

**ANALYSIS OF THE MILK PRODUCTION OF
DAUGHTER GROUPS OF PROVEN SIRES
REMAINING IN THE HERDS FOR THREE
CONSECUTIVE LACTATIONS**

Y. A. AFIFI (1)

The milk yield of cows with a low production in the first lactation increased considerably more in the succeeding lactations than those which started with a higher production.

The group of cows which were considered as high producers in the first lactation always possessed the highest level of milk production in succeeding lactations.

The heifers showed a great variation in lactation length. There was a negative relation between lactation length and average daily milk yield (-0.14). The repeatability of (0.67) obtained from the first three lactations showed that the total milk yield had a higher repeatability than average daily milk yield (0.34), while lactation length possessed a very low repeatability (0.18). The use of proven sires and the continuous selection for milk yield during the first three lactations had led to less genetic difference between the daughter groups. Under these conditions, the sires did not exert great influence on the phenotypic variance of average daily milk yield. However, there was a great variation between progeny groups in the percentage, of cows which left the herd during the first three lactations.

The progeny of different sires bred at any farm does not represent all the daughters of those sires, since the farmer keeps only limited numbers of progeny as replacements or as breeding stock to increase the size of the herd. It is to be expected that the variation in milk production characteristics differs from one farm to another as the breeding policy adopted differs from herd to herd according to the decision of the farmer.

Therefore, it was decided to investigate to what extent the sires influence the variation in milk yield between the progeny groups of different proven sires after they are subjected to selection by the farmers.

The study also included the relation between total milk production, lactation length and average daily milk yield using the records of the cows which remained in the herds for three consecutive lactations as breeding stock.

Material and Methods

Milk production is greatly influenced by physiological and environmental factors. To obtain reliable estimates of the influence of sires on the difference between progeny groups remaining in the herds for three consecutive lactations, these factors should be eliminated to a large extent especially the variance due to month of calving, age at first calving and management of the herds.

(1) Animal Production Dept. Ministry of Agriculture, Dokki, Giza.

Therefore, the animals used in this study were distributed at random over big numbers of herds (136) in one province of the Netherlands, all of them calved at about two years old and started their lactation between the end of 1960 and middle of 1961, of which 71% calved in early spring (February — April). Moreover, the above mentioned factors had been eliminated by the statistical methods and complete analysis of variance for cross classification was carried out by using the model given by Becker (1964) to determine the degree of contribution of the sire in the total variance of average daily milk yield. The study included 703 Friesian females sired by 15 progeny tested bulls belonging to A.I. Association. They were kept on the same farms until they completed their third lactation and did not include cows with less than three lactation records. In this analysis average daily milk yield was used to eliminate to ascertain extent the difference in total milk yield which may be due to difference in lactation length.

All the statistical analysis were calculated with aid of electronic data processing machines. Significance was determined from tables by Snodcor (1956).

Results and Discussion

A.—VARIATION IN MILK YIELD AND LACTATION LENGTH THROUGH THE FIRST THREE LACTATIONS :

1. *Milk Yield*

The milk yield increased with succeeding lactations ; in the second lactation it was 20.7 percent more than that of the average of the first lactation yield. In the third lactation the amount of milk produced was 27.2 percent higher than that of the first lactation (Table 1). However, the cows that started with considerably low yield in the first lactation increased in yield more in the succeeding lactations than those which started with higher milk production. The increase of the low producing group (<9 kg/day) was 31.9 and 44.7 percent more than their yield in the first lactation for the second and third seasons respectively. The increase was 14.3 and 18.1 percent, respectively, for the high producing groups (>14 kg/day). The greater increase in milk yield from first to later lactations of cows with a low yield in the first lactation is due to the incomplete repeatability of yield. Low yield is partly due to chance and the same chance will not necessarily operate during the later lactations, so the yield becomes nearer to the average in later lactations. The average daily milk yield showed the same direction in the consecutive lactations, it was 11.7, 14.3 and 15.4 kg per day in the first, second and third lactations respectively. The group of cows which had been considered as high producers in the first lactation (>14 kg/day) always possessed the highest level of milk production in the succeeding lactations, whereas the low producer cows (>9 kg/day) relatively possessed the lowest level of milk yield. The increase in milk production associated with the advance in age is supposed to be due to the increase of the amount of secretory tissue with succeeding lactations and this increase depends to some

extent on the udder development which does not reach its maximum in the first lactation. Wada and Turner (1959) found that the content of desoxyribonucleic acid (DNA) in the mammary glands of mice increased considerably from the first to the second lactation and that there was a further slight increase from the second lactation to the third lactation, indicating a corresponding increase in the number of secretory cells. The second possibility which may be involved in this interpretation is that production of heifers is restricted because their relatively smaller feed intake is naturally coupled with the additional requirements of growth. Whereas with advancing age the body development reaches its maximum and the ability of cows to consume more food is increased.

2. Length of Lactation

The heifers showed a great variation in lactation length ranging from less than 260 days to more than 340 days. However, 64 percent of the heifers had lactation length less than 310 days, whereas 36 percent produced milk for a period more than 310 days. The group of heifers having first lactation length less than 310 days showed increase in the succeeding lactations. The average lactation length in the first, second and third lactations was 280, 298 and 295 days respectively. The second groups of cows (>310 days) showed a gradual decrease in the succeeding lactations. The average length of this group was 333, 304 and 296 days respectively. All groups are thus close to the average in later lactations. The groups of cows with relatively longer lactation length in the first lactation produced more milk than cows with shorter lactation length (Table 2). However, the average daily milk yield did not show the same relation, but on the contrary some groups of cows with a lactation length more than 310 days (groups 8 & 9) possessed relatively lower daily average milk in first lactation. Moreover, the correlation coefficient between lactation length, total milk yield and average daily milk yield within sires showed that there was a highly significant correlation between lactation length and total milk yield. But there was a negative correlation between lactation length and average daily milk yield. This was significant for all lactations except the first (Table 3). On the other hand, there was a highly significant positive correlation between total milk yield and average daily milk yield. The negative relation between lactation length and average daily milk yield may be due to the effect of suppressing pregnancy on milk production. Brody et al (1923) stated that the last two months of gestation have an inhibitory effect upon production of milk. At this period, the levels of oestrogen and progesterone in the blood increase quite considerably with the result that production is inhibited. Since the cows used in this study calved once a year, we expect that cows which produced milk for periods greater than 10 months were subjected to the inhibitory effect of gestation. The cows which had relatively long lactation lengths and possessed higher average daily milk yields may have had longer service periods than normal which retarded the commencement of gestation. Mahadevan (1951) showed that prolonging the service period will increase the persistency of yield. Besides that it is quite common that the farmer tends to make the service periods rather long for high producing cows.

TABLE 1.—THE EFFECT OF MILK PRODUCTION LEVELS IN THE FIRST LACTATION ON THE MILK YIELD OF THE FOLLOWING LACTATIONS.

Classes of average daily milk in the first lactation kg.	No. of cows	* First lactation			Second lactation			Third lactation		
		Kg. milk per lactation	Lactation length in days	Average daily milk yield for each Class	Kg. milk per lactation	Lactation length in days	Average daily milk yield for each class	Kg. milk per lactation	Lactation length in days	Average daily milk yield for each class
< 9	44	2542	307	8.28	3354	289	11.60	3680	284	12.96
9.1 — 10	83	3049	321	9.50	3854	298	12.93	4032	290	13.97
10.1 — 11	123	3188	304	10.49	4037	300	13.46	4300	294	14.63
11.1 — 12	152	3503	307	11.41	4318	305	14.14	4463	297	15.03
12.1 — 13	132	3772	304	12.41	4408	300	14.69	4591	295	15.85
13.1 — 14	78	4061	303	13.40	4680	307	15.24	5001	305	16.40
> 14	87	4513	301	14.99	5159	304	16.97	5329	300	17.76
\bar{X}	699	3572	306	11.67	4315	301	14.33	4547	296	15.36

* The classification was only based on average daily milk yield of first lactation and 4 cows were excluded from the material, 3 of them produced less than 6 kg milk per day and one produced more than 20 kg per day.

TABLE 2.—THE EFFECT OF LACTATION LENGTH OF THE FIRST LACTATION ON THE MILKING DAYS OF THE FOLLOWING LACTATION.

Classes of lactation length in the first lactation	No. of cows	* First lactation			Second lactation			Third lactation		
		Kg. milk per lactation	Average lactation length per each class	Kg. milk per day	Kg. milk per lactation	Average lactation length per each class	Fg. milk per day	Kg. milk per lactation	Average lactation length per each class	Kg. milk per day
< 260	43	2879	247	11.66	3880	305	13.05	4143	280	14.80
261 — 270	38	3148	265	11.88	4637	297	13.66	4366	293	14.90
271 — 280	75	3287	277	11.87	4138	298	13.89	4483	291	15.25
281 — 290	95	3352	286	11.72	4201	296	14.19	4323	291	15.38
291 — 300	91	3426	296	11.57	4398	302	14.23	4378	298	15.38
301 — 310	105	3697	307	12.01	4386	310	14.15	4730	314	15.06
311 — 320	80	3783	315	12.01	4486	303	14.80	4370	299	15.61
321 — 330	62	3709	325	11.41	4327	298	14.52	4505	296	15.22
331 — 340	34	3760	335	11.22	4445	301	14.77	4591	290	15.26
> 340	76	4431	360	12.30	4643	316	14.69	4728	300	15.76
X	699	3572	306	11.67	4315	301	14.33	4547	296	15.36

* The classification was based on lactation length at first lactation.

TABLE 3.—CORRELATION COEFFICIENT BETWEEN TOTAL MILK YIELD, LACTATION LENGTH AND AVERAGE DAILY MILK YIELD WITHIN SIREs AT EACH LACTATION NUMBER.

Characters	No. of cows	1st Lactation	2nd Lactation	3rd Lactation
Total milk yield × lactation length	701	.577 **	.485 **	.518 **
Total milk yield × average daily milk yield	701	.318 **	.748 **	.433 **
Lactation length × average daily milk yield	701	-.057	-.138 **	-.135 **

-51-

TABLE 4.—INTRA — COW CORRELATION BETWEEN RECORDS OF CONSECUTIVE LACTATIONS (within Sires)

Character	Lactation Number	2nd Lactation	3rd Lactation	Repeat-ability
Total milk yield	1st Lactation	.661	.517	.607
	2nd Lactation		.613	
Lactation length	1st Lactation	.221	.116	.177
	2nd Lactation		.194	
Average daily milk yield . .	1st Lactation	.273	.321	.338
	2nd Lactation		.422	

TABLE 5.—COMPARISON BETWEEN DAUGHTER GROUPS FOR TOTAL MILK YIELD, LACTATION LENGTH AND AVERAGE DAILY MILK YIELD IN THE CONSECUTIVE LACTATIONS

Sire No.	No. of daughters during first three lactations	1st lactation			2nd lactation			3rd lactation			*Percentage of daughters which left the herd
		Kg. milk per lactation	lactation length in days	Kg. milk per day	Kg. milk per lactation	Lactation length in days	Kg. milk per day	Kg. milk per lactation	Lactation length in days	Kg. milk per day	
1	48	3491	309	11.29	4285	301	14.23	4545	292	15.57	31
2	48	3805	305	12.47	4566	308	14.82	4791	295	16.24	37
3	46	3498	309	11.32	4426	309	14.32	4692	293	15.71	35
4	43	3775	298	12.67	4416	308	14.34	4357	283	15.40	15
5	65	3792	304	12.47	4346	292	14.88	4572	294	15.55	40
6	46	3423	308	11.11	4237	306	13.85	4669	305	14.31	34
7	35	3742	321	11.61	4733	322	14.70	4977	318	15.65	39
8	39	3357	306	10.97	4143	300	13.81	4267	295	14.46	41
9	57	3578	303	11.81	4293	293	14.65	4520	284	15.91	26
10	52	3625	310	11.69	4268	299	14.27	4780	307	15.57	32
11	27	3304	307	10.76	4082	300	13.60	4323	298	14.51	29
12	57	3675	317	11.59	4212	298	14.13	4390	295	14.88	19
13	49	3375	295	11.44	4258	310	13.73	4610	301	15.32	33
14	42	3472	299	11.61	4264	291	14.65	4494	287	15.66	33
15	49	3393	301	11.27	4091	295	13.86	4252	300	14.17	37
X	703	3567	306	11.66	4307	302	14.26	4526	296	15.36	32

* Percentage of daughters which left the herd during the first three lactations.

Lactation length vary between daughter groups of different sires (Table 5.). It ranged from 295 to 321 in first lactation, from 291 to 322 in the second lactation and from 287 to 318 in the third lactation. The differences between daughter groups were statistically significant in all lactations except for the first one (Table 6).

TABLE 6.—VALUES FOR TOTAL MILK YIELD, LACTATION LENGTH AND AVERAGE DAILY MILK YIELD BETWEEN DAUGHTER GROUPS OF SIRES DURING THE FIRST THREE LACTATIONS

d.f. of sires	d. f. of cows	1st lactation			2nd lactation			3rd lactation		
		Total milk yield	Lactation length	Average daily milk yield	Total milk yield	Lactation length	Average daily milk yield	Total milk yield	Lactation length	Average daily milk yield
14	688	2.50**	1.10	1.94**	1.87**	2.33**	1.65	2.49**	2.42**	1.50

* Significant (P 0.05)

** Highly significant (P 0.01)

The repeatability of total milk yield, lactation length and average daily milk yield was estimated by intra-cow correlation between records of consecutive lactations within sires. The results presented in Table 4. indicated that repeatability showed a higher value for consecutive records than for non-consecutive ones. Total milk yield had a higher repeatability than average daily milk yield; the value was .607 and .338 respectively. Lactation length possessed a very low repeatability; the value was .177. This figure indicates that lactation length is influenced by various non-genetic factors such as farm management.

B.—THE CONTRIBUTION OF SIRES IN THE TOTAL VARIANCE OF AVERAGE DAILY MILK YIELD :

To estimate the degree of contribution of sires in the total variance of average daily milk yield the following model given by Becker (1964) for complete analysis of variance for cross-classification was applied.

$$\frac{Y}{ijklm} = u + \frac{a}{i} + \frac{b}{j} + \frac{c}{k} + \frac{(ab)}{ij} + \frac{(ac)}{ik} + \frac{(bc)}{jk} + \frac{(abc)}{ijk} + \frac{e}{ijklm}$$

$\frac{Y}{ijkM}$ = Average daily milk yield of m^{th} cow of K^{th} sire in J^{th} month in i^{th} herd.

U = constant

$\frac{a}{i}$ = effect of i^{th} herd

$\frac{b}{j}$ = effect of J^{th} month

$\frac{c}{k}$ = effect of K^{th} sire

$\frac{(ab)}{ij}$ = interaction of herds and months

$\frac{(ac)}{ik}$ = interaction of herds and sires

$\frac{(bc)}{jk}$ = interaction of months and sires

$\frac{(abc)}{ijk}$ = interaction of herds, months and sires

$\frac{e}{ijkm}$ = residual effect

\underline{a} , \underline{b} , \underline{c} , \underline{ab} , \underline{ac} , \underline{bc} , \underline{abc} and \underline{e} considered independent random

variable with zero mean and variance δ_a^2 , δ_b^2 , δ_c^2 , δ_{ab}^2 , δ_{ac}^2 , δ_{bc}^2 , δ_{abc}^2

and δ_w^2 respectively.

The computation was facilitated by the cooperation of the Mathematical Department of the Agricultural University Wageningen, the Netherlands. Their program, LH 405 in Fortran for IBM 1620, suited the experimental design of our data the results obtained are presented in Table 7. The only interpretation which can be drawn from the table will be restricted to the main effect of months of calving, herds and sires which may be taken with most reliable results since they contain the highest K values.

Month of calving did not influence the total variance of average daily milk yield especially during first and third lactations where there was no effect at all. This results is expected since 71 % of the cows used in this study calved in early spring and there was no normal distribution for months of calving over the year.

Under the prevailing conditions mentioned before, the effect of herds was eliminated by randomising the cows over many herds. This resulted in decreasing the herd's effect on the phenotypic variance to less than 5 percent (Table 7). The average daily milk yield varied slightly between various daughter groups, ranged from 10.67 to 12.67 kgs in first lactation, from 13.60 to 14.88 kg in second lactation and from 14.17 to 16.24 in the third lactation (Table 5).

TABLE 7.—PERCENTAGE OF CONTRIBUTION OF GENETIC AND SOME ENVIRONMENTAL FACTORS TO THE TOTAL VARIANCE OF AVERAGE DAILY MILK YIELD AT DIFFERENT LACTATION NUMBER

Character Lactation Number	Average daily milk yield		
	1st Lactation	2nd Lactation	3rd Lactation
Source of variation	%	%	%
Herds	5.0	3.0	0.0
Months of calving	0.0	2.0	0.0
Sires	0.0	1.0	0.0
Herds x months of calving	3.0	0.0	0.0
Herds x sires	0.0	10.0	0.0
Months x sires	69.0	6.0	0.0
Herds x months x sires	0.0	0.0	90.0
Unknown factors	21.0	76.0	10.0

The differences between daughter groups for the average daily yield were statistically insignificant in all lactations except the first one (Table 6). The proportion of the total variance of average daily milk yield which is attributed to sires influence is very small (Table 7). This may be due to several reasons, firstly in this study the average daily milk yield of each cow was used instead of total lactation which may result in reducing the differences between the individual cows. Secondly, the cows used in the investigation were only the cows which remained in the herds during the first three lactations and were subject to selection for milk yield by the farmers during this period. This may reduce the differences in average daily milk yield between progeny groups of different sires which remained in the herds as breeding stocks, and also reduced the proportion of genetic variance. Thirdly, the

daughter groups were descendent of progeny tested sires selected by A.I. centers, this may also reduce the proportion of total variance which is attributed to the influence of sires.

In the first lactation the major contribution to variance of average daily milk yield is months X sires interaction, it occurs because in certain months by chance a rather high number of heifers of some bulls had calved whereas in other months there were no daughters calved. In the third lactation the major contribution was herds X months X sires interaction this is due to the nature of data obtained in the third lactation as it happened in certain herds a large numbers of cows sired by different bulls had calved in certain months.

On the other hand, there is wide difference between progeny groups in the percentage of cows which left the herds during the first three lactation periods, it ranged from 15 to 41 percent (Table 5). The insignificant difference between the daughter groups for average daily milk yield gives an indication that the farmers almost culled from the herds most of the cows which did not reach certain level of milk production they desire. It was not possible to analyse the difference between variance in different lactation which is attributed to culling because the milk production of most of the culled cows was not available since they left herds before they had completed their lactations.

From what was mentioned above we could come to conclusion that the extensive use of proven sire and the continuous selection the farmers practised in their farms during the first three lactations number had contributed in improving the milk yield of the herds. The average daily milk yield in first lactation for 64 percent of the cows used in this investigation was 13.16 kg per day (449 heifers—3962 kgs of milk—301 days—13.16 kgs per day).—This value is above the average of the breed in first lactation in the same province which came to 11 kg per day. However some heifers are still in the herds with low production (< 10 kg/milk per day) but the percentage of such cows was relatively small, 18 percent. It is possible that the low producing heifers were kept in the herds as a result of different ways of management practised in different farms.

In the farms where the replacement rate is relatively higher than other herds the farmers are obliged to save heifers from the middle and low classes of milk production to cover the replacement demands especially when the farmers like to keep the same number of milking cows in their herd.

Acknowledgement

I wish to express my whole hearted gratitude to Prof. Dr. Th. Stegenga Professor of Animal Breeding of Agriculture University, Wageningen, The Netherlands, for his guidance and valuable advice throughout this study. I am also grateful to Prof. Dr. M.T. Ragab, Chairman of the Council of the Board of the Meat and Milk Organization for his interest and criticism. I feel greatly indebted to Mr. A. Keuls for his guidance in analysing the data of this work with the aid of electronic data processing machine.

REFERENCES

- BECKER, W. A. (1964). "*Manual of Procedures in quantitative genetics*".—Washington. State University, Pullman, Washington.
- BRODY, RAGSDALE, AND TURNER, (1923). *Jour. Gen. Physiol.* 5 : 441.
- MAHADEVAN, P. (1951). *J. Agric. Sci.* Vol. 41 : 80.
- SNEDECOR, G.W. (1956). Statistical Methods "*The Iowa State Univ. Press Ames, Iowa.*
- WADA, H. AND TURNER, C. W. (1959). *J. Dairy Sci.* Vol. 42 : 1198.

دراسة تحليلية لبعض صفات انتاج اللبن لمجاميع بنات الثيران المختبرة التي مكثت في القطيع ثلاث مواسم حليب متتابعة

الملخص

الهدف من هذا البحث هو معرفة عما اذا كانت هناك فروق بين مجاميع بنات الثيران المختبرة من حيث انتاج اللبن وتقدير مدى تأثير الثور على أحداث هذه الاختلافات وقد شملت الدراسة أيضا العلاقة بين انتاج اللبن وطول موسم الحليب ومتوسط انتاج اللبن اليومي وقد استخدم في هذا البحث ٧٠٣ بقرة فريزيان وهي تمثل بنات ١٥ ثورا مختبرا استخدمت بواسطة محطات التلقيح الصناعي باحدى محافظات هولندا وهذا العدد من الأبقار مكث في القطعان المختلفة لمدة ثلاثة مواسم حليب متتابعة وقد تبين من هذه الدراسة الآتي :

١ - ان الأبقار المنخفضة الانتاج في موسم الحليب الأول زاد انتاج لبنها خلال مواسم الحليب المتتابعة بنسبة تزيد كثيرا عن الأبقار العالية الادرار . فبالنسبة للمجموعة المنخفضة الانتاج والتي كان متوسط انتاج لبنها أقل من تسعة كيلو جرامات في اليوم كانت الزيادة في انتاج اللبن خلال موسم الحليب الثاني والثالث ٣١٩٪ ، ٤٤٧٪ على التوالي عن انتاج أول موسم بينما بلغت نسبة الزيادة ١٤٣٪ ، ١٨١٪ على التوالي بالنسبة للمجموعة التي زاد انتاج لبنها عن ١٤ كيلو جراما في اليوم .

٢ - مجموعة الأبقار التي اعتبرت عالية الانتاج خلال موسم الحليب الأول استمرت محافظة على انتاجها المرتفع خلال مواسم الحليب المتتابعة وذلك عند مقارنتها بالمجموعات الأخرى .

٣ - كان هناك اختلاف كبير بين الأبقار بالنسبة لطول موسم الحليب وعلى الأخص خلال موسم الحليب الأول اذ تراوحت هذه الفترة بين أقل من ٢٦٠ يوما الى أكثر من ٣٤٠ يوما .

٤ - وجد ارتباط سلبي بين طول موسم الحليب ومتوسط انتاج اللبن اليومي بينما يوجد ارتباط ايجابي بين مجموع انتاج اللبن خلال موسم الحليب ومتوسط انتاج اللبن اليومي .

٥ - كان المعامل التكرارى لانتاج اللبن خلال الثلاثة مواسم الحليب الأولى يزيد عن المعامل التكرارى لمتوسط انتاج اللبن اليومى خلال هذه الفترة اذ بلغت القيمة المقدرة ٦٠.٧ ر. ٣٢٨ ر. على التوالى أما بالنسبة لطول موسم الحليب فان المعامل التكرارى لهذه الصفة كان ذا قيمة منخفضة اذ بلغ ١٧٧ ر.

٦ - تبين أن استخدام الطلائق المختبرة واستمرار عملية الانتخاب خلال الثلاثة مواسم الحليب الأولى أدى الى تقليل التباين بين مجاميع بنات الثيران المختبرة من حيث متوسط انتاج اللبن اليومى وكذلك خفض التباين الوراثى كما انه تحت الظروف سابقة الذكر لم يكن للثور تأثير ملموس على الاختلاف الظاهرى لانتاج اللبن .

٧ - وجد أن هناك اختلاف كبير بين مجاميع بنات الثيران المختلفة من حيث نسبة الأبقار التى تركت القطيع خلال ثلاثة مواسم الحليب الأولى اذ تراوحت هذه النسبة بين ١٥ - ٤١ ٪ .

٨ - أدى استخدام الطلائق المختبرة واستمرار اجراء عملية الانتخاب بين الأبقار خلال ثلاثة مواسم الحليب الأولى الى المساهمة فى تحسين انتاج اللبن داخل القطعان المختلفة اذ كان متوسط انتاج اللبن اليومى خلال موسم الحليب الأول يزيد عن ١١ كيلوا جراما فى اليوم بالنسبة لـ ٦٤ ٪ من الأبقار التى مكثت فى القطيع تحت الظروف السابقة الذكر .