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EFFECT OF INBREEDING ON DAIRY TRAITS OF FRIESIAN COWS IN EGYPT

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ABSTRACT

A total of 2161 normal lactation records of Friesian cows kept at Sakha Farm of the Animal Production Research Institute, Ministry of Agriculture, Egypt during the period from 1978 to 2000 were used for measuring the level of inbreeding coefficients in this herd. The traits of concern were milk yield 305 days (305dMY), lactation period (LP), dry period (DP), days open (DO), lifetime milk yield (LTMY), total lactation period (TLP) and number of lactations completed (NLC). Inbreeding coefficients had no significant effect on 305 d MY, LP, DP and DO, but had highly significant effects on LTMY, TLP and NLC. A percent of 73.56 of cows were considered non inbred. Percent of Inbreeding depression per 1% increase of inbreeding was calculated to be -0.52 kg for 305dMY, -0.42 days for LP, -2.6 days for DP, +0.48 days for DO, -1.39 kg for LTMY, -1.65 days for TLP and +6.19 % lactation for NLC, when the level of inbreeding was from 0 to 6.25%. The corresponding percentages were -0.61 kg, -0.47 days, -1.37 days, +2.02 days, -2.8 kg, -2.42 days and +4.13 % lactation, respectively for the above traits, when the level of inbreeding was from 0 to 12.50%. The effects of inbreeding were cumulative and relatively larger on lifetime production traits than milk yield traits. This indicates the necessity for active management of the rate of inbreeding in dairy traits to monitor and control it in a breeding programme. The present study concluded that the losses due to inbreeding can easily be minimized through careful attention to identification of the mating and computerized mate selection programmes.

Keywords: inbreeding coefficient, inbreeding depression, milk yield traits, lifetime production traits, Friesian cows, Egypt.

INTRODUCTION

Inbreeding occurs when two related animals are mated together. The progeny of this mating is inbred and is likely to have more genes in common compared to the offspring of two unrelated animals. However, to a certain point, we can have many related animals in the population and still avoid strong inbreeding in our animals by choosing parents to made that are less related than average. Unfortunately, over time an increase in familial relationships within the population will catch up with the population and it will no longer be easy to avoid matings of closely related individuals, this will lead to the inability to avoid inbreeding in our dairy populations. To a large extent we face this problem today (SØrensen *et al.*, 2005). Similarly, Freyer *et al.*, (2005) clarified that current trends toward increased relationship between daughters of frequently used sires indicate that inbreeding will become increasingly difficult to avoid in the future.

The breeding strategies currently applied in dairy cattle breeding are effective in generating genetic gain. However, the reproductive technologies used have increased the focus on the superior animals, especially bulls, this will increase the probability of generating inbred animals. Associated with inbreeding is the decline in performance usually known inbreeding depression (Smith *et al.*, 1998).

Effects of inbreeding on productive and reproductive traits of dairy cattle are well defined by many authors in different countries (Smith *et al.*, 1998 and Thompson *et al.*, 2000) Vice versa, Vasconcellos and Tonhati (1998) reported non significant effect of inbreeding on milk yield, calving interval and age at first calving of Murrah buffaloes in Brazil.

The objectives of the present study were to estimate the inbreeding levels in a herd of Friesian cows in Egypt and to evaluate its effects on 305 days milk yield, lactation period, dry period, days open, lifetime milk yield, total lactation period and number of lactation completed after adjusting for some environmental factors.

MATERIALS AND METHODS

A total of 2161 normal lactation records collected from 696 Friesian cows kept at Sakha Farm, of the Animal Production Research Institute, Ministry of Agriculture, Egypt during the period from 1978 to 2000 were used in this study. Abnormal records affected by mastitis, udder troubles or reproductive disorders were excluded. Cows were kept loose under semi-open sheds all the year around and were grazed on Egyptian clover (*Trifolium alexandrinum*), from December to May, otherwise, were fed on limited amounts of clover hay and rice straw. Concentrate rations were offered according to milk production and pregnancy status. All reasons of cow disposal were considered when dealing with longevity except cows sold for production purposes.

The traits of concern were 305 days milk yield (305 d MY), lactation period (LP), dry period (DP) , days open (DO), lifetime milk yield (LTMY), lifetime lactation periods (TLP) and number of lactation completed (NLC).

The inbreeding coefficients (F) were calculated for each individual cow (Wright, 1922) using the MTDFNRM model of the MTDFREML program according to (Boldman *et al.*, 1995) and cows(696) were categorized according to their inbreeding level into: non inbred (F = zero, N = 512), lowly inbred (F = >zero to 6.25, N = 171) and mildly inbred (F > 6.25 to 12.50%, N = 13). Data were adjusted for the fixed effects using the least squares method.

Statistical analysis

Analysis was performed by the least squares method using the GLM procedure of the SAS, (1990) according to the following model.

$Y_{ij} = u + k_i + e_{ij}$

Where: Y_{ij} is the dependent variable (305 d MY, LP, DP, DO, LTMY, TLP and NLC); U is the overall mean; K_i includes the fixed effects and e_{ij} is the random error ~ N (0, o^2).

The fixed effects considered for 305 d MY, LP, DP and DO traits were month of calving (1, 2, 3,……and 12), year of calving (1981, 1982,……and 2000), order of lactation (1,2,……and 9) and class of inbreeding coefficient levels (1, 2 and 3) and LTMY, TLP and NLC traits the fixed effects were month of birth (1, 2,…..and 12), year of birth (1978, 1979,……and 1996) and class of inbreeding coefficient levels (1, 2 and 3).

RESULTS AND DISCUSSION

Means, standard deviations (SD) and coefficients of variation (CV %) for 305 d MY, LP, DP, DO, LTMY, TLP and NLC are presented in Table1.

The values of the CV's were generally high for all traits reflecting large amount of variations among cows specially for DP, DO and LTMY.

Least squares analysis (Table 1) showed a highly significant effect for year of calving on all milk yield traits. In the same manner, month of calving on 305dMY. Results of the current study agree well with Sultan and Khattab (1989), Khattab and Ashmawy (1990), Khattab and Sultan (1991) and El-Arian (2005), whose researches were performed on Friesian cattle in Egypt. Effects of month and year of calving might due to the changeable climatic and nutritional conditions around and across years.

Also, highly significant effect was found for both inbreeding level and year of birth on all lifetime production traits. While the effect of inbreeding level was not significant on all milk yield traits.

Table (1): Summary of unadjusted means, standard deviations (SD), coefficients of variability (CV%) and test of significance of different factors affecting milk yield and lifetime production traits studied in Friesian cows.

Trait	Means	SD	CV%	Test of significant					
				df: Month of calving	Year of calving	Order of lactation	Class Inbreeding coefficient	Month of birth	Year Of birth
				11	19	8	2	11	18
305dMY, kg	2585	997	38.6	**	**	*	NS	----	----
LP, days	315	101	32.1	NS	**	NS	NS	----	----
DP, days	129	29	71.7	NS	**	NS	NS	----	----
DO, days	168	108	64.4	NS	**	NS	NS	----	----
LTMY, kg	11359	6838	60.2	----	----	----	**	NS	**
TLP, days	1342	707	52.7	----	----	----	**	NS	**
NLC, lact.	4.3	2.1	49.8	----	----	----	**	NS	**

NS= not significant, * and **= significant at P< 0.05 and 0.01, respectively.

The percent of inbred cows calculated for 696 cows born from 1978 to 1996 was 26.44 %. Out of this number, 512 cows were non inbred (F= 0%) and 184 were inbred (F= > zero to 12.50%) (Table 2, Fig. 1). The percent of inbred cows in this herd has increased over year at variable rates. Table 2 and Figure 2 declared that the relative amount of increased for the number of inbred cows over the years, especially from 1985 to 1995. These levels were higher than those reported in other studies on different breeds of dairy cows, Vasconcellos and Tonhati (1998) reported an average inbreeding coefficient of 2.94% with a range from zero to 31.30 % in a herd of Murrah buffaloes, Weigel and Lin (2002), obtained an average relationship of 10.9 % between a pool of 141 high - ranking Holstein sires and 1433 elite Holstein cows and 16.4% between 135 Jersey sires and 1139 elite cows.

Table (2): Percent (%) of inbred cows to the total number of cows according to year of birth.

Year of birth	No. of cows		% inbred cows / total number of cows
	Non inbred cows	Inbred cows	
1978	5	0	0
1979	12	0	0
1980	26	2	7.1
1981	26	4	13.3
1982	35	4	10.3
1983	45	0	0
1984	49	3	5.8
1985	24	17	41.5
1986	26	20	43.5
1987	33	29	46.8
1988	35	19	35.2
1989	34	11	24.4
1990	14	8	36.4
1991	30	16	34.8
1992	25	18	41.9
1993	21	10	32.3
1994	42	5	10.6
1995	19	15	44.1
1996	11	3	21.4

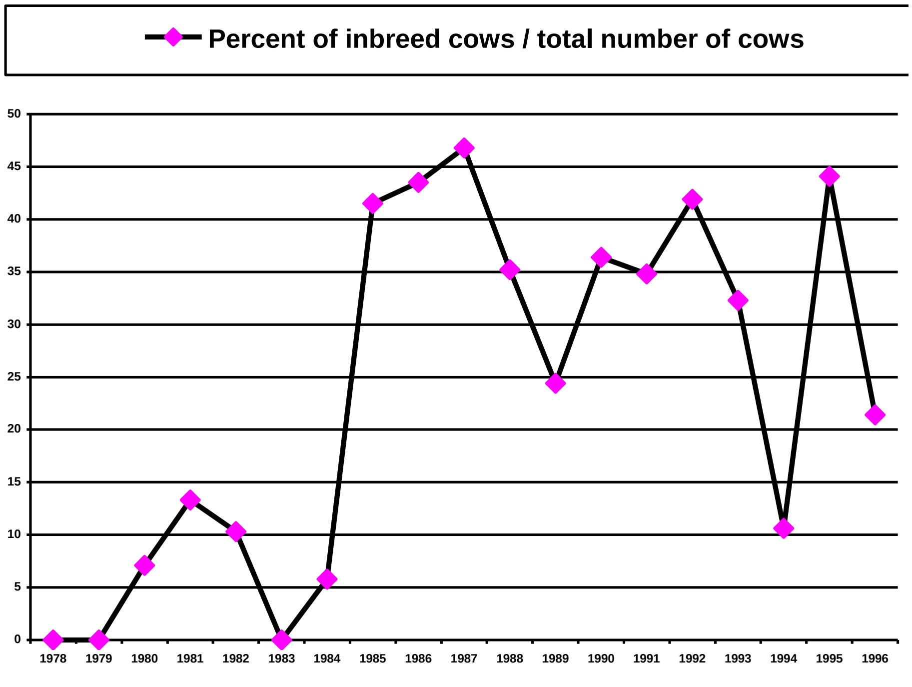

Figure (1): The percent of inbred cows to the total number of cows according to year of birth

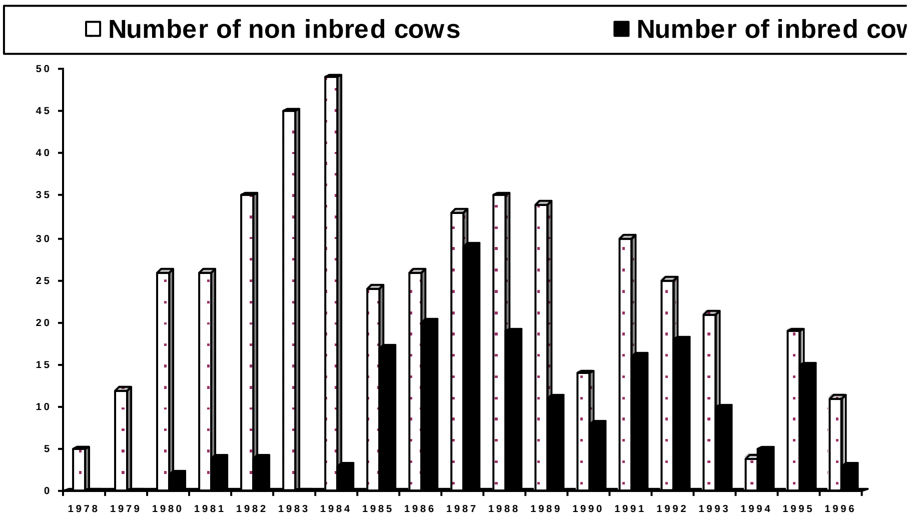

Fig (2): The number of inbred and non inbred cows according to year of birth

The increased number of inbred cows by time is expected in any closed herd. Short and Lawlor (1992) found that mean inbreeding coefficient of U.S Holstein cows had increased from 0.9 % for animals born in 1940 to 3.5 % for those born in 1990. However this increase could possible, be controlled by the utilization of an adequate reproductive management programme or by increasing sires from other populations (Vasconcellos and Tonhati, 1998). SØrensen *et al.*, (2005) yielded 3.4 % average inbreeding level for Danish Holstein and 1.3 % for Danish Red calves born in 2003 and con concluded that Danish Holstein is very close to the minimum effective population size and tools are needed to monitor the selection process in order to control inbreeding, and with respect to Danish Red, as a synthetic population, considerably more genetic diversity should hold and if importation continues, less inbreeding problems should be expected.

Least square means of the studied traits under different levels of inbreeding are presented in Table (3 & 4).

Inbreeding depression was -99 kg of milk, -9 days, -24 days, +5 days, -1120 kg of milk, -158 days and +1.2 lactation for 305dMY, LP, DP, DO, LTMY, TLP and NLC, respectively when inbreeding level increased from 0 to 6.25% (Table 4). These rates were -235 kg of milk, -20 days, -25 days, +42 days, -4498 kg of milk, -462 days and +1.6 lactations for the same traits, respectively, when inbreeding level increased from 0 to 12.50%. While its were -136 kg of milk, -11 days, -1 day, +37 days, -3378 kg of milk, -304 days and +0.4 lactations for the above mentioned traits, respectively, when inbreeding level increased from 6.25 to 12.50%.

Table (3): Least square means ± SE of various traits studied affected by the inbreeding coefficient levels (F %) for Friesian cows.

Inbreeding level (F %)	No.	Traits						
		305dMY	LP	DP	DO	LTMY	TLP	NLC
Zero	1438	3022 ± 52	337 ± 4	146 ± 3	166 ± 3	12852 ± 303	1531 ± 22	3.3 ± 0.06
6.25	689	2923 ± 37	328 ± 3	122 ± 4	171 ± 5	11732 ± 215	1373 ± 31	4.3 ± 0.09
12.50	34	2787 ± 20	317 ± 17	121 ± 16	208 ± 19	8354 ± 173	1069 ± 120	4.7 ± 0.36

Table (4): Inbreeding depression, inbreeding depression as a percent to the least squares mean performance at 0 % level of inbreeding and percent inbreeding depression per 1% inbreeding.

Inbreeding level (F%)	305dMY	LP	DP	DO	LTMY	TLP	NLC
	Inbreeding depression						
0 – 6.25	-99	-9	-24	+5	-1120	-158	+1.2
0 - 12.50	-235	-20	-25	+42	-4498	-462	+1.6
6.25 - 12.50	-136	-11	-1	+37	-3378	-304	+0.4
	Inbreeding depression as a percent to the mean performance at 0 level of inbreeding						
0 – 6.25	-3.27	-2.67	-16.4	+3.0	-8.7	-10.3	+38.7
0 - 12.50	-7.7	-5.9	-17.1	+25.3	-35.0	-30.2	+51.6
6.25 - 12.50	-4.5	-3.3	-0.3	+22.3	-26.3	-19.9	+12.9
	%Inbreeding depression per 1% inbreeding						
0 – 6.25	-0.52	-0.42	-2.6	+0.48	-1.39	-1.65	+6.19
0 - 12.50	-0.61	-0.47	-1.37	+2.02	-2.8	-2.42	+4.13
6.25 - 12.50	-0.73	-0.52	-0.05	+3.57	-4.2	-3.18	+2.06

Inbreeding depression per 1% increase of inbreeding was calculated (Table 4) to be -0.52 kg for 305dMY, -0.42 days for LP, -2.6 days for DP, +0.48 days for DO, -1.39 kg for LTMY, -1.65 days for TLP and +6.19% lactations for NLC, when the level of inbreeding was from 0 to 6.25%. The corresponding values were -0.61 kg, -0.47 days, -1.37 days, +2.02 days, -2.8 kg, -2.42 days and +4.13% lactations, respectively for the above traits, when the level of inbreeding was from 0 to 12.50%.

It can be seen from the results of the first two levels of inbreeding an accumulated direct effects of inbreeding level on the mean performance of the various traits studied, if not altered by future efforts to control them, such trends will lead to numerous harmful effects on the performance of productive and lifetime production traits in dairy cattle in the future.

Similarly, Wiggans *et al.*, (1995) estimated a reduction of 21.3 kg of milk for each 1% increase in inbreeding level in Jersey breed. Also, a Smith *et al.*, (1998) estimated a reduction of 5.1 days in lactation period for each 1% increase in inbreeding level of Holstein Friesian cows and Vasconcellos and Tonhati (1998) an negative effect of inbreeding on lactation length.

Inbreeding depression as a percent to the mean performance of the traits at zero level of inbreeding were -7.7% kg of milk, -5.9% days, -17.1% days, +25.3% days, -35.0% kg of milk, -30.2% days and +51.6%

lactation, for the same traits studied, respectively, when the level of inbreeding increased from 0 to 12.50% (Table 4).These indicated that the effects of inbreeding on lifetime production traits were relatively larger than its effects on milk yield traits. Similar results were obtained by Smith *et al.*, (1998) who reported that inbreeding decreased first lactation mature equivalent (ME) milk and lifetime milk by 23.7 kg and 176.9 kg, respectively, per 1 % increase in inbreeding and concluded that cumulative effects of inbreeding on lifetime performance of dairy cows are often greater than effects on the individual traits themselves. This is exemplified in the effect of inbreeding on first lactation ME milk as compared to the same effect on lifetime milk production. Expressed as a percent of additive standard deviation, inbreeding has a 60 % greater effect on lifetime milk production as it does on first lactation ME milk production.

Freyer *et al.,* (2005) in USA dairy cattle reported inbreeding depression of -27 kg of milk for total milk yield and –177 kg of milk for the whole lifetime, per 1% increase of inbreeding.

The effect of inbreeding on reproductive traits was discussed by Bonczek and Young (1980) who found an increase of 0.24 services per conception, 0.84 days open and 0.65 days in age at first freshening per 1% increase in inbreeding of Holstein cows.

Also, Hermas *et al.,* (1987) reported that 1% inbreeding caused an increase of 2.3 days open of Guernsey cows. Miglior *et al.*, (1994) found inbreeding depression of 9.84 kg of milk of Holstein cows for each 1% ob inbreeding.

Moreover, Thompson *et al.,* (2000) concluded that increased inbreeding, and consequently decreased heterogeneity impaired survival, health, vigor and reproductive efficiency and generate increased frequency of animals affected by genetic defects.

Conclusion

The goal of any mating is to produce the most superior animal possible. The genetic superiority of the mating must be balanced, however, against the inbreeding depression that it generates.

The present study concluded that the losses due to inbreeding can easily be minimized through careful attention to identification to control inbreeding by avoiding matings of genetically related animals, it becomes difficult to avoid such matings without the aid of computer. Therefore, computerized mate selection programmes, may have potential as a tool for controlling inbreeding.

The reduction in inbreeding depression generates enough profit to justify the use of such computerized mating programmes. This service could be sponsored by breeding companies for a negligible cost. However, the limitation of the pedigree information at the farm level might form a barrier and leads to utilization of informations on only one or two generations when trying to avoid inbreeding.

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REFERENCES

Boldman, K. G., Kriese, L. A. ,Van Vleck, L.D. ,Van Tassell, C. P. and Kachman, S.D. (1995). A manual for use of MTDFREML. A set of program to obtain Estimates of variances and covariance's (DRAFT). U.S. Department of Agriculture, Agriculture Research Service. 114pp.

Bonczek, R. R. and Young, C. W., (1980). Comparison of production and reproduction traits of two inbred lines of Holstein cattle with attention to the effect of inbreeding. J. Dairy Sci., 63:107 (Abstr.).

El-Arian, M. N. (2005). Selection indices for Friesian cows using two methods of Calculating relative economic values for some important productive and Reproductive traits. J. Agric. Sci. Mansoura Univ. 30: 7285-7296.

Freyer, G. Sanchez, J. H. and Cassell, B. G. (2005). A note on inbreeding in dairy cattle breeding. Arch. Tierz., Dummerstorf 48: 130-137.

Hermas, S. A. Young, C. W. and Rust, J. W. (1987). Effects of milk inbreeding on productive and reproductive performance of Guernsey cattle. J. Dairy Sci. 70:712.

Khattab. A.S. and Ashmawy, A. A. (1990). Factors for standardizing 305 day lactation records of Friesian cows for age at calving. Egypt. J. Anim. Prod. 27: 161- 170.

Khattab, A.S. and Sultan, Z. A. (1991). A comparison of different selection indices for genetic improvement of some dairy traits in Friesian cattle in Egypt. J. Anim. Breed. Genet. 108: 349- 353.

Miglior, F., Burnside, E. B. and Dekkers, J. C. M. (1994). Nonadditive genetic effects and inbreeding depression for somatic cell counts of Holstein cattle. I. Dairy Sci., 78:1168.

SAS. (1990) SAS User's Guide. Statistical Analysis System. Institute Inc., Cary., NC.

Short, T. H. and Lawlor T. J. (1992). Inbreeding in the U S. Holsteins and its effect on yield and type traits. J. Dairy Sci. 75 (Suppl. 1): 154 (Abstr.),

Smith, L. A., Cassell, B.G. and Pearson, R. E. (1998). The effects of inbreeding on lifetime performance of dairy cattle. J. Dairy Sci., 81:2729-2737.

SØrensen, A. C., SØrensen M. K. and Berg, P. (2005). Inbreeding in Danish dairy cattle breeds. J. Dairy Sci., 88:1865-1872

Sultan, Z. A. and Khattab A. S. (1989). Genetic and phenotypic parameters of lifetime production traits in Friesian cattle in Egypt. Annals. of Agric, Sci. Moshtohor, 27:273- 291.

Thompson, J. R., Everett, R. W. and Wolfe, C. W. (2000). Effects of inbreeding on production and survival in Holsteins. J. Dairy Sci. 83: 2131- 2138.

Vasconcellos, B. F. and Tonhati, H. (1998). Inbreeding and its effects on some productive and reproductive traits in a Murrah buffalo herd. J. Anim. Breed. Genet. 115: 299-306.

Weigel, K. A. and Lin, S. W. (2002). Controlling inbreeding by constraining the average relationship between parents of young bulls entering AI progeny test programs. J. Dairy Sci. 85: 2376-2383.

Wiggans, G. R., VanRaden, P. M. and Zuurbier, J. (1995). Calculation and use of inbreeding coefficients for genetic evaluation of United States dairy cattle. J. Dairy Sci. 78: 1584-1590.

Wright, S. (1922). Coefficients of inbreeding and relationship. Am. Naturalist, 56: 330-338.

تأثير التربية الداخلية على صفات اللبن فى أبقار الفريزيان فى مصر

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تم استخدم عدد ٢١٦١ سجل حليب لأبقار الفريزيان بمزرعة سخا التابعة لبحوث الإنتاج الحيوانى - وزارة الزراعة – مصر خلال الفترة من ١٩٧٨ إلى ٢٠٠٠ لقياس مقدار التربية الداخلية فى القطيع وتأثيرها على صفات إنتاج اللبن فى ٣٠٥ يوم، طول موسم الحليب، طول فترة الجفاف، طول فترة الأيام المفتوحة، إنتاج اللبن خلال حياة البقرة، إجمالى فترة الحليب خلال حياة البقرة وعدد مواسم الحليب الكاملة.

كان تأثير معامل التربية الداخلية غير معنوي على صفات إنتاج اللبن في ٣٠٥ يوم، طول موسم الحليب، طول فترة الجفاف، طول فترة الأيام المفتوحة بينما كان تأثيره عالي المعنوية علي صفات إنتاج اللبن خلال حياة البقرة وإجمالى فترة الحليب خلال حياة البقرة وعدد مواسم الحليب الكاملة. كانت نسبة ٧٣,٥٦% من الأبقار غير مرباة تربية داخلية.

حسبت النسبة المئوية لأثر التربية الداخلية الناتج عن زيادة معامل التربية الداخلية بمقدار ١% فكانت - ٠,٥٢ كجم لصفة إنتاج اللبن فى ٣٠٥ يوم ، - ٠,٤٢ يوم لطول موسم الحليب ، - ٢,٦ يوم لطول فترة الجفاف ، +٠,٤٨ يوم لطول فترة الأيام المفتوحة،- ١,٣٩ كجم لإنتاج اللبن خلال حياة البقرة ، - ١,٦٥ يوم لإجمالي فترة الحليب خلال حياة البقرة ،+٦,١٩% موسم لعدد مواسم الحليب الكاملة،عندما كان مستوى التربية الداخلية من صفر الى ٦,٢٥%. وبالمثل كانت النسب المئوية – ٠,٦١ كجم، - ٤٧.٠ يوم، - ٣٧.١ يوم، +٢,٠٢ يوم، -٨.٢ كجم، - ٢,٤٢ يوم، + ٤,١٣% موسم على التوالى لنفس الصفات السابقة عندما كان مستوى التربية الداخلية من صفر الى ١٢,٥٠%.

كان تأثير التربية الداخلية تراكمى وكبير نسبيا على صفات الحياة الإنتاجية عن صفات إنتاج اللبن. وهذا يوضح ضرورة **الإدارة والرعاية** الفعالة لمعدل التربية الداخلية فى صفات اللبن بالتحكم والمراقبة في برنامج التربية. وقد أوصت هذه الدراسة بأن الفقد الناشئ عن التربية الداخلية يمكن أن يكون أقل ما يمكن بسهولة من خلال العناية الفائقة في تحديد التزاوجات وبرامج اختيارها كمبيوتريا٠

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