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GENETIC AND NON GENETIC EFFECTS ON MASTITIS DISEASE IN FRIESIAN COWS

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ABSTRACT

The data of 1388 productive records for 279 Friesian cows were studied during the period from 1987 to 2008 in dairy farm belonging to Faculty of Agriculture, University of Alexandria.

The traits under study were total milk yield (TMY, kg), 305 day milk yield (305-dMY, kg), lactation length (LL, days), persistency of lactation (Per, kg), first service period (FSP, days), days open (DO, days), and mastitis score (M.Score). The model included the fixed effects of parity, year of calving, season of calving and age at first calving as fixed effects and errors. Mean of mastitis score was (0.023 ± 0.002). Analysis of variance showed significant effects (P< 0.0001) of parity, year of calving and age at first calving on mastitis score, while, non significant effects of season of calving on mastitis score. Heritability estimate for mastitis score was 0.119. Also, genetic correlation among mastitis score and all traits studied were positive, while, phenotypic correlation were lower positive and negative values. Also, estimated breeding values of mastitis score for cows, dams and sires were 0.022, 0.015 and 0.008, respectively. Additions, when the averages of the traits under the study increased the times of infection increased except persistency. Also, the present results showed that numbers of infected cows by mastitis were increased in multiparious, older ages at first calving and winter season.

INTRODUCTION

Mastitis is one of the important diseases in dairy herds. It is characterized by visible signs such as clots and flakes in the milk (Hamann, 2005), and decreased milk production, swelling of the udder, pain of the quarter and increased body temperature (Smith and Hogan, 1993, and Harmon, 1994).

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Mastitis score was affected by many factors such as sire, parity and year of calving which had significant effect on this trait (Dohoo *et al*., 1984 and Kadarmideen *et al.*, 2001). While, non significant effect was observed by Badran (1989) for effect of parity. Also, Ettema and Santos (2004) showed that the cows were calving during summer and fall tended to have a higher incidence of mastitis than those were calving in winter and spring months. While, Bunch *et al*. (1984) observed that cows calved in winter tended to have mastitis earlier in lactation than those were calved in the other seasons of the year. Addition, Wanner *et al.* (1999) observed that older cows had more incidence of mastitis than earlier cows, while, Ettema and Santos (2004) found that older cows had less incidence than earlier ones.

Also, heritability values estimated were obtained by many investigators such as Bloemhof *et al*. (2009) and Hansen *et al.* (2002) were 0.03 and 0.037, respectively. While genetic and phenotypic correlations were estimated by Kadarmideen *et al*. (2000) found that correlation values were 0.03 and 0.35, respectively.

MATERIALS AND METHODS

The data of 1388 productive records for 279 Friesian cows were studied during the period from 1987 to 2008 in dairy farm belonging to Faculty of Agriculture, University of Alexandria, situated at 10 km far from Alexandria City. The animals were under the prevailing feeding and management regiems practiced in the farm. The animals were housed free in open yards; they were fed clover (*Trifolium Alexandrinum*) for nearly six months from November to May. During summer and autumn months (June to October) the animals were fed on green sorghum. Concentrate rations were fed twice daily according to weight of the animals and their milk production level. The cows were artificial inseminated by frozen semen. Heifers were served for the first time when they reached 15-18 month of age and 350 Kgs live body weight. Pregnancy was detected by rectal pulpation on day 60 after the last service. Cows were machine milked twice daily at 6.00 a.m., and 5.00 p.m in herring bone parlor.

The data of clinical mastitis were of a binomial distribution, since the scoring of clinical mastitis was either resistant or infected. Modification of the data of the score for clinical mastitis was the percentage of months of lactation during which the cows had clinical mastitis one or more time. Range of possible scores was from Zero to 100 (Young *et al.* (1960)). In the present study, the cows were divided into 4 classes (0, 1, 2, 3 and over)

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according to their rate of infection by mastitis. The study aimed to investigate the changes in rate of infection by mastitis during different parities, years of calving, seasons of calving and ages at first calving and also to study the effect of mastitis on some milk productive and reproductive traits.

Data were analyzed by linear mixed model least squares analysis with unequal subclass numbers using the PROC GLM procedure of SAS (SAS, 2004).

The following model was used:

$$Y_{ijklm} = \mu + S_{\mathbf{i}} + A_{\mathbf{j}} + P_{\mathbf{k}} + C_{\mathbf{l}} + Dm + e_{ijklmn}$$

Where:

Y_{ijklm} = the individual observation of M.Score;

μ = the overall mean,

$S_{\mathbf{i}}$ = the random effect of i th sire,

$A_{\mathbf{j}}$ = the fixed effect of j th age at first calving,

$P_{\mathbf{k}}$ = the fixed effect of k th parity,

$C_{\mathbf{l}}$ = the fixed effect of l th calving year

$D_{\mathbf{m}}$ = the fixed effect of m th season of calving and

$\mathbf{e_{ijklmn}}$ = the error term, assumed to be randomly and independently distributed with a mean equal to 0 and variance equal to δ^2e.

Heritability, genetic and phenotypic correlation, and breeding value were estimated by using Multiple Traits Derivative Free Restricted Maximum Likelihood (MTDFREML) according to Boldman *et al.* (1995) by using Animal Model.

RESULTS AND DISCUSSION

There were some genetic and non genetic factors affecting mastitis score (Table 1). The results obtained showed that sire, parity, year of calving and age at first calving had highly significant effects on mastitis score. Similar result were obtained by Dohoo e*t al*. (1984), Fleischer *et al*. (2001), Kadarmideen *et al*. (2001) and Wanner *et al*. (1999), respectively. On the other hand, season of calving had non significant effect on mastitis score, the same result for effect of season of calving on mastitis score was observed by Bunch *et al*. (1984).

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Table (1): Analysis of variance for some factors affecting mastitis score (M. Score).

S.O.V	Mean Square
Sire	0.009****
Parity	0.021****
Year of calving	0.059****
Season of calving	0.002
Age at first calving	0.006****

****** P <0.0001**

From figure (1), the results showed that mastitis score significantly increased with advancing parities, the highest mastitis score was 0.055±0.009 in lactation ≥6 and the lowest one was 0.011±0.006 in the first lactation. It contributed this trend with the increase of the rate of milk production during parities. The present results were agreed with Kadarmideen *et al*. (2001) they observed that the means incidence mastitis for the first, second, third and fourth parity were 0.060, 0.068, 0.083 and 0.098, respectively. This may be related to increasing production with age and that resistance becomes poorer for mature cows.

Mastitis score was ranged from 0.004±0.008 in the year 1997 to 0.086±0.008 in the year 1993. Differences in mastitis score were highly significant during years of calving and their averages tend to decreased with years as shown in figure (2). It may explain due to improving health management in herd from year to another year besides improved environmental conditions. In the same trend, Kadarmideen *et al.* (2001) reported that the highest incidence of mastitis (0.089) was in the year 1994 and the lowest value (0.051) in the year 1997. In general, the effect of year of calving was due to nutritional and other managerial conditions from year to another.

Mastitis score was ranged from 0.028 in autumn to 0.031 in winter as shown in figure (3). The differences of Mastitis score during seasons of calving were not significant. The highest mastitis score for cows in spring and winter may explain due to higher milk production for cows which calved

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in spring and winter seasons. There results were agreement with those reported by Kadarmideen *et al.* (2001), they observed that the means incidence mastitis for summer, autumn, winter and spring seasons were 0.067, 0.069, 0.071 and 0.078, respectively for Holstein Friesian in the United Kingdom. In general, the effect of season of calving was due to the changes in climatic conditions and seasonal differences in nutrition.

Differences in mastitis score due to age at first calving (AFC) were significant (P <0.0001) as shown in table (1). It is evident from the results presented in figure (4), that the highest mean of M.Score was 0.041 and the lowest one was 0.022 for the heifers calved for the first time at 25-28 and 33-36 months of ages, respectively, and that M.Score tended to decreased with advancing AFC. This may be attributed to that heifers calved later for the first time were more resistant.

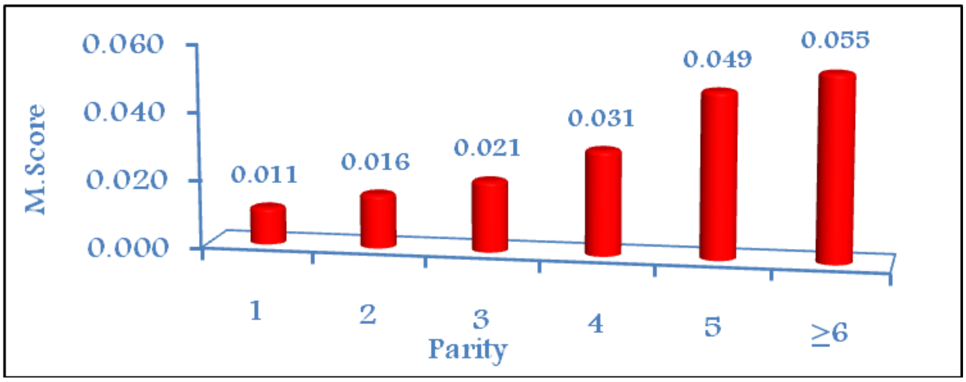

Figure (1): The averages of mastitis score in different parities.

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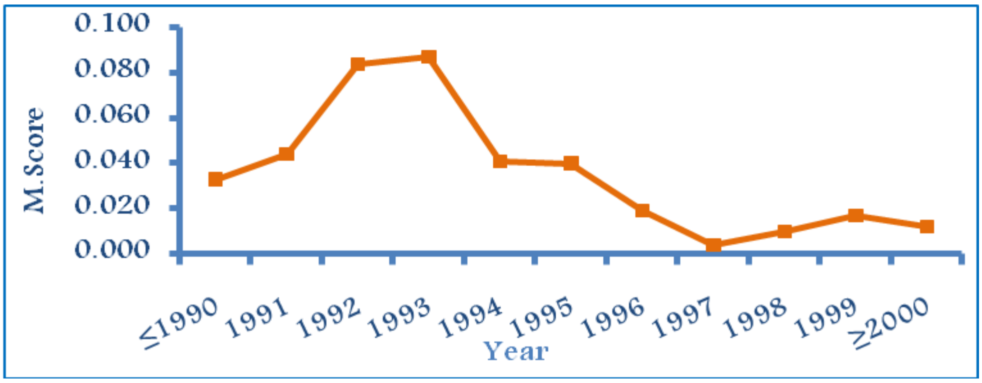

Figure (2): The averages of mastitis score in different years of calving.

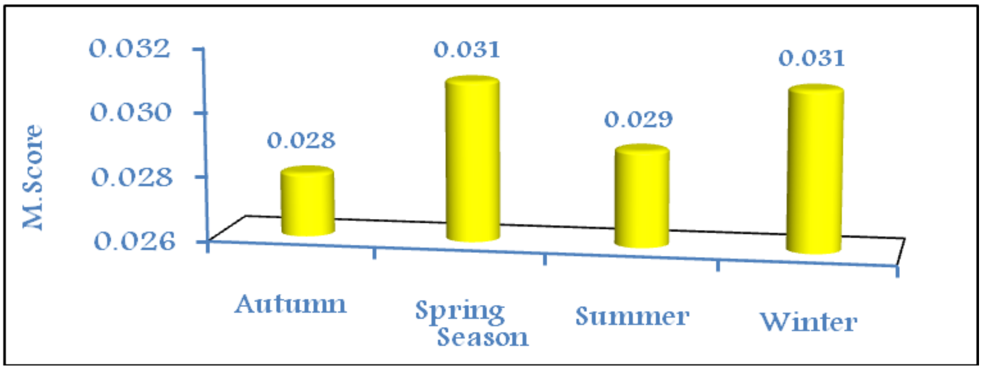

Figure (3): The averages of mastitis score in different seasons of calving.

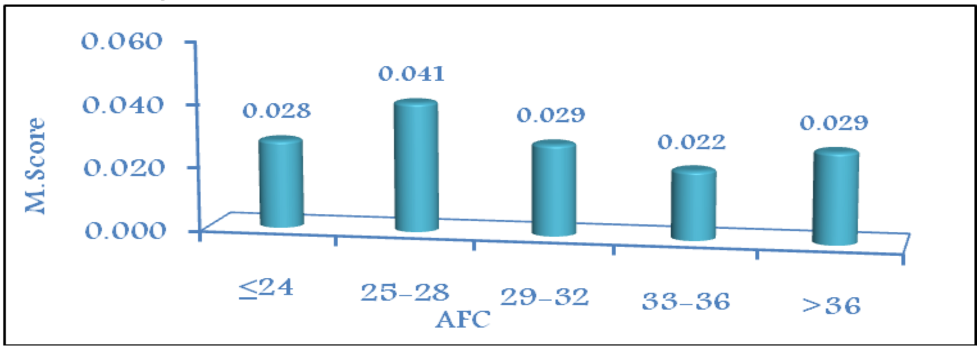

Figure (4): The averages of mastitis score in different classes ages at first calving.

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Mastitis infection effects:

The changes of mastitis infection times with some milk productive and reproductive traits are presented in table (2). Cows which were infected by mastitis 3 times and over had the highest 305 day milk yield (4511.9±167.3 kg) than those not infected by mastitis (4206.1±28.9 kg) while the differences among means of 305 day milk yield during classes of infection were not significant. Similar result was observed by Ghanem *et al*. (1991) who found that the average 305-days milk production of 112 cows affected with mastitis in their first or second lactation was 3506 kg, while the average of comparable health 173 cows was 2921 kg.

In the same trend, there were no significant differences between means of peak yield in different classes of infection by mastitis disease, and the highest peak yield (22.6±0.7 kg) was observed for cows infected by mastitis 3 times and over, but the lowest one (21.8±0.2 kg) was scored by cows non infected cows. These results disagree with, El Zubeir and El Owni (2006) who showed that mastitis decreased the level of peak yield for the first, second and third parities in Friesian cows in Sudan. Also, El Owni and El Zubeir (2006) found that the peak yield decreased due to infection during the second lactation, when comparing healthy and newly infected cows with those infected previously during, both the first and second lactations

Persistency of lactation tended to decrease by increasing times of mastitis infection; healthy cows had the highest persistency (194.6±1.3 kg) than those infected 3 times and over (187.9±7.4 kg), whereas differences between persistency means according to number of infections were not significant. This result was in agreement with Niroshan (2006) who observed that there were negative effects of mastitis on persistency, it decreased with increasing mastitis infection, and it increased more in multiparious cows than that in primiparious ones.

Table (2) showed that when the averages of life time milk yield increased, the number of infection by mastitis increased, and the differences between these means were significantly. This means that higher producers cows were more infected with mastitis than lower producers and the times of infection increased with advanced the lactation. Pytlewski *et al.* (2010) found that mastitis had effect on

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culling rate which decreased longevity or life time milk yield for Polish Black-and-White Holstein-Friesian cows.

Also, days open was increased with advancing number of infection by mastitis, and the longest days open (167.5±28.9 days) was noticed for cows infected 3 times and over, but the lowest one (112.3±5.9 days) was scored by cows infected only one time by mastitis disease, and the changes of days open during different number of infections were significant. Similar result was obtained by Tomlinson *et al*. (2008) who found that clinical mastitis had effect on days open and increase the period from calving to conception from 85.4 to 143.5 days for Holstein cows

Table (2): The effect of mastitis infection on Friesian cattle performance (X ±S.E).

Mastitis Classes	No. Cows	%	Traits				
			305 day milk yield	Peak yield	Persistency*	Life time yield	Days open
0	1195	86.1	4206.1±28.9	21.8±0.2	194.6±1.3	14838.9^{c}±257.1	129.1^{b}±2.4
1	120	8.64	4319.9±96.7	21.9±0.1	191.2±3.3	15388.5^{cb}±918.4	112.3^{b}±5.9
2	43	3.1	4424.5±152.1	22.5±0.6	191.2±1.3	16840.4^{b}±1546.4	120.9^{b}±11.7
3 and over	30	2.16	4511.9±167.3	22.6±0.7	187.9±7.4	19019.7^{a}±2382.8	167.5^{a}±28.9

Value with the same superscript in each column are not significantly different ^{a,b,c} ($P<0.05$).

(*) Persistency = Total milk yield / Peak yield.

The frequency of numbers and percentages of infection by mastitis during parity were shown in table (3), the monoparious cows had the lowest numbers of infection than multiparious cows, this may be explained due to increasing of milk production with advancing parities. In multiparious cows, the risk of developing clinical mastitis

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increases with increasing parity (Steeneveld *et al*., 2008). Multiparious cows suffer more severe yield loss than primiparious cows (Hortet *et al*., 1999 and Bennedsgaard *et al*., 2003). Also, there were differences in numbers and percentages of cows infected by mastitis from year to another, the highest numbers and percentages were during the period from 1992 to 1995, these results may be due to bad environmental conditions and management.

From table (3), the highest percentages of mastitis infections were observed in winter followed by autumn or summer seasons, these results may be attributed to climatic conditions. In this respect, the percentages of mastitis infection tend to increase gradually with increasing AFC till 33-36 month of age and then it decreased and that younger heifers had lower percentages of mastitis infection. It may be due to increasing milk yield with advancing ages of heifers at first calving.

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Table (3): The numbers and percentages of mastitis infection in Friesian cattle during parity, year of calving, season of calving and age at first calving.

Factor		No. Records	Mastitis classes							
			0		1		2		3 and over	
			No	%	No	%	No	%	No	%
Parity	**Monoparious**	270	224	18.7	27	22.5	10	23.3	9	30
	Multiparious	1118	971	81.3	93	77.5	33	76.7	21	70
Year	**≤1990**	89	81	6.8	6	5	2	4.7	0	0
	1991	53	43	3.6	6	5	1	2.3	3	10
	1992	72	46	3.8	14	11.7	7	16.3	5	16.7
	1993	129	75	6.3	30	25	15	34.9	9	30
	1994	150	117	9.8	23	19.2	8	18.6	2	6.6
	1995	193	155	13	28	23.3	5	11.6	5	16.7
	1996	169	154	12.8	10	8.3	2	4.7	3	10
	1997	119	119	10	0	0	0	0	0	0
	1998	121	121	10.1	0	0	0	0	0	0
	1999	100	100	8.4	0	0	0	0	0	0
	≥2000	193	184	15.4	3	2.5	3	6.9	3	10
Season	**Autumn**	407	361	30.2	29	24.2	8	18.6	9	30
	Spring	351	308	25.8	28	23.3	10	23.2	5	16.7
	Summer	291	246	20.6	27	22.5	14	32.6	4	13.3
	Winter	339	280	23.4	36	30	11	25.6	12	40
AFC	**≤24**	312	276	23.1	26	21.7	6	14	4	13.3
	25-28	223	195	16.3	13	10.8	9	20.8	6	20
	29-32	440	371	31	45	37.5	14	32.6	10	33.4
	33-36	274	240	20.1	22	18.3	8	18.6	4	13.3
	>36	139	113	9.5	14	11.7	6	14	6	20
Total		**1388**	**1195**	**100**	**120**	**100**	**43**	**100**	**30**	**100**

Genetic and phenotypic correlation (r_G and r_P)

The present results in table (4) showed that there were a positive genetic correlation between mastitis scores and each of total milk yield, 305 day milk yield, lactation length, persistency, first service period and days open which being 0.90, 0.47, 0.93, 0.28, 0.25 and 0.40, respectively. This means that the cows which improved genetically for high milk production and more persistency would be associated with more susceptibly to mastitis infection.

In the same trend, Carlen *et al*. (2004) reported that genetic correlation between total milk yield and mastitis score was 0.45 in the second lactation. Also, Kadarmideen *et al.* (2000) found that genetic correlation between 305 day milk yield and mastitis score was 0.35.Addition, the same authors observed that genetic correlation between first services period and mastitis score was 0.32. However, Badran (1989) recorded that genetic correlation between persistency and mastitis score was –0.13.

Also, from the same table, phenotypic correlations between mastitis score and each of total milk yield, 305 day milk yield, lactation length, persistency, first service period and days open were 0.004, 0.03, -0.02, -0.05, 0.004 and 0.02, respectively and these results indicated that selection for one of the previous traits weakly effect on mastitis score.

Similarly, Kadarmideen *et al.* (2000) indicated that phenotypic correlation between 305-day milk yield and mastitis score were 0.02 and 0.04. Addition, the same researchers observed that phenotypic correlation between first service period and mastitis score was 0.02. On the other hand, Badran (1989) reported that phenotypic correlation between persistency and mastitis score was -0.72.

Table (4): The estimates of genetic (r_G) and phenotypic (r_P) correlations among mastitis score and some milk production and reproductive traits.

Traits	**Mastitis Score**	
	r_G	r_P
Total milk yield	0.90	0.004
305 day milk yield	0.47	0.03
Lactation length	0.93	-0.02
Persistency	0.28	-0.05
First service period	0.25	0.004
Days open	0.40	0.02

Breeding value (BV)

In the present study, heritability value estimated for mastitis score was 0.119 as shown in table (5), this result was slightly equal to that estimated by Kadarmideen *et al*., 2000 (0.126) in the second lactation for Holstein Friesian cattle. On the other hand, it was higher than that recorded by Bloemhof *et al*., 2009 (0.03). In the present study, because of this estimate was lower, so susceptibility of cows for mastitis infection may be more depended on environment than genetic.

Also, the cows breeding values (BV'C) estimates for mastitis score were ranged from -0.012 to 0.010 and the accuracy of breeding values of cows for mastitis score was 0.95. While, the dams breeding values (BV’D) estimates for mastitis score were ranged from -0.008 to 0.007 and its accuracy was 0.57. Addition, the sires breeding values (BV'S) estimates for mastitis score were ranged from -0.003 to 0.005 and its accuracy in this respect was 0.60, as shown in table (5). These results refer to the major effect of cow breeding value for this trait compared with their dams and sires breeding value.

Table (5): Estimates of heritability and breeding values of cows (BV'C), dams (BV'D) and sires (BV'S) for mastitis score for Friesian cattle.

BV	Mastitis Score (h^2=0.119)				
	No	**Max**	**Min**	**Range**	**Accuracy**
BV'C	279	0.010	-0.012	0.022	0.95
BV'D	211	0.007	-0.008	0.015	0.57
BV'S	55	0.005	-0.003	0.008	0.60

Genetic trend

From figure (5), the BV'C for M.Score were fluctuated from year to another and the

highest cows breeding values were scored in the year 1996, but, the year 1995 scored the lowest value, while, the dams breeding values

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took consistent trend during different years, Also, the sires breeding values were took the same trend as dams breeding values, but, the year 1998 scored the lowest value.

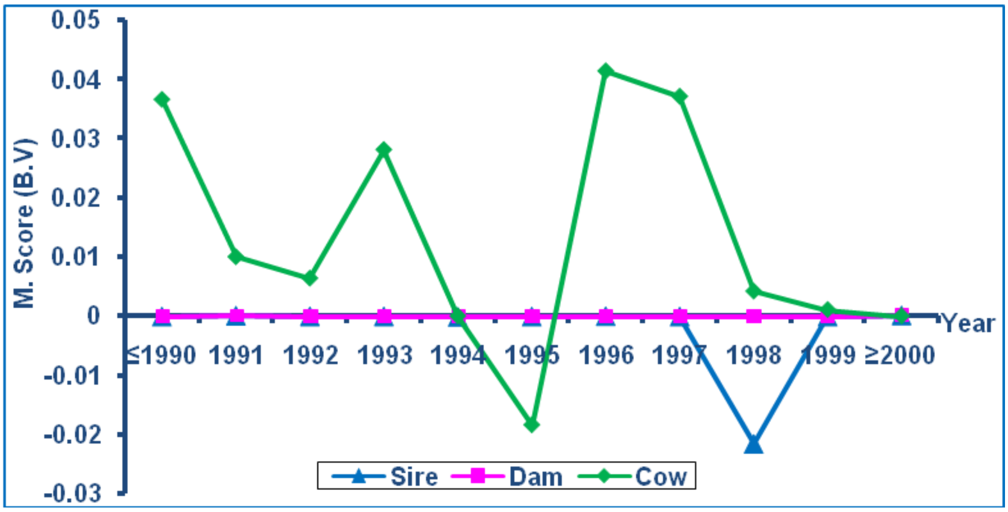

Figure (5): Genetic trends of breeding values for mastitis score in cows and their dams and sires.

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الملخص العربى

التأثيرات الوراثية وغير الوراثية على الاصابه بمرض التهاب الضرع فى أبقار الفريزيان

تم استخدام 1388 سجل لبن خلال الفترة من سنه 1987 حتى سنه 2008 لعدد 279 بقرة فريزيان فى مزرعة إنتاج الألبان التابعة لكلية الزراعة جامعه الاسكندريه.

وتتلخص أهداف الدراسه فى:

دراسه تأثير بعض العوامل البيئيه (ترتيب موسم الحليب ، سنه الولادة ، موسم الولادة و العمر عند أول ولادة) وكذلك تأثير الطلوقه على صفه معدل الاصابه بالتهاب الضرع وكذلك دراسه العلاقه مابين صفة معدل الاصابه بالتهاب الضرع وبعض الصفات الانتاجيه (انتاج اللبن المعدل لـ 305 يوم ، انتاج اللبن طوال الحياة الانتاجيه ، اعلى متوسط انتاج لبن و المثابرة على الحليب) وبعض الصفات التناسليه (الفترة المفتوحه) ، كذلك تم تقدير بعض المعايير الوراثيه والمظهريه (المكافئ الوراثى ، الارتباط الوراثى والارتباط المظهرى) وكذلك تم تقدير القيمه التربويه لصفه معدل الاصابه بالتهاب الضرع.

والنتائج المتحصل عليها يمكن استعراضها بايجاز فيما يلى:

بلغ المتوسط العام لصفه معدل الاصابه بالتهاب الضرع 0.023±0.002 ، وقد كان لكل من الطلوقه وترتيب موسم الحليب وسنه الولادة والعمر عند أول ولادة تأثير عالي المعنوية على صفه معدل الاصابه بالتهاب الضرع بينما لم يكن لموسم الولادة أى تأثير معنوى على تلك الصفه.

وقد وجد أنه لم تكن هناك أى اختلافات أو فروقات معنويه ما بين متوسطات كل من صفه انتاج اللبن المعدل لـ 305 يوم وصفه أعلى متوسط انتاج لبن وصفه المثابرة على الحليب ، من جهه أخرى وجدت هناك اختلافات معنويه ما بين متوسطات كل من صفه انتاج اللبن الكلى طوال الحياة الانتاجيه ومتوسطات صفه الفترة المفتوحة.

قيمه المكافئ الوراثي لصفه معدل الاصابه بالتهاب الضرع بلغت 0.119 ، فى حين أخذت جميع قيم الارتباط الوراثى بين تلك الصفه والصفات الانتاجيه والتناسلية موضع الدراسة قيما موجبه بينما كانت قيم الارتباط المظهرى بين تلك الصفه و والصفات الانتاجيه والتناسلية تحت الدراسه منخفضه وأخذت قيما موجبه وأخرى سالبه.

وكانت القيمه التربويه لصفه معدل الاصابه بالتهاب الضرع للأبقار والأمهات والطلائق 0.022 ، 0.015 ، 0.008 على الترتيب.