	NO.	TC	Milk return	TR	NP
			Mean ± S.E	Mean ± S.E	Mean ± S.E	Mean ± S.E
Winter	Private	989	34609.7^{a}±74.0	68316.2^{a}±581.1	75570.6^{a}±581.1	40960.9^{a}±540.9
	Gov.	753	29591.9^{b}±84.8	36465.1^{b}±666.0	42913.9^{b}±666.0	13322^{b}±619.8
	Total	1742	32100.8^{A}±56.3	52390.7^{A}±441.9	59242.3^{A}±441.9	27141.4^{A}±411.3
Summer	Private	751	34483.6^{a}±85.0	66634.7^{a}±666.9	73890.2^{a}±666.9	39406.6^{a}±620.7
	Gov.	602	29525.3^{b}±94.9	35198.6^{b}±744.9	41642.4^{b}±744.8	12117.1^{b}±693.2
	Total	1353	32004.5^{A}±63.7	50916.7^{B}±499.9	57766.3^{B}±499.9	25761.8^{B}±465.2

Means within the same column carrying different superscripts (small letters) are significantly different ($P < 0.05$). Means within the same column carrying different superscripts (capital letters) are significantly different ($P < 0.05$). (Gover): Governmental - (NO.): Number - (TC): Total cost – (TR): Total return (NP): Net profit.

3.3. Effect of parity order and sector interaction on productive and reproductive performance of Holstein-Friesian dairy cows

Data summarizing results for the effect of parity within the production sector on DIM, DMY, 305MY, DPL, S/C, and DO are presented in Tables (4 and 5).

The average DIM differed significantly among different parities, not production sectors. Regarding parity orders they were (385.1, 362.2, 375.3, 371.2, 333.5 and 355.8d, respectively).The first parity for the governmental sector had the longest lactation length (395.0d), while the fifth parity for the governmental sector had the shortest lactation length (325.0d). The average DMY and 305MY were differed significantly among different parities within production sectors, regarding parity orders they were (23.1, 7053.7 and 24.7, 7536.9 and 25.6, 7804.9 and 25.0, 7625.6 and 25.5, 7778.7 and 23.5, 7165.1 kg, respectively). The third parity for the Private sector had the highest value (33.8 and 10304.3 kg, respectively), while the sixth parity for the governmental sector had the lowest value (14.6 and 4460.1kg, respectively). The average DPL differed significantly between the two sectors not parity, the highest value was recorded for the private sector at the second parity (77.6d), while the lowest value was for the governmental sector at the sixth parity (64.3d). The average S/C neither differed significantly between the two sectors nor parities except for the sixth parity it differed significantly between private and governmental sectors (4.2 and 3.2), the highest value was for the fourth parity for the private sector (4.7), while the lowest value was for the sixth parity for the governmental sector (3.2). The average DO differ significantly between the two sectors not parities, the highest value was for the third parity of the governmental sector (257.8d), while the lowest value was for the second parity of the private sector (176.9d).

3.4. Effect of parity order within sectors on economic indices of Holstein-Friesian dairy cows.

Data summarizing results for the effect of parity production sector on economic indices are presented in Tables (6). TC was differed significantly among different parities within production sector, in responding to TC within parity order it was (32045.5, 31855.7, 32301.7, 32451.2, 32582.0 and 31099.2 EGP, respectively).

Table 4 Effect of parity order within sectors on some productive traits of Holstein-Friesian dairy cows.

Parity	Sector	NO.	DIM	DMY	305 MY	DPL
			Mean ± S.E	Mean ± S.E	Mean ± S.E	Mean ± S.E
1st	Private	696	375.2^{abc}±4.5	29.5^{b}±0.3	9005.8^{b}±97.8	68.9^{ab}±1.1
	Gov.	507	395.0^{a}±5.3	16.7^{cd}±0.4	5101.7^{cd}±114.6	76.3^{a}±1.3
	Total	1203	385.1^{A}±3.5	23.1^{C}±0.2	7053.7^{C}±75.4	72.6^{A}±0.9
2nd	Private	468	347.8^{bcd}±5.5	33.0^{a}±0.4	10068.8^{a}±119.3	77.6^{a}±1.4
	Gov.	443	376.5^{abc}±5.7	16.4^{cd}±0.4	5005.0^{cd}±122.6	72.7^{ab}±1.4
	Total	911	362.2^{ABC}±4.0	24.7^{BC}±0.3	7536.9^{BC}±85.5	75.1^{A}±1.0
3rd	Private	290	361.8^{abcd}±7.0	33.8^{a}±0.5	10304.3^{a}±151.6	69.9^{ab}±1.8
	Gov.	213	388.7^{ab}±8.2	17.4^{c}±0.6	5305.6^{c}±176.9	68.1^{ab}±2.0
	Total	503	375.3^{AB}±5.4	25.6^{A}±0.4	7804.9^{A}±116.5	69.0^{A}±1.3
4th	Private	167	363.9^{abcd}±9.3	32.7^{a}±0.7	9986.3^{a}±199.7	76.5^{a}±2.3
	Gov.	120	378.5^{abc}±10.9	17.3^{cd}±0.8	5264.9^{cd}±235.6	69.7^{ab}±2.7
	Total	287	371.2^{AB}±7.2	25.0^{AB}±0.5	7625.6^{AB}±154.4	73.1^{A}±1.8
5th	Private	87	342.1^{cd}±12.8	32.0^{ab}±0.9	9758.1^{ab}±276.7	76.4^{a}±3.2
	Gov.	47	325.0^{d}±17.5	19.0^{c}±1.2	5799.3^{c}±376.5	70.0^{ab}±4.4
	Total	134	333.5^{C}±10.8	25.5^{A}±0.8	7778.7^{A}±233.6	73.2^{A}±2.7
6th	Private	32	351.0^{bcd}±21.2	32.4^{a}±1.5	9870.1^{a}±456.3	77.3^{a}±5.3
	Gov.	25	360.6^{abcd}±24.0	14.6^{d}±1.7	4460.1^{d}±516.2	64.3^{b}±6.0
	Total	57	355.8^{BC}±16.0	23.5^{BC}±1.1	7165.1^{BC}±344.5	70.8^{A}±4.0

Means within the same column carrying different superscripts (small letters) are significantly different (P < 0.05). Means within the same column carrying different superscripts (capital letters) are significantly different (P < 0.05). (Gov.): Governmental - (NO.): Number - (DIM): Days in milk - (DMY): Daily milk yield – (305MY): Total milk yield within 305 days- (DPL): Dry period length.

Table 5 Effect of parity order within sectors on some reproductive traits of Holstein-Friesian dairy cows.

Parity	Sector	NO.	Service/ Conception (S/C)	Current days open (DO)
			Mean ± S.E	Mean ± S.E
1st	Private	696	4.3^{a}±0.1	184.5^{bc}±5.3
	Gov.	507	3.8^{ab}±0.1	256.7^{a}±6.2
	Total	1203	4.0^{A}±0.1	220.6^{A}±4.1
2nd	Private	468	4.0^{ab}±0.1	176.9^{c}±6.5
	Gov.	443	3.9^{ab}±0.1	254.4^{a}±6.6
	Total	911	4.0^{A}±0.1	215.6^{A}±4.6
3rd	Private	290	4.3^{a}±0.2	181.5^{c}±8.2
	Gov.	213	4.3^{a}±0.2	257.8^{a}±9.6
	Total	503	4.3^{A}±0.1	219.6^{A}±6.3
4th	Private	167	4.7^{a}±0.2	202.8^{bc}±10.8
	Gov.	120	4.0^{ab}±0.3	251.1^{a}±12.8
	Total	287	4.4^{A}±0.2	227.0^{A}±8.4
5th	Private	87	4.1^{a}±0.3	213.9^{abc}±15.0
	Gov.	47	3.7^{ab}±0.4	204.3^{bc}±20.4
	Total	134	3.9^{A}±0.3	209.1^{A}±12.7
6th	Private	32	4.2^{a}±0.5	230.9^{ab}±24.7
	Gov.	25	3.2^{b}±0.6	219.0^{abc}±28.0
	Total	57	3.7^{A}±0.4	225.0^{A}±18.7

Means within the same column carrying different superscripts (small letters) are significantly different (P < 0.05). Means within the same column carrying different superscripts (capital letters) are significantly different (P < 0.05).

The fourth parity for the private sector had the highest value (34849.1EGp), while the sixth parity for the governmental sector had the lowest value (27657.5 EGP). Milk return, TR and NP were differed significantly among different parities within production sector, regarding Milk return, TR and NP within parity order they were (49376.3, 56222.6 and 24177.1 - 52758.3, 59608.1 and 27752.4 - 54634.6, 61489.0 and 29187.4 - 53379.5, 60242.7 and 27791.5 - 54450.9, 61307.4 and 28725.1-50155.9, 57009.6 and 25910.5 EGP, respectively) the highest values for milk return, TR and NP were recorded for the third parity for the private sector (72130.2, 79386.8 and 44546.1 EGP, respectively), while the sixth parity for the governmental sector had the lowest values (31221, 37684.8 and 10027.3 EGP, respectively).

4. DISCUSSION

This study aimed to evaluate the effects of calving season and parity order on the productivity and profitability of private and governmental dairy farms in Egypt.

The non-significant effect of calving season on lactation length might be due to uniformity in the availability of fodders and feed all over the year. This result is similar to Kaleri et al. (2017), Sharif et al. (2018) and Mundan et al. (2020), who found a non-significant effect of calving season on lactation period (LP). Also, Mote et al. (2019) explained that season of calving exerted a non-significant influence on DIM in Holstein Friesian × Gir crossbred, but it is on contrary with Usman et al. (2012), Hossein-Zadeh (2013) and Mohammed and Atta (2019), who concluded that season of calving had a significant effect on DIM of Holstein Friesian cows. In responding to the significant effect of the sector on lactation length, this might be due to the reason of better feeding management in the private sector that led to the early conception of these cows in comparison with the governmental one, this result on the same line with Hadad (2020), who concluded that the differences in LP due to the herd type were significant, while the effects of calving season on LP were not significant. On the contrary, Coffie (2014) found a non-significant effect of herd type on lactation length. Regarding the effect of calving season within the production sector on DMY and 305MY, they differed significantly within the two calving seasons. private sector winter calvers had the highest values, while governmental sector summer calvers had the lowest values, might be due to high temperature in summer that increased the respiratory rate and severely depresses feed intake and milk yield (Amasaib et al., 2011). In responding to different levels of milk production between the two production sectors, this result might be due to variation in the level of management. These results in agreement with Lazarević et al. (2013), who found a significant effect for the calving season and herd type on the milk yield, also Atallah et al.

(2015), who recorded that calving season and special sectors had the significant lead of milk production, also Mikó et al. (2016), Kunbhar et al. (2017), Mohamed et al. (2017) and Mohammed and Atta (2019) found a significant increase of milk yield in winter season than in summer one, while disagreed with Bala et al. (2017) and Kaleri et al. (2017), who recorded a non-significant effect of calving season on milk yield. Regarding the significant increase of DPL in the summer rather than winter season, might be attributed to low availability of green fodder and high environmental temperatures in summer season, so DP may increase to relief heat stress, for the improvement of dry period better management should be followed (Suhail et al., 2010). This result agreed with Zewdu et al. (2015) and Kaleri et al. (2017), who found that DP affected significantly by calving season, as summer season had the longest period. In responding to the slight increase of DO in winter season might be due to the adverse effect of heat stress on conception rate and subsequently increase the number of S/C, these results are in agreement with Tadesse et al. (2010), who found a non-significant effect of calving season on DO, while Zewdu et al. (2015) and Kunbhar et al. (2017) recorded a significant increase of DO for summer season than winter one, also Melendez and Pinedo (2007), who recorded significant effect of calving season on S/C and DO, also Hammoud et al. (2010) and Mengistu and Wondimagegn (2018) showed a significant effect of calving season on DO.

In responding to the production sector, it had a non-significant effect on S/C and DO. This agreed with Hadad (2020), who concluded that the production sector had a non-significant effect on CI. In contrary Rehman et al. (2008) found that CI differed significantly among different herds. Concerning the effect of calving season on TC, the non-significant increase of total production cost for winter season compared with summer season nearly agreed with Mohamed et al. (2017) who stated that feed cost and TC were significantly increased at winter season than summer one, while disagreed with Atallah et al. (2015), who found significant increase of feed cost in summer season rather than winter one. TC showed significant increase for private sector than governmental one within both seasons, this might be due to better management and high feed cost for the private sector than the governmental one for maximizing milk production. In responding to the effect of calving season on milk return, TR and NP, there was a significant effect of calving season within production sector on milk return, TR and NP, this result might be due to higher milk yield in the winter season and private sector than summer and governmental one, these results were in accordance with Ahmed (2011), Atallah et al. (2015) and Mohamed et al. (2017), who concluded that winter season had significantly higher profitability measures including milk return, total return and net return. Effect of parity order within production sector on some productive traits of Holstein-Friesian dairy cows. The average DIM differed significantly among different parities not production sectors. This result in accordance with Al-Samarai et al. (2015), Choudhary et al. (2017) and Hadad (2020), who found a significant effect of parity on lactation length, while disagreeing with M'hamdi et al. (2012), Wondifraw et al. (2013) and Yilmaz and Koc (2013) who showed a non-significant effect of parity order on DIM, also this result disagreed with Uddin et al. (2011) and Ahmed (2011), who concluded that production sector had a significant effect on lactation length. Concerning the effect of parity order within the production sector on DMY and 305 milk yield.

The average DMY and 305MY differed significantly among different parties and sectors, the third parity for Private sector had the highest value, while the sixth parity for governmental sector had the lowest value. This result might be attributed to the increase in cow's weight over the years and development of the udder tissue, and Milk yield increased till the age of 6 years after that it begins to decrease (Çardak, 2016), this result in the same line with Chegini et al. (2015), Faid-Allah (2015) and Gamaniel et al. (2019), who said that increase in parity order resulted in a significant increase in the milk yield. Also, Lazarević et al. (2013) and Petrović et al. (2015) concluded that milk yield was different significantly among different herds. This result might be due to managemental variation. Likewise, Hadad (2020) concluded that total milk yield affected significantly among parities and sectors.

Table 6 Effect of parity order within sectors on collective efficiency measurements of Holstein-Friesian dairy cows.

Parity	Sector	NO.	TC	Milk return	TR	NP
			Mean ± S.E	Mean ± S.E	Mean ± S.E	Mean ± S.E
1st	Private	696	34342.7^{a}±87.4	63040.9^{b}±684.9	70294.0^{b}±684.8	35951.2^{b}±637.3
	Gov.	507	29748.2^{cd}±102.4	35711.6^{cd}±802.4	42151.2^{cd}±802.4	12403^{cd}±746.7
	Total	1203	32045.5^{B}±67.3	49376.3^{C}±527.5	56222.6^{C}±527.5	24177.1^{C}±490.9
2nd	Private	468	34599.8^{a}±106.6	70481.9^{a}±835.2	77737.0^{a}±835.2	43137.2^{a}±777.2
	Gov.	443	29111.6^{d}±109.6	35034.7^{cd}±858.4	41479.2^{cd}±858.4	12367.6^{cd}±798.9
	Total	911	31855.7^{C}±76.4	52758.3^{BC}±598.9	59608.1^{BC}±598.8	27752.4^{BC}±557.3
3rd	Private	290	34840.7^{a}±135.4	72130.2^{a}±1061	79386.8^{a}±1060.9	44546.1^{a}±987.3
	Gov.	213	29762.7^{cd}±158.0	37138.9^{c}±1238	43591.3^{cd}±1238.0	13828.6^{cd}±1152.1
	Total	503	32301.7^{AB}±104.1	54634.6^{A}±815.2	61489.0^{A}±815.2	29187.4^{A}±758.6
4th	Private	167	34849.1^{a}±178.5	69904.5^{a}±1398.2	77165.5^{a}±1398.1	42316.5^{a}±1301.1
	Gov.	120	30053.4^{bc}±210.6	36854.5^{cd}±1649.4	43319.8^{cd}±1649.3	13266.4^{cd}±1534.9
	Total	287	32451.2^{AB}±138.0	53379.5^{AB}±1081.1	60242.7^{AB}±1081.1	27791.5^{AB}±1006.1
5th	Private	87	34506.4^{a}±247.3	68306.9^{ab}±1937.1	75561.5^{ab}±1937.0	41055.0^{a}±1802.6
	Gov.	47	30658^{b}±336.4	40595^{c}±2635.5	47053.3^{c}±2635.4	16395.3^{c}±2452.6
	Total	134	32582.2^{A}±208.7	54450.9^{A}±1635.4	61307.4^{A}±1635.3	28725.1^{A}±1521.9
6th	Private	32	34540.8^{a}±407.7	69090.7^{a}±3194	76334.5^{a}±3193.9	41793.7^{a}±2972.3
	Gov.	25	27657.5^{c}±461.3	31221^{d}±3613.7	37684.8^{d}±3613.5	10027.3^{d}±3362.8
	Total	57	31099.2^{C}±307.8	50155.9^{BC}±2411.5	57009.6^{BC}±2411.3	25910.5^{BC}±2244.0

Means within the same column carrying different superscripts (small letters) are significantly different ($P < 0.05$). Means within the same column carrying different superscripts (capital letters) are significantly different ($P < 0.05$). (Gov.): Governmental – (NO.): Number - (TC): Total cost – (TR): Total return – (NP): Net profit.

On contrary, Choudhary et al. (2017) explained that parity order significantly affected total milk yield, as the mean values for the third lactation were higher than second lactation but lower than the first lactation. In responding to the effect of parity order and sector interaction on DP. The average DP differed significantly between the two sectors not parity. This result is close to Barozai et al. (2011), who showed that Holstein Friesian cattle that raised under intensive management had comparatively higher DP in 3rdlactation cows, followed by cows in the 2nd lactation, and 6th parity had the lowest DPL, while disagreed with Usman et al. (2012), who explained that the effect of parity was non-significant on DP. Regarding the effect of parity order within production sector interaction on S/C. The average S/C neither differed significantly between two sectors nor parities except for the sixth parity it differed significantly between private and governmental sectors. This result in accordance with Sattar et al. (2005), who explained that parity order had a non-significant effect on service period, while disagreed with Attalla (1997), who explained that the production sector had a significant effect on the number of S/C.

Concerning the effect of parity order within production sector on DO. The average DO varied significantly between the two sectors not parity. This result might be due to the variation in the management system, fertility traits and milk yield of cows within different sectors (Ahmed, 2011). This result is similar to Ansari-Lari et al. (2010), who recorded a non-significant effect of parity on DO, while Al-Timimy (2003) and Hadad (2020) found a non-significant effect of parity and sector on calving interval. While, Rehman et al. (2008) and Pirzada (2011) recorded a significant effect of parity on CI, also Mengistu and Wondimagegn (2018) showed that cows with first parity recorded the lowest DO, while the highest at the second parity. In responding to the effect of parity on economic indices, effect of parity within production sector on TC. TC differed significantly among different parities and sectors, the highest value was for the fifth parity, while the lowest value was for the sixth parity. This is on the contrary with Mohamed et al. (2017) who found that 1st and 2nd parities had higher total production cost than subsequent parities. Concerning the effect of parity within production sector on milk return, TR and NP. Milk return, TR and NP were differed significantly among different parities and sectors. This result is close to that of Vijayakumar et al. (2017), who found that a significant effect of lactation number ($P < 0.001$) on 305MY where the maximum milk yield was during 3rd lactation, Also Dangar and Vataliya (2015) showed that there is highly significant effect of parity on lactation milk yield, as the highest lactation milk yield was observed during 5th parity and significant drop was clear after 8th parity. These results disagreed with Mohamed et al. (2017), who concluded that 1st and 3rd parity had higher DMY and 305MY than subsequent lactations, so they showed a higher net return.

5. CONCULSION

This study revealed that calving season and parity play important roles in the productivity, profitability, and economic efficiency of Holstein Friesian dairy cows. The private sector for winter season calvers and the third parity had the highest 305MY and NP, while the governmental sector for summer season calvers and the sixth parity had the lowest values. TC differed significantly within parity and sector, not season, it was the highest value for the private sector at the fourth parity, while the sixth parity for the governmental sector had the lowest value. The private sector achieves higher farm profitability than the governmental one. Cows at the third to the fifth parity, and those calving in winter season had the best economic efficiency of Holstein Friesian dairy farms, so culling the dairy cow after 5th parity is more profitable.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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