THE LACTATION CURVE OF THE COW AT THE ASCENDING PHASE

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The lactation period of cows can be divided into two parts, the ascending and the descending phases. The ascending phase begins at calving and ends at the peak. The time between these points is the duration of the ascending phase. Different ways to find the peak and different methods to draw an average lactation curve have been discussed in a previous paper (12, p. 162).

The lactation curves at the ascending phase are usually drawn on the basis of daily milk yields. The lactation curve can also be drawn on the basis of the amounts of milk corrected for 4 per cent fat content. In that case, however, the peak is reached more rapidly than when actual milk yields are used, due to the fact that the fat percentage of the milk decreases during the ascending phase (11, p. 292).

On the basis of the height of the peak, it is possible to make some kind of prediction on the continuation of lactation. According to BLAU (2, p. 164) the correlation between the absolute peak and the yield of the first 100 days after calving was $r = + 0.9608 \pm 0.003$ and the correlation between the absolute peak and the yield of the lactation period (calculated as a yield of 300 days) $r = + 0.9014 \pm 0.008$.

The height of the peak and the duration of the ascending phase vary considerably in different cows and also in the same cow in different lactation periods. This is true even when the cows are healthy and are fed according to standards. In the material collected by MAYMONE and MALOSSINI (11, p. 278) and consisting of cows of different breeds and age, the maximum daily production was reached in 66.8 % of the cases within the first month of lactation, in 94.2 % within the two first months, and in 98.7 % within the three first months after calving. The mean of the duration of the ascending phase was 28.3 days and the standard deviation 18.5 days. The above-mentioned authors as well as KAJANOJA and SILVENNOINEN-LARPES (9, p. 7)

could not find any significant correlation between the height of the peak and the duration of the ascending phase. According to BLAU (2, p. 388) the duration of the ascending phase seems to be directly related to the height of the peak. JOURNET and JARRIGE (7, p. 136) found that the duration of the ascending phase increases when the peak increases until the limit of 25 kg.

Many factors influence the lactation curve at the ascending phase. Studies in monozygous cattle twins performed by KRONACHER and SANDERS (10, p. 162) indicate the considerable influence of inheritance on the shape of the lactation curve. The lactation curves of the same pair closely resembled each other, whereas the curves of different pairs were greatly different. Likewise, breed differences are based to a great extent on the influence of inheritance. According to the data of DRAKELEY and WHITE (ref. 11, p. 276) Jersey cows in England attain their maximum daily yield around the 45th day, Ayrshire cows around the 35th day and British Friesian cows around the 30th day after calving.

According to JOHANSSON (6, p. 82) the age of the cow influences the lactation in such a way that the peak usually increases until the 6th lactation and then begins to decrease. The persistency of the milk yield is at the first lactation greater than at later lactations.

The influence of the season during which calving takes place is essentially a result of the differences between winter and pasture feedings. Especially in earlier times, cows who calved in the spring often had a higher peak than those which calved in the autumn. Such was the case in the East Finnish breed according to BRUUN (3, p. 46) and in the Norfolk and Penrith breeds in England according to SANDERS (13, p. 359). On the contrary, according to the recently published study of BLAU (2, p. 388), German Friesian cows calved in the summer have a lower peak and a shorter duration of the ascending phase than cows calved in the winter.

The yield of the lactation period, especially in the early part of the lactation period, depends to a considerable extent on the condition and nutrient reserves of the cow at the time of calving (4, p. 390). BAYLEY and HEIZER (1) studied the influence of the cow's condition at calving on the milk yield during lactation. They found that e.g. cows in »good» condition at calving produced on an average 270 kg more milk during lactation than cows in »fair» condition at calving. It is obvious that the former cows had a higher peak than the latter cows. The cows in »excellent» condition, however, did not give more milk than cows in »good» condition. Also KAJANOJA and SILVENNOINEN-LARPES (9, p. 7) found that fat cows have a higher peak production than lean ones.

SANDERS (14, p. 228) studied the influence of the dry period on the lactation at the ascending phase. If the length of the dry period was 40 days or more, the peak production was about 3 kg per day higher than when the dry period was 0—19 days. On the contrary, there was no difference in peak production irrespective of dry period when this period was 60 days or over or only 20—39 days in length. JOHANSSON (6, p. 82) paid special attention to the dry period before the second calving. If the dry period at that time is shorter than 30 days, the peak is lower than normal.

TURNER et al. (15, p. 528) studied the influence of the number of milkings

per day on the peak production and the duration of the ascending phase. Of the 80 records studied 40 were those of cows milked twice per day, 32 of cows milked three times per day, and 8 of cows milked four times per day. The cows milked twice per day had a peak averaging 17 kg, which was reached on the fifteenth or sexteenth day after calving. The cows milked three times per day had an average peak of 23 kg which was reached on the eighteenth day, and the cows milked four times per day had a peak of 37 kg which was not reached until the twenty- eighth day after calving.

FLUX and PATCHELL (5) found in experiments with monozygous twin cows that maximum daily milk yield and the time needed to reach that yield were reduced by underfeeding for 10 days after calving and then returning to normal feeding. Underfeeding for 5 days had no significant effect.

According to KAJANOJA (8, p. 114), a rather considerable energy-underfeeding has a lowering effect on the daily milk yield and thus also on the height of the peak. This decrease, however, does not correspond to the underfeeding, since cows which have just calved and which are underfed readily utilize body fat reserves for milk production.

Experimental material

Daily milk weighings in cows at the ascending phase have been carried out on the University Farm Viik since the year 1947. In each cow these weighings have been performed until the peak has evidently been passed. From 1947 until the end of the control year 1960—61 the production level of the herd has considerably risen. The statistics have therefore been divided into three parts in such a way that in each part the mean production of the cattle in the different control years is of approximately the same magnitude. In the first part belong the control years 1946–47—1949–50, in the second part the control years 1950–51—1956–57 and in the third part the control years 1957–58—1960–61. In the following text these periods will be called the first, the second, and the third sequence. The mean production of milk fat in the herd varied in different control years in the first sequence 151—177 kg, in the second sequence 183—204 kg, and in the third sequence 219—242 kg. In each sequence the lactation at the ascending phase of a cow and factors influencing on it are treated separately. The material of the first sequence and of the beginning of the second sequence is nearly the same as that used by Kajanoja and Silvennoinen-Larpes (9).

In this paper only the lactation of healthy cows are considered. Retention of after-birth, difficult calving, and twinning, for instance, are cases which had no detrimental effect on the lactation. In these cases the cows have been considered as healthy. If the calf was born dead, and if lactation was subsequently disturbed, the mother was not considered as a healthy cow. In the case of actinomycosis, the cow was considered as healthy unless the disease caused lack of appetite. In the case of parturient paresis, grass tetany, ketosis, indigestion, diarrhea, mastitis or abortion, the cows were not considered as healthy except if the disease was so moderate that no effect on the lactation could be observed. If one or two udder

quarters lost their ability of action during the ascending phase, the cow was not considered as healthy. If a cow was removed from the herd during the first lactation because of a too low production, it has been omitted from the experimental material.

In each lactation the peak production and the time involved in reaching it, i.e. the duration of the ascending phase, have been calculated. The peak production is the mean of three consecutive best days with the requirement, however, that the production of the second of these three days must be as high or higher than that of the preceding of following day. The peak production is considered to be reached on the second of these three days. Thus the ascending phase ends on the day of peak production. The day of calving is considered as the 0-day, the following day as the first day etc. If several peak productions of the same height occur, the ascending phase is considered to terminate at the first peak.

In each period the material has been divided in two groups so that the lactations of the winter and the pasture feedings have been treated separately. Each of these groups has further been divided in two subgroups: the first includes lactations of cows at the first lactation and the second includes lactation of older cows. All such lactations in which the ascending phase belongs partly to the winter feeding and partly to the pasture feeding period, have been omitted. This grouping has been used both in drawing average lactation curves and in treating the factors influencing lactation at the ascending phase.

The average lactation curves have been designed in such a way that both productions and the times involved in reaching them are averages. In designing such curves, the peak production and the duration of the ascending phase are firstly calculated separately for each cow. Thereafter the productions are calculated as a mean of three days at different times from calving, for instance 1/8, 1/4, 1/2, 3/4, and 5/4 of the duration of the ascending phase. Following this, the means of productions of individual cows at these different points of time are calculated and by means of these averages the average lactation curve is drawn. The designing of such lactation curves has been more thorougly described in an earlier paper (12, p. 162). In that paper lactation curves designed in this way are compared with lactation curves designed in some other ways. Figures 1—3 show the average lactation curves designed in the manner described above.

Influence of season on the lactation

The mean milk and milk fat productions of the herd rose during the time during which statistics of daily milk yields were collected. It is seen from Figures 1—3 and Table 1 that both the peak production and the duration of the ascending phase increased. The figures also show that the lactation curves are rather linear in the interval 1/4—4/4 from the duration of the ascending phase.

In the first sequence the p e a k p r o d u c t i o n in both the winter and pasture feeding periods was at about the same level in cows older than heifer-cows. On the contrary, heifer-cows at winter feeding had a peak production averaging 3.6 kg greater than at pasture feeding ($P < 0.001$). In the second sequence the

Table 1. The means of peak productions, durations of the ascending phase and the lactation tangents at the ascending phase in different sequences.
W_1 The first lactation in the winter feeding period
W_n Later » » » » » »
P_1 The first » » » pasture » »
P_n Later » » » » » »

	1st sequence				2nd sequence				3rd sequence			
	W_1	W_n	P_1	P_n	W_1	W_n	P_1	P_n	W_1	W_n	P_1	P_n
Number of cows	12	65	7	27	49	148	25	54	50	96	11	40
Peak production, kg	17.6	21.8	14.0	21.6	18.4	26.0	16.2	20.8	19.3	26.6	17.6	24.2
Duration of the ascending phase, days	38	31	25	25	39	32	33	28	45	36	34	33
Tangent at the ascending phase, kg/day	0.56	0.82	0.64	0.95	0.53	0.93	0.58	0.83	0.48	0.83	0.56	0.83

cows at winter feeding had a considerably higher peak than at pasture feeding. In cows older than heifer-cows the average difference was 5.2 kg ($P < 0.001$) and in heifer-cows 2.2 kg ($P < 0.001$). Also in the third sequence the cows at winter feeding had a higher peak than cows on pasture, although the differences were not so great as in the second sequence. In cows older than heifer-cows the difference averaged 2.4 kg ($P < 0.001$) and in heifer-cows 1.7 kg ($P < 0.05$).

Accordingly, the cows were found to have on an average a higher peak in the winter feeding period than on pasture. At the end of the decade 1940 the difference was still small because of bulky feeding in the winter feeding period. In the beginning and in the middle of the decade 1950, the difference was very considerable because the winter feeding became more concentrated whereas the pasture feeding remained

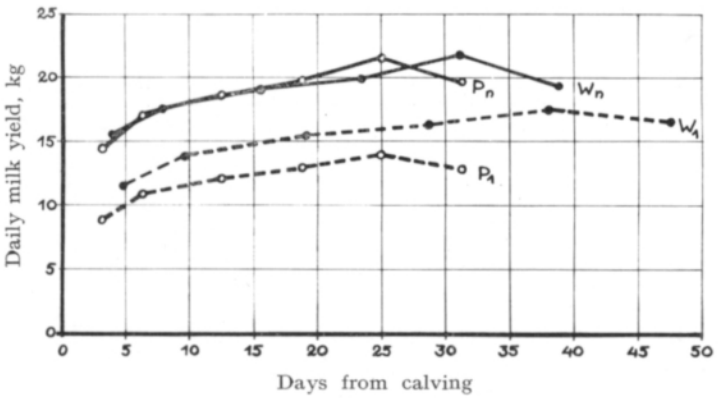

Fig. 1. Average lactation curves from the control years 1946–47 — 1949–50 (the first sequence).
W_1 The first lactation in the winter feeding period (12 cows)
W_n Later » » » » » » (65 »)
P_1 The first » » » pasture » » (7 »)
P_n Later » » » » » » (27 »)

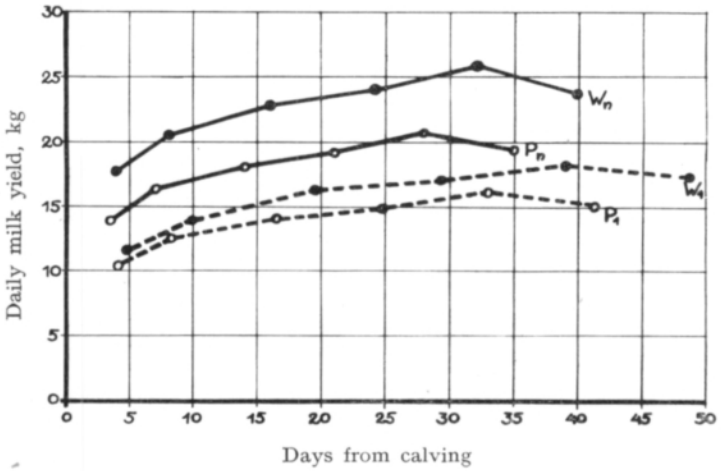

Fig. 2. Average lactation curves from the control years 1950–51 — 1956–57 (the second sequence).
W_1 The first lactation in the winter feeding period (49 cows)
W_n Later » » » » » » (148 »)
P_1 The first » » » pasture » » (25 »)
P_n Later » » » » » » (54 »)

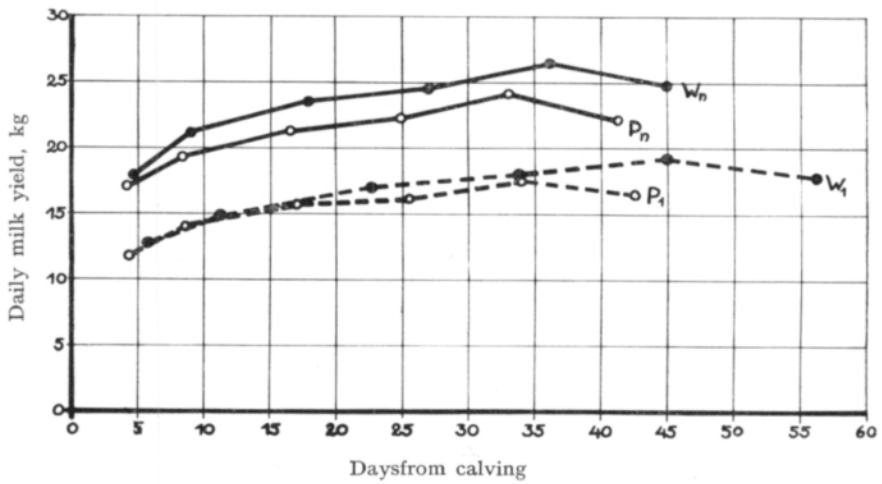

Fig. 3. Average lactation curves from the control years 1957–58 — 1960–61 (the third sequence).
W_1 The first lactation in the winter feeding period (50 cows)
W_n Later » » » » » » (96 »)
P_1 The first » » » pasture » » (11 »)
P_n Later » » » » » » (40 »)

approximately unchanged. Thereafter the difference in peak productions between winter and pasture feedings has decreased. As can be seen from Table 1, the peak production during winter feeding was only slightly higher in the third sequence than in the second sequence, whereas the difference at the pasture feeding was very considerable. The cows older than heifer-cows at pasture feeding had on an average

3.4 kg higher peak production in the third sequence than in the second sequence ($P < 0.001$). In heifer-cows this difference was not significant, 1.4 kg ($0.1 < P < 0.2$). The winter feeding in the two last sequences remained nearly unchanged, while the quantity of pasture grass eaten by the cows, on the contrary, increased. In the second sequence the cows consumed about 12 kg dry matter of grass and in the third sequence 14 kg dry matter of grass of the same value per head and day. In addition, it can be mentioned that concentrated were given in the following amounts: 1 kg if the cow's energy need was 11 food units, 2 kg if the need was 12 food units, and 3 kg if the need was 13 food units or more.

The duration of the ascending phase was generally greater at winter feeding than at pasture feeding. If cows of all ages are considered, the duration of the ascending phase in the first sequence was 32 days in stall and 25 days on pasture, in the second sequence 34 days in stall and 30 days on pasture, and in the third sequence 39 days in stall and 33 days on pasture. The significance of the difference in the first sequence was $P < 0.01$, in the second sequence $P < 0.02$ and in the third sequence $P < 0.001$. The duration of the ascending phase was in general significantly longer at winter than at pasture feeding in both heifer-cows and older cows treated separately.

The duration of the ascending phase of heifer-cows is generally longer than that of older cows. This is true especially in the winter feeding period. Although the difference was not statistically significant in the first sequence ($0.1 < P < 0.2$), it was very significant in the second sequence ($P < 0.001$) and rather significant in the third sequence ($P < 0.01$). On the contrary, in the pasture feeding period there was no significant difference in the duration of the ascending phase in any sequence between the heifer-cows and older cows.

On the basis of the peak production and the duration of the ascending phase it is possible to calculate the so called lactation tangent at the ascending phase which is the ratio between the peak production and the duration of the ascending phase (kg/day). It describes how rapidly the milk yield rises on an average from calving until the peak, i.e. during the ascending phase. The averages of the tangents of individual cows at winter feeding varied in heifer-cows 0.48 — 0.56 kg/day and in older cows 0.82 — 0.93 kg/day. Consequently the daily milk yield rose at winter feeding in heifer-cows more slowly than in older cows (the value of P in the different sequences was at most 0.01). The mean values of the tangents at pasture feeding varied in heifer-cows 0.56 — 0.64 kg/day and in older cows 0.83 — 0.95 kg/day. Consequently also at pasture feeding the milk yield rose in heifer-cows more slowly than in older cows (P value at most 0.02). This result is to be expected, because the peak production of heifer-cows is considerably lower than that of older-cows, and in addition the ascending phase is generally longer in the former than in latter cows.

There was no significant difference in the values of the tangent between winter and pasture feedings. This is due to the fact that although the peak production in the winter feeding period is higher, the ascending phase is correspondingly longer than in the pasture feeding period.

It has been established above that the cows in the second and third sequences

had a higher average peak in the winter than in the pasture feeding period. At the same time, the duration of the ascending phase was generally longer at winter than at pasture feeding. Consequently there seems to be a positive correlation between the peak production and the duration of the ascending phase. In order to confirm this, the correlation in older cows during the winter feeding period was calculated separately for each sequence. In the first sequence the correlation was $r = + 0.37$ and the regression coefficient $b = 0.11$ kg/day ($P < 0.01$). According to the value of the regression coefficient, the peak production rises on an average 0.1 kg when the duration of the ascending phase increases by one day. Both in the second and the third sequence the correlation was $r = + 0.10$ which in neither sequence was statistically significant. On the basis of partly the same material, KAJANOJA and SILVENNOINEN-LARPES (9, p. 5) observed that cows with a high and a low peak production reached the peak at the same time.

Influence of condition and dry period on the lactation

At the University Farm Viik the cows are weighed 5 days, 3 months and 6 months after calving, and in the case of a late calver (the interval between two calvings exceeding 15 months) in addition 12 moths after calving. At the time of the weighings, the condition (degree of fatness) of the cow is estimated using a system of 7 classes, I—VII. Very fat cows belong to the condition class I, very lean cows to class VII. The cows in normal condition belong to class IV.

In the following section, attention is paid to the influence of the condition class on the peak production and the duration of the ascending phase. In the first sequence the correlation between the peak production and the numerical value of the condition class in cows older than heifer-cows was $r = - 0.22$ and the regression coefficient $b = - 1.02$ kg per condition class ($P < 0.05$). According to the value of the regression coefficient, the peak production increases on an average one kilogram when the cow becomes fatter by one condition class. In these same cows the correlation between the duration of the ascending phase and the condition class was $r = - 0.25$ and the regression coefficient $b = - 3.6$ days per condition class ($P < 0.05$). According to this regression coefficient, the duration of the ascending phase increases on an average 3.6 days when the cow becomes fatter by one condition class. In heifer-cows the correlation between the peak production and the condition class was $r = - 0.45$ and the regression coefficient $b = - 1.61$ kg per condition class ($P = 0.05$). On the contrary, no significant correlation existed between the duration of the ascending phase and the condition class in heifer-cows. The low correlations mentioned above indicate that the influence of the condition class on the lactation at the ascending phase is negligible assuming that the cows are in normal or good condition. On the basis of nearly the same material, KAJANOJA and SILVENNOINEN-LARPES (9, p. 7) found that fat cows have a higher peak than the lean ones.

In the second and third secuences cows were considerably fatter than in the first sequence. During the winter feeding most of the older cows belonged to the condition classes II and III and only about 1/10 to classes IV and V. No significant

correlation was found between the peak and the condition class nor between the duration of the ascending phase and the condition class. It was further found that the cows belonging to class IV had on average peak as high as that of the cows in classes II and III. During the pasture feeding most of the cows belonged to the condition class III, and therefore in this case the influence of the condition on the lactation could not be studied. It seems that the condition has only a small influence on the lactation of older cows if they are in normal or in good condition.

In the second sequence there were 49 lactations in heifer-cows at winter feeding. Of these, 17 cows belonged to the condition class II, 22 to class III, and 10 to class IV. The cows in classes II and III had a peak averaging 2.0 kg higher than cows in class IV ($P < 0.01$). No significant difference existed in the peak productions of cows in classes II and III.

In the third sequence there were 50 lactations in heifer-cows at winter feeding. Of these, 46 belonged to classes II and III and only 4 to class IV. The cows in classes II and III had an average peak production 3.2 kg higher than the cows in class IV ($P < 0.001$). On the contrary, the cows in classes II and III had average peaks of the same height. The duration of the ascending phase of cows in classes II and III was not longer than that of cows in class IV. It seems that heifer-cows in normal condition do not have as high a peak production as fat cows have, whereas, on the other hand, the peak of cows older than heifer-cows in normal condition is as high as that of fat cows.

In most of the cows the d r y p e r i o d varied from 1 to 2 ½ months. During this interval the length of the dry period seemed to have no influence on the height of the peak. In some of the cows the length of the dry period was over 2 ½ months, at most 7 months. These cows had a peak of about the same height as cows whose dry period was 1 to 2 ½ months. It seems that if the length of the dry period is at least one month, it has no great influence on the peak production.

In the first sequence there was one cow which had no dry period before the second calving but which produced 3 kg milk daily immediately before the second calving. At the second lactation the peak production of this cow was only 10 kg, even though it the first lactation it had a peak of 15 kg and at the third lactation a peak of 19 kg after a dry period of 40 days. The duration of the ascending phase at the second lactation was 23 days. In general, the shortage of the dry period before the second lactation has a detrimental effect on lactation of cows (cf. p. 174).

The beginning of the ascending phase and its use in predicting the peak production

The rise in milk is yield is rapid during the first days after calving. In the third sequence the yield of the first day (the following day after calving) varied in general 40—60 %, the yield of the second day 45—65 % and the yield of the third day 55—70 % of the peak production. The figures, however, do not accurately indicate the productive capacity of the udder as compared with the maximal capacity, because milk is secreted in the udder already prior to calving and because the udder is not completely emptied in the three first milkings. Further, milk is secreted more slowly in a full udder.

On the other hand, the mean production of the three first days expressed as percentage of the peak, which in the following description is called the r e l a t i v e production of three first days, may indicate rather well the productive capacity at the outset of the ascending phase as compared with the maximal productive capacity. In most cases, already on the calving day a large part of the milk secreted in the udder prior to calving is removed, and the rest of the milk is removed within three days. In addition, the three first days include milkings in which the udder is thoroughly emtied. The above-mentioned mean indicates the average relative production two days after calving.

Attention is paid to the relative production of the three first days only in the winter feeding period, because in the pasture feeding period the cows were about a week indoors after which the lactation continued on the pasture. In the first sequence this relative production in heifer-cows was on an average 51 % and in older cows 61 %. In the third sequence the corresponding figures were 49 % and 55 %. In each sequence the lactation began relatively more slowly in heifer-cows than in older cows ($P < 0.001$). KAJANOJA and SILVENNOINEN-LARPES (9, p. 4) found that the shape of the relative lactation curve in heifer-cows resembles that of the older cows. Only during the first 10 days the rise in lactation in heifer-cows is somewhat slower than in older cows.

The relative production of the three first days varies considerably. Its standard deviation in heifer-cows is 7 and in older cows 8 per cent units (per cent of the peak production). It was found that in cows older than heifer-cows in the first and third sequences there was no significant correlation between the relative production of the three first days and the peak production. KAJANOJA and SILVENNOINEN-LARPES (9, p. 5) found that older cows with the relative high peak production have a relative lactation curve at the ascending phase of about the same shape as the cows with a low peak production. Only in the beginning of the ascending phase, the curve of the cows with a low peak is above that of cows with a high peak.

In the first sequence in the winter feeding period in cows older than heifer-cows, the correlation between the mean of the a b s o l u t e production of the three first days (x) and the peak production (y) was $r = + 0.64$, the regression coefficient $b_{\frac{y}{x}} = 0.86$ kg/kg and the regression equation $y = 0.86 \cdot x + 10.4$ ($P < 0.001$). In the third sequence the corresponding correlation coefficient was $r = + 0.71$, the regression coefficient $b_{\frac{y}{x}} = 0.87$k g/kg and the regression equation $y = 0.87 \cdot x + 13.7$ ($P < 0.001$). According to the regression coefficient in both sequences, the peak production increases on an average 0.9 kg when the production of the first three days increases 1 kg. Because the correlation is rather close, it is possible that the peak production could be predicted by the aid of the regression equation. The standard error of estimate in regression for cows older than heifer-cows at winter feeding was 3.0 kg in the first sequence and 2.5 kg in the third sequence. Thus the regression equation can be used to predict the peak production in cows older than heifer-cows at winter feeding on the basis of the mean production of the first three days. The accuracy in the first sequence will be only 6 kg and in the third sequence 5 kg if a reliability of 95 per cent is desired.

In addition, the author has studied the possibility of predicting the peak production on the basis of the production on the tenth day. The production on the tenth day has been calculated as a mean of the 9th, 10th, and 11th day after calving. The correlation between the production of the 10th day (x) and the peak production (y) in cows older than heifer-cows at winter feeding in the first sequence was $r = +0.86$, the regression coefficient $b_{\frac{y}{x}} = 1.06$ kg/kg and the regression equation $y = 1.06 \cdot x + 2.1$ ($P < 0.001$), in the second sequence $r = +0.82$, $b_{\frac{y}{x}} = 0.89$ kg/kg and $y = 0.89 \cdot x + 6.4$ ($P < 0.001$) and in the third sequence $r = +0.84$. $b_{\frac{y}{x}} = 0.95$ kg/kg and $y = 0.95 \cdot x + 5.5$ ($P < 0.001$). The correlations are thus very close. According to the regression coefficients, the peak production increases on an average 1 kg when the production of the 10th day increases 1 kg. The standard error of estimate in regression in the different sequences was about 2 kg. Thus the peak production can be predicted on the basis of the production of the 10th day by the aid of the regression equation with an accuracy of 4 kg if a reliability of 95 per cent is desired.

The difference between the peak production and the production of the 10th day was 3.2 kg in the first sequence, 4.0 kg in the second sequence and 4.5 kg in the third sequence. No significant correlation was found between these differences and the production of the 10th day. The peak production could thus be estimated by adding to the 10th day the amount 3.2 kg in the first sequence, 4.0 kg in the second sequence and 4.5 kg in the third sequence. In the first sequence the distribution of the differences deviated considerably to the left; in both of the latter sequences it was nearly normal. Since the standard deviation of these differences in each sequence was about 2 kg, the peak production can be estimated by this method with only on accuracy of 4 kg if a reliability of 95 per cent is desired. In the two latter sequences at winter feeding, the most probable value for the peak production in cows older than heifer-cows can be found by adding 4 kg to the production of the tenth day (the mean of the 9th, 10th, and 11th days). By adding 8 kg (4 kg + 2·2 kg) to the production of the 10th day, an upper limit to the peak production is found which is only seldom exceeded. In both of the latter sequences only 2 % of the cows exceeded this limit.

Summary

Since the year 1947 daily milk yields of Ayrshire cows at the ascending phase have been obtained at the University Farm Viik. In this paper only healthy cows are considered. Because the yearly milk production has considerably increased since 1947, the milk records have been divided into three sequences: the first consists of the control years 1946–47 — 1949–50, the second 1950–51 — 1956–57 and the third 1957–58 — 1960–61. In each sequence average lactation curves have been drawn separately for heifer-cows and older cows in both the winter and pasture feeding periods. The lactation curves have been designed in such a way that both

productions and the durations of the ascending phase or fixed fractions of them (1/8, 1/4, 1/2, 3/4, 5/4) are averages (Figures 1—3). The designing of these curves has been more thoroughly described in an earlier paper (12, p. 162). In the present paper attention has been paid to some of the factors influencing the lactation curve at the ascending phase. The following points were noted.

The average peak production of cows older than heifer-cows at winter feeding was 21.8 kg in the first sequence, 26.0 kg in the second sequence, and 26.6 kg in the third sequence. At pasture feeding the corresponding figures were 21.6 kg, 20.8 kg, and 24.2 kg. The duration of the ascending phase at winter feeding in cows older than heifer-cows in the first sequence was on an average 31 days, in the second sequence 32 days, and in the third sequence 36 days. At pasture feeding the corresponding figures were 25, 28, and 33 days. The average peak productions as well as the average of the times involved in reaching them were higher at winter than at pasture feeding. The feeding in both periods was intensive during the second and third sequences. At winter feeding the duration of the ascending phase was generally longer in heifer-cows than in older cows.

The lactation tangent at the ascending phase, which is the ratio between the peak production and the duration of the ascending phase (kg/day), was on an average lower in heifer-cows both at winter (about 0.5) and at pasture feeding (about 0.6) than in older cows (both at winter and pasture feedings 0.8—0.9). No significant difference was found in the values of lactation tangent at winter and at pasture feedings.

The influence of the condition of the cows on the peak production and the duration of the ascending phase of cows older than heifer-cows is slight, assuming that the cows at parturition are in normal or good conditions. Heifer-cows in normal condition, on the contrary, do not have an average peak production as high as cows in good condition. The duration of the ascending phase of the heifer-cows in normal condition is, however, about as long as that of cows in good condition. Only a few cows in a thin condition were included in this study.

The length of the dry period has no great influence on the peak production if the dry period is at least one month in length. A too short dry period before the second lactation has a detrimental effect on lactation.

It was found that at winter feeding the mean production of the three first days in per cent of the peak production was smaller in heifer-cows (about 50 %) than in older cows (about 60 %). According to this, lactation in heifer-cows begins both absolutely and relatively more slowely than in older cows.

There is a rather close correlation between the mean production of the three first days and peak production. At winter feeding in cows older than heifer-cows, the peak production can be predicted on the basis of the mean production of the three first days by the aid of the regression equation. The accuracy, however, will be only 5 or 6 kg if a reliability of 95 per cent is desired.

There is a very close correlation between the production of the tenth day (the mean of the 9th, 10th, and 11th day) and peak production. At winter feeding in cows older than heifer-cows, the peak production can be predicted on the basis of the production of the tenth day either by the aid of the regression equation or

by adding to the production of the tenth day the difference between the peak production and the production of the tenth day. The accuracy will be 4 kg for a reliability of 95 per cent. In the two latter sequences the most probable value for the peak production can be found by adding 4 kg to the production of the tenth day.

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SELOSTUS:

LEHMÄN MAIDONTUOTANTOKÄYRÄSTÄ HERUMISKAUTENA

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Helsingin yliopiston Viikin koetilan ayrshirekarjassa on suoritettu päivittäisiä maidon punnituksia heruvilla lehmillä vuodesta 1947 lähtien. Tässä kirjoituksessa kiinnitetään huomiota ainoastaan terveitten lehmien herumiseen. Koska tuotanto on mainitusta vuodesta huomattavasti noussut, on herumista koskeva tilasto jaettu kolmeen jaksoon, joista ensimmäiseen kuuluvat tarkkailuvuodet 1946—47 — 1949—50, toiseen 1950—51 — 1956—57 ja kolmanteen 1957—58 — 1960—61. Kunakin jaksona erikseen on piirretty keskimääräisiä herumiskäyriä, erikseen sisäruokinta- ja laidunkausina samoin myös ensikantoisista ja niitä vanhemmista lehmistä. Herumiskäyrät on piirretty siten, että sekä tuotannot että herumiskauden pituudet ja herumiskauden määrätyt murto-osat (1/8, 1/4, 1/2, 3/4, 5/4) ovat keskiarvoja. Keskimääräisten herumiskäyrien piirtäminen on tarkemmin esitetty aikaisemmassa kirjoituksessa (12, p. 162). Tässä kirjoituksessa kiinnitetään huomiota muutamien tekijöitten vaikutukseen herumisessa. Tällöin todettiin mm. seuraavaa.

1. Ensikantoisia vanhemmat lehmät heruivat sisäruokintakautena ensimmäisenä jaksona keskimäärin 21.8, toisena 26.0 ja kolmantena 26.6 kiloon. Laidunkautena vastaavat luvut olivat 21.6 kg, 20.8 kg ja 24.2 kg. Herumiskauden pituus oli sisäruokintakautena ensikantoisia vanhemmilla lehmillä ensimmäisenä jaksona keskimäärin 31, toisena 32 ja kolmantena 36 päivää. Vastaavat luvut laidunkautena olivat 25, 28 ja 33 päivää. Sisäruokintakautena lehmät heruivat siis korkeammalle samallakuin herumiskauden pituus oli suurempi kuin laidunkautena. Ruokinta oli kumpanakin kautena ensimmäisiä tarkkailuvuosia lukuunottamatta voimakas. Ensikantoisten lehmien herumiskauden pituus oli sisäruokintakautena keskimäärin suurempi kuin ensikantoisia vanhempien lehmien.

2. Herumistangentti, joka on herumishuipun korkeuden ja herumiskauden pituuden suhde (kg/p), oli ensikantoisilla lehmillä sekä sisäruokinta- (n. 0.5) että laidunkausina (n. 0.6) keskimäärin pienempi kuin ensikantoisia vanhemmilla lehmillä (sekä sisäruokinta- että laidunkausina 0.8—0.9). Sen sijaan herumistangentin arvoissa ei ollut merkitsevää eroavuutta sisäruokinta- ja laidunkausien välillä.

3. Lehmän lihavuuskunnon vaikutus ensikantoisia vanhempien lehmien herumishuippuun ja herumiskauden pituuteen on vähäinen, jos lehmät poikiessaan ovat normaalissa tai lihavassa kunnossa. Lihavuuskunnoltaan normaalit ensikantoiset lehmät eivät keskimäärin heru yhtä korkealle kuin lihavat lehmät. Niitten herumiskauden pituus on kuitenkin suunnilleen yhtä pitkä kuin lihavien lehmien. Laihoja lehmiä ei aineistoon juuri kuulunut.

4. Ummessaoloaika ei ainakaan huomattavasti vaikuta herumishuipun korkeuteen, jos ummessaoloaika on vähintään yhden kuukauden pituinen. Jos lehmä ennen toista poikimista ei ole ummessa, on heruminen toisena lypsykautena sangen heikko.

5. Sisäruokintakauden aineistoon perustuen todettiin, että kolmen ensimmäisen päivän tuotannon keskiarvo prosenteissa herumishuipusta oli ensikantoisilla lehmillä keskimäärin (n. 50 %) pienempi kuin ensikantoisia vanhemmilla lehmillä (n. 60 %). Tämän mukaan ensikantoiset lehmät heruvat paitsi absoluuttisesti myös suhteellisesti hitaammin kuin ensikantoisia vanhemmat lehmät.

6. Kolmen ensimmäisen päivän tuotantojen keskiarvon ja herumishuipun välillä vallitsee melko voimakas vuorosuhde. Näitten tekijöitten välisen regressioyhtälön avulla herumishuippu on ennustettavissa kolmen ensimmäisen päivän tuotannon perusteella sisäruokintakautena ensikantoisia vanhemmilla lehmillä kuitenkin ainoastaan 5 tai 6 kilon tarkkuudella, jos pyritään 95 prosentin varmuuteen.

7. Kymmenennen päivän tuotannon (9., 10. ja 11. päivän keskiarvo) ja herumishuipun välillä vallitsee sangen voimakas vuorosuhde. Näitten tekijöitten välisen regressioyhtälön avulla samoinkuin lisäämällä 10. päivän tuotantoon herumishuipun ja 10. päivän tuotannon keskimääräinen erotus herumishuippu voidaan ennustaa sisäruokintakautena ensikertaisia vanhemmilla lehmillä 10. päivän tuotannon perusteella noin 4 kilon tarkkuudella, jos pyritään 95 prosentin varmuuteen. Kahtena viimeisenä jaksona herumishuipun todennäköisin arvo saadaan lisäämällä 10. päivän tuotantoon 4 kg.