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Incidence and economics of clinical mastitis of Holstein Friesian dairy cows under Egyptian conditions

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ABSTRACT

Mastitis is an endemic disease that is considered to be one of the most frequent and costly dairy diseases, so that the aim of this study was to investigate different factors affecting mastitis incidence, and their effect on productivity and profitability of dairy farms. Data used in this study were estimated from 1353 lactation records of Friesian dairy cows within private and governmental farms. The productive, reproductive and economic data for a whole lactation season were recorded for healthy and mastitic cows. Four risk factors for mastitis were included (production sector, calving season, parity and milk-production level). Data were classified according to risk factors into two production sectors private and governmental, two calving seasons, summer and winter and Six lactation orders from 1stto 6th, two milk production levels (high and low milk producing cows). Winter calving, older and high producing cows and private sector had the highest mastitis incidence, mastitis reduced the 305-milk yield of Mastitic cows by 33.7 & 20.3Kg during disease period, and 62.7 & 37.7Kg milk was discarded during the treatment period for private and governmental sector respectively. Finally, economic loss of mastitis per animal estimated 695.7 EGP yearly.

1. INTRODUCTION

Mastitis is considered as the costliest disease of dairy cows. Estimating its economic losses could give the farmers and veterinarians a clear vision into the costs of this disease at herd level and helps them to make appropriate decisions toward its control (Moru et al., 2018). Mastitis is defined as an inflammatory changes of the mammary gland that may be non-infectious (caused by chemical, physical or traumatic factors) or infectious (caused by pathogen infection). Clinical Mastitis (CM) is characterized by abnormal milk secretions with or without local or systemic signs of inflammation. Subclinical mastitis may be more frequently recognized in dairy animals compared to other species. This may be especially true in industrialized dairy production systems where markers of inflammation are monitored as a component of milk quality and productivity improvement programs (Aryeetey et al., 2008). It is difficult to control mastitis because it is a multifactorial and contagious disease. The primary source of contagious pathogens is the infected mammary glands and the pathogens spread within the herd occurs usually during milking, so we should keep the environment clean and dry (Huijps et al., 2010). Sharma et al. (2018) concluded that the herd-level prevalence of subclinical mastitis and causative factors influencing mastitis differ from herd to herd, place to place and time to time. Studies on mastitis from various parts of Haryana state, India reflect high incidence over the decades, they recorded that (33.76%) and (18.17%) cases were found positive for subclinical mastitis and CM, respectively. The majority of clinical cases of mastitis were chronic, occurring during the first five months of lactation and the first two parities, Staphylococci (51.16%) were the most prevalent organism followed by Streptococci (37.94%), E. coli (8.41%) and Corynebacterium Pyogenes (1.62%). Barua et al. (2014) recorded a higher prevalence of subclinical mastitis (65.91%) in high yielding cows (>10 liters/day) than medium yielding (42.85%). The most significant factors associated with clinical and subclinical mastitis were increasing parity and Holstein breed, and for subclinical mastitis also free-stalls with automatic milking (Hiitiö et al., 2017). CM results in many negative outcomes for the dairy cow including pain, decreased production, culling and death (Ruegg, 2011). Mastitis has important economic implications for the industry due to cost associated with reduced milk production and milk quality, premature culling of animals, veterinary treatment, and animal welfare (Heikkilä et al., 2012).Mastitis had a great depressive effect on the productive and reproductive efficiency of primiparous and multiparous Egyptian Holstein dairy cows in different seasons (El-Tarabany and Ali, 2015a). CM significantly ($P < 0.05$) increased calving to first estrus (+ 7.7d), and to calving first insemination intervals (+6.5d)

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compared to non-affected ones, also cows with CM before conception required (31d) more and (+0.47) inseminations to conceive than the healthy cow (Elmaghraby et al., 2017). Days open and number of S/C were higher in the mastitic groups than in controls (Lavon et al., 2019). Preventing or controlling subclinical mastitis improved the farmer's profits through reductions in milk losses, reduced feed, and other variable costs and optimum culling rate (Gülzari et al., 2018). The average total failure costs of mastitis were estimated to be $ 209.66/ farm/year of which SCM contributed 54% of the costs. The average total failure costs per lactating cow per farm per year were $86.28, with a large variation between farms (range $0 to $1543.69). Milk production losses made the largest contribution (80%), while culling contributed 13% to 17% to the total failure costs. Costs of veterinary services, drugs, discarded milk and labor made a minor contribution to the total failure costs of mastitis (Mekonnen et al., 2019). So, to improve the productivity and profitability of dairy cows, it is necessary to study diseases affecting animal's performance and farm economy. Therefore, our current study was planned to estimate the prevalence and losses of mastitis disease and its effect 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 EL Sharkia provinces) during the period extended from summer 2016 to winter 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 Holstein Friesian dairy cows. All animals in 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 recorded at each milking. The collected data were milk production records and reproduction records. Cows detected with clinical mastitis were moved into a hospital pen.

2.2. Productive traits
They included 305MY, DIM, DMY, DPL and calves sales. 305MY = 305 x 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 and 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:
1. Fixed costs = Depreciation cost of building + Depreciation cost of animal + Depreciation cost of parlor (Ahmed, 2011).
2. Variable costs = Feed cost + Veterinary cost+ Labor cost + Fuel cost (Ahmed, 2011).
3. Total costs = Fixed costs + Variable costs (Kavoi et al., 2010), in addition to disease cost (Treatment costs and costs of discarded milk).
4. Total returns = Returns from milk sales (amount of kg milk produced X price of kg milk) + Value of calves sold (the price of one-day-old calf) + Fecal matter (amount of fecal matter produced m^3 X price of m^3) (Ahmed, 2011).
5. Net profit = Total returns –Total costs (Ribeiro et al., 2008).

2.5. Data classification:
The data were classified into several categories to estimate the incidence of mastitis among the production sector, calving season, parity and milk production level. Data were classified according to (Production sector, calving season, lactation order (parity) and milk production), into two production sectors private and governmental (El-Tahawy, 2007), 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), Six lactation orders extended from 1st to 6th, two milk production levels (high and low milk-producing cows).

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 different variables (production sector, calving season, lactation order (parity), and milk production). Duncan's Multiple Range-Test (Duncan, 1955) was used to test differences among means. Statistical significance between mean values was set at ($P \leq 0.05$).
This statistical model was constructed to determine the incidence of mastitis among different variables (production sector, calving season, lactation order (parity) and milk production level), according to the following equation

$$V_{jknp} = \mu + S_j + Se_k + P_n + M_p + e_{jknp}$$

Where:
V_{jknp} =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).
M_p = effect of milk production level (high and low milk-producing cows).
e_{jknp}= un-explained error term.

3. RESULTS

3.1. Incidence of Mastitis within calving season, parity and different milk production level.

Incidence of clinical mastitis related to calving season, parity and milk production level were presented in Table (1), also incidence of mastitis between high and low milk production was included in Chart 3.

The incidence of clinical mastitis was higher in winter calving cows (27.3%) than those in summer (23.3%). Concerning parity order, incidence of mastitis increased with increasing parity, the highest estimates for mastitis was recorded for the 6th parity (38.6%). Regarding milk yield, high producing cows had higher incidence of mastitis (35.0) compared with low producing cows (6.9%).

Table 1 Incidence of mastitis within calving season, parity and different milk production level.

		Total	Healthy cows		Mastitic cows		Chi Sq.
		No.	No.	%	No.	%	
Calving season	Winter	1742	1267	72.7	475	27.3	$X^2 = 6.4$*
	Summer	1353	1038	76.7	315	23.3	
Parity order	1st	1203	980	81.5	223	18.5	$X^2 = 64.92$*
	2nd	911	668	73.3	243	26.7	
	3rd	503	349	69.4	154	30.6	
	4th	287	190	66.2	97	33.8	
	5th	134	83	61.9	51	38.1	
	6th	57	35	61.4	22	38.6	
Milk production	High	2052	1334	65.0	718	35.0	$X^2 = 287.0$*
	Low	1043	971	93.1	72	6.9	

Incidence of mastitis within different calving seasons of private and governmental Holstein-Friesian dairy farms was presented in Chart 1. The private sector had a higher mastitis incidence (40.4 & 38.5%, respectively) than the governmental sector (10 &4.3%, respectively) for winter and summer calving respectively.

Chart 1 Incidence of mastitis within different calving seasons of private and governmental Holstein-Friesian dairy farms

Incidence of mastitis within different parities within private and governmental Holstein-Friesian dairy farms was included in Chart (2). Private sector had higher mastitis incidence compared with governmental one, private sector within the 4th parity showed the highest incidence (54.5%), while governmental sector within 1st parity had the lowest incidence (4.5%).

3.2. Effect of mastitis on some productive and reproductive traits.

Data summarizing results for the effect of mastitis on 305MY, S/C and DO are included in Table 2. Milk yield differed significantly between healthy (7308.5Kg) and mastitic cows (7860.3Kg), Mastitic cows for private sector had the highest value (5904.3 Kg), while healthy cows for governmental sector had the lowest value (5066.5Kg), although Mastitic cows had the highest 305MY, mastitis reduced the 305MY of those cows by (33.7 & 20.3Kg) during disease period, and (62.7 & 37.7Kg) milk was discarded during the treatment period for private and governmental sector respectively. Regarding S/C, mastitis had a non-significant increase on S/C, it was (4.1 & 3.9) for mastitic and healthy cows, respectively. In responding to DO, also mastitis had a non-significant increase on DO, it was (215.4&214.7d) for mastitic and healthy cows respectively.

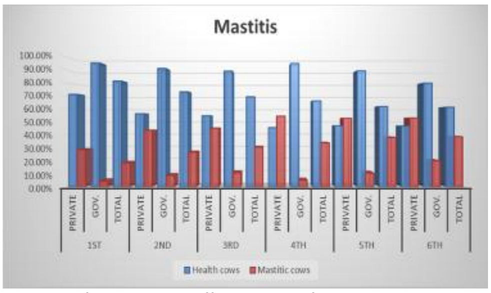

Chart 2 Incidence of mastitis within different parities of private and governmental Holstein-Friesian dairy farms.

Chart 3 Incidence of Mastitis between high and low milk producing Holstein-Friesian dairy cows.

Table 2 Effect of mastitis on some productive and reproductive traits of Holstein-Friesian dairy cows.

Cows	Sector	NO.	305 MY	S/C	Current DO
			Mean ± S.E	Mean ± S.E	Mean ± S.E
Healthy	Private	1051	$9550.5^{a}\pm80.42$	$3.8^{ab}\pm0.1$	$174.1^{d}\pm4.3$
	Gov.	1254	$5066.5^{c}\pm73.6$	$3.9^{b}\pm0.1$	$255.3^{a}\pm3.9$
	Total	2305	$7308.5^{B}\pm54.5$	$3.9^{AB}\pm0.1$	$214.7^{A}\pm2.9$
Mastitic	Private	689	$9816.4^{a}\pm99.3$	$4.8^{a}\pm0.1$	$204.2^{c}\pm5.3$
	Gov.	101	$5904.3^{b}\pm259.4$	$3.4^{b}\pm0.3$	$226.5^{b}\pm13.9$
	Total	790	$7860.3^{A}\pm138.9$	$4.1^{A}\pm0.1$	$215.4^{A}\pm7.4$

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 - (305MY): Total milk yield within 305 days - (S/C): Service per conception - (DO): Days open.

3.3. Economic losses of Mastitis

Data summarizing economic losses of mastitis were presented in Table 3. S/C cost was non-significantly increased in mastitic cow compared with a healthy one, it was (464.0& 427.5EGP, respectively). Concerning total costs of mastitis, they were differed significantly between private and governmental sectors, they were (834.8 &556.5 EGP, respectively), and these costs included reduced milk cost (236.5 & 142.3EGP, respectively), discarded milk cost (439.3&264.2 EGP, respectively), and treatment cost (158.9&150EGP, respectively). Finally, economic losses of mastitis per animal were 695.7 EGP yearly.

Table 3 Economic losses of mastitis.

Cows	Sector	NO.	S/C cost	Reduced milk cost	Discarded milk cost	Treatment cost	Total cost of mastitis
			Mean ± S.E	Mean ± S.E	Mean ± S.E	Mean ± S.E	Mean ± S.E
Healthy	Private	1051	458.5^{b}±10.1	-	-	-	-
	Gov.	1254	396.5^{c}±9.2	-	-	-	-
	Total	2305	427.5^{AB}±6.8	-	-	-	-
Mastitic	Private	689	584.5^{a}±12.4	236.5^{a}±4.0	439.3^{a}±3.6	158.9^{a}±0.1	834.8^{a}±5.5
	Gov.	101	343.6^{d}±32.5	142.3^{b}±6.8	264.2^{b}±9.4	150^{b}±0.2	556.5^{b}±14.5
	Total	790	464.0^{A}±17.4	224.5±3.8	351.8±5	154.5±0.1	695.7±7.8

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 - (S/C): Service per conception.

3.4. Effect of mastitis on economic indices.

Data summarizing results for the effect of mastitis on TVC, TC, TR and NP are presented in Table 4. TVC increased significantly for healthy cows (29053.3EGP) compared with Mastitic cows (28739.1EGP), but by the addition of TFC and disease cost, TC became higher for mastitic cows (32284.0EGP) than healthy cows (31873.5EGP). Regarding TR and NP, they increased significantly for mastitic cows (61872.3 7& 29588.3EGP, respectively) than healthy cows (58011.6 & 26138.1EGP, respectively).In responding to partial measures (TR/NP%), it was slightly higher for a healthy cow of the private sector (215.9%) compared with mastitic one in the same sector (214.6%), but totally it was significantly higher for Mastitic cows (206.9%) than healthy ones (174.4%).

Table 4 Effect of mastitis on economic indices of Holstein-Friesian dairy cows.

Cows	Sector	NO.	TVC	TC	TR	NP	TR/TC%
			Mean±S.E	Mean±S.E	Mean±S.E	Mean±S.E	Mean±S.E
Healthy	Private	1051	31259.0^{a}±69.2	34174.1^{b}±71.0	74111.7^{a}±562.9	39937.6^{a}±524.0	215.9^{a}±1.1
	Gov.	1254	26847.7^{b}±63.4	29572.9^{c}±65.0	41911.5^{c}±515.3	12338.7^{c}±479.7	139.6^{c}±0.7
	Total	2305	29053.3^{A}±46.9	31873.5^{B}±48.1	58011.6^{B}±381.6	26138.1^{B}±355.2	174.4^{B}±1.1
Mastitic	Private	689	31407.7^{a}±85.5	35136.7^{a}±87.7	75964.4^{a}±695.2	40827.7^{a}±647.2	214.6^{a}±2.6
	Gov.	101	26070.4^{c}±223.2	29431.2^{c}±229	47780.1^{b}±1815.9	18348.9^{b}±1690.4	154.5^{b}±4.8
	Total	790	28739.1^{B}±119.5	32284.0^{A}±122.6	61872.3^{A}±972.2	29588.3^{A}±905.0	206.9^{A}±2.0

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 - (TVC): Total variable cost – ((TC): Total cost (TR): Total return – (NP): Net profit.

4. DISCUSSION

Mastitis is a multi-etiological complex disease that adversely affects the animal health, and economics of milk production of dairy farms in developing and developed countries. A variety of non-genetic factors affect the incidence of clinical mastitis, so in this study, we tried to investigate different factors affecting mastitis incidence, such as calving season, parity, and different milk production level of Holstein-Friesian dairy cows. Concerning calving season, incidence of clinical mastitis (CM) was higher in the winter calving than in summer one. This result may be due to that the wet season is very suitable for growth of the most types of microorganism causing mastitis (Dego and Tareke, 2003), also Fadlelmoula et al. (2007) illustrated that the high frequency of mastitis in winter season may be attributed to teats exposure to a dirty environment, and teat lesions with intramammary infections. These results agreed with El-Tarabany and Ali (2015a) who concluded that winter calving was associated with a higher incidence of mastitis than those calved during summer, also Sharma et al. (2016) showed that cows calved during winter (rainy) season are more susceptible to infection, with more number of somatic cells count (SCC) in their milk. Regarding parity order, the incidence of mastitis increased with increasing parity, this result may be due to the older animals are more susceptible to infection than younger ones, as with advancing age, the udder becomes more pendulous leads to increasing the risk of teat injury and exposed it to microbial infections (Radostits et al., 2000), also younger cows (primiparous) had higher defense mechanism (Polymorph nuclear leukocyte function is more active)compared with aged cows (multiparous)(Dego and Tareke, 2003).This result agreed with Elghafghuf et al. (2014) and Abebe et al. (2016) who concluded that Parity (older cows) and the early lactation period are important risk factors for CM. Regarding milk yield, high producing cows had a higher incidence of mastitis compared with low producing cows, this result agreed with Jamal et al. (2018) who recorded that the most important risk factors for mastitis recurrence were parity (older cows) and higher milk production, also Sinha et al. (2019) recorded that the percentage of incidence of clinical mastitis was maximum in high milk-producing cows. Finally, these results in the same line with Ibrahim and Ghanem (2019) who found that mastitis incidence differed significantly among milk yield, parity and calving season. The private sector had higher mastitis incidence than governmental one for both calving season and parity order. This result may be due to private sectors had higher milk yield compared with governmental one, and high milk-producing cows are more susceptible to mastitis than low producing one (Jamali et al., 2018). Regarding the effect of mastitis on some productive and reproductive traits of Holstein-Friesian dairy cows.305MYdiffered significantly between healthy and mastitic cows, for the private sector and had the highest value, while healthy cows for governmental sector had the lowest value. These results may be due to that the high milk-producing cows are more susceptible to mastitis than the low producing one, so mastitic cows in general had the highest milk production, but within disease period milk decreased by 35% and remained milk were discarded for three days (period of treatment).Therefore, there were milk reduction and economic losses for mastitic cows during this period, although as a whole mastitic cows were high milk producing. These results were in accordance with Ibrahim and Ghanem (2019) who explained that mastitis had an adverse effect on the productive and economic efficiency of dairy farms due to the reduction of milk yield, milk returns and increasing the costs of treatment, while disagreed with El-Tarabany and Ali (2015b) and who concluded that mastitic cows had significantly decreased 305MY compare to healthy ones , Regarding S/C and DO, mastitis had higher S/C and DO compared to healthy ones, this result was nearly similar to Mohapatra and Ashutosh (2017) who showed that cows that suffered from mastitis after first AI had increased S/C and Days open. Concerning the effect of mastitis on economic indices of Holstein-Friesian dairy cows. TVC increased significantly for healthy cows compared with Mastitic cows, but by the addition of TFC and disease cost, TC became higher for mastitic cows than healthy cows. Regarding TR and NP, they increased significantly for mastitic cows than healthy ones. The high TR and NP may be related to high milk production, but if those cows did not suffer from mastitis they will give higher 305MY, TR, NP, also by estimating TR/NP%, it was slightly higher for a healthy cow of private sector compared with mastitic one in the same sector, but totally it was significantly higher for mastitic cows than healthy ones. These results may be due to cow related-factors, as the highest percentage of mastitic cows are highly producing cows, so with mastitis the milk decreased but still higher than healthy ones (low producing cows). This result nearly agreed with Ibrahim and Ghanem (2019) who explained that mastitis reduced the productive and economic efficiency of dairy farms due to the reduction of milk yield, milk returns and increasing of treatment cost, while disagreed with El-Tarabany and Ali (2015b) who recorded that mastitis decreased total returns / total cost % versus healthy cows.

5. CONCULSION

Environmental factors are important risk factors causing CM in dairy herds. In our study, we tried to investigate non-genetic factors (calving season, parity, level of milk production and production sector) that affect the incidence of CM. Winter calving, older cows, high-producing cows and private sector had the highest mastitis incidence, mastitis reduced the 305-MY of Mastitic cows by (33.7 & 20.3Kg) during disease period, and (62.7 & 37.7Kg) milk was discarded during the treatment period for private and governmental sector respectively. Finally, economic losses of mastitis per animal estimated 695.7 EGP yearly, so we recommended that cows after the fifth parity should be culled from the dairy herd, with high care during the winter season to keep the udder clean and dry, and give the high producing cows immunostimulant drugs to reduce the incidence of mastitis.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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