DRY PERIOD AND MILK YIELD.

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Investigators have very differing opinions regarding the relation between the dry period and milk yield. The author has dealt with the different and partly contradictory results of the investigations touching this question in an earlier study of Finnish Ayrshire cattle (5). Some reasons for the different results were given. However, owing to the inadequacy of the material it was not possible to weigh their validity. As there has been an opportunity to complement the material later it has been possible to make some comparisons between the dry period and milk yield. At the same time the aim has been to find out whether the length of lactation due to the cow's genotype, upon which the shape of the lactation curve and its favourability is for a great part dependent, may be judged on the basis of the dry period.

As it has been stated in the earlier study (5, p. 149) the material was collected from the milk yield and other data obtained in general cattle test from the control years 1929—1930 to 1938—1939. The material for the following investigation contains those daughters of the Ayrshire bulls included in the abovementioned earlier study whose first, second and third lactation periods coincided with the above nine control years. The commencement of the dry period is calculated from the time when the daily milk yield of the cow has permanently fallen under one kilo, which is the method used in the Finnish test bookkeeping. Information as to the lactation yield has been available as to only a small portion of the cows included in the material, for which reason the number of animals in certain calculations is very small. Despite this fact the results obtained will undoubtedly throw light on this question, which is so important from the standpoint of cattle breeding.

In my earlier ivestigation I put particular emphasis on the fact that the dry period brings about variations in the milk yield simultaneously both as a nongenetic and a genetic factor and that this is a fact always to be taken into consideration in investigations of this nature. The dry period acts as a non-genetic factor when its effect is studied during a rest period preceding lactation, whereas it is a genetic factor when the shape of the lactation curve is studied, which is to a great extent dependent on the number of lactation days or the length of the dry period subsequent to lactation. In the following study the dry period in the first mentioned case is called preceding dry period (P. D. P.) and in the latter case current dry period (C. D. P.).

Preceding Dry Period.

Since both the preceding and the current dry period of the cows of high yield are on an average shorter than those of the cows of low yield, in studying the effect of the preceding dry period a comparison may not be made between lactation yield as such and the dry period preceding lactation, as it has been done in the majority of investigations. Such a comparison involves not only the effect of the preceding dry period i. e. the rest period, but also the effect of the current dry period, or in other words the effect on the yield of the length of the lactation period which is dependent on genotype; these two effects are direct opposites. The correlation figures between the length ot the preceding dry period and the milk yield obtained by means of such comparisons is for a great part dependent upon how much the length of the dry period varies due to the different genotypes of cows. If the differences between the cows' genotypes are great in this respect, in other words if the individual differences in yield of different cows is mainly due to genetic variation of the length of lactation and therefore at the same time of the length of dry period, it seems that the preceding dry period has a relatively small effect on the yield. Whereas, if the genotype of the cows with respect to the dry period is about the same, the effect of the preceding dry period (rest) becomes more apparent and the correlation between it and the yield becomes greater. From this it may be gathered that there is no possibility of studying the relation between preceding dry period and lactation yield unless the genetic variation of yield which is caused by different lengths of the dry period is taken into consideration.

Sanders (8) has aimed at eliminating the yield variation in question by using 100 to indicate the milk yield of the first lactation period and by estimating the yield of the other lactation periods in proportion to it. When he got a higher correlation coefficient between the first dry period and the second lactation period ($+0.455 \pm 0.026$) than between the yields of the later dry periods and of the subsequent lactation period ($+0.120 \pm 0.039$), he concluded that the first dry period had a greater effect on the milk yield than the later ones.

The author has earlier (5, p. 31) expressed the opinion that such a result is due to the method of dealing with the material. Namely, if the yield of the first lactation period, chosen as a basis of comparison, is low for some reason as compared to the other lactation periods, the first dry period is in general long. In this case a relatively higher figure than usual is obtained for the second lactation period i. e. that following the long dry period. The case is quite the opposite when the yield of the first lactation period is unusually high in comparison with the others, and when the first dry period is also generally short. Thus the relative yield of the lactation period following the first long dry period is in general high and that of one following the short dry period low without the length of the first dry period as such having anything to do with the yield of the second lactation period. This fact has no effect on the correlation between the later lactation periods and the preceding dry periods, because the basis of comparison, the yield of the first lactation period is no longer in correlation with these dry periods. The truth of this conception has been proved. When the correlation coefficient between the relative yield of the first dry period and the second lactation is calculated according to Sanders's method for our Ayrshire material, the figure obtained is $+0.29\pm0.08$. The correlation coefficient got between the yield of the second dry period and the third lactation amounts to only $+0.06\pm0.08$. In this case the milk yields of lactation have been corrected on the basis of number of previous lactations and current lactation using correction factors presented earlier by the author (5, p. 66 and 127). JOHANSSON and HANSSON (2, p. 43) have also corrected the dry period according to the variation of calving interval. As we are concerned in particular with the significance of the rest period preceding lactation we do not consider it justifiable to change its length, although the dry period is indeed dependent on the length of calving interval. Therefore, the dry period has not been corrected in any way in this study.

According to the abovementioned correlation coefficients the first dry periods of the Finnish Ayrshire cattle should also have a greater effect on the yield of the second lactation than that of the later dry periods on the yield of the subsequent lactations. This is not, however, the case. If instead of the yield of the first lactation we take the milk yield of the third lactation as a basis for comparison and use the figure 100 to designate it and according to it calculate the relative milk yield for the second lactation, we get a correlation coefficient between this yield and the first dry period which is only -0.04 ± 0.08. Thus, since a value has been used to designate the relative yield of the second lactation which has not been dependent upon the correlation between the yield of the first lactation and the next dry period, virtually the same correlation coefficient has been obtained between it and the first dry period as between the second dry period and the yield of the third lactation. Contrary to SANDERS's *belief the first dry period has no greater an effect on the milk yield of the next lactation than the later dry periods have on the milk yields of the lactation periods following them.*

The correlation coefficients given above between the first dry period and the milk yield of the second lactation ($r = -0.04\pm0.08$) and between the second dry period and the yield of the third lactation ($r = +0.06\pm0.08$) are so small that judging from them the preceding dry periods have no effect on the milk yield. According to earlier investigations e. g. SANDERS' (8) and JOHANSSONS's and HANSSON's (2) the correlation in question is curvilinear, wherefore there is reason to suspect that also in this material the low values of the correlation coefficients are due to this reason.

Table 1. Relative milk yields of second and third lactations and preceding dry period (P. D. P.).

P.D.P, days	II lactation (III=100)		III lactation (I=100)		II (III=100) and III (II=100) lactations	
	n	Relative yield	n	Relative yield	n	Relative yield
0—9	14	102.1	2	85.0	16	100.0
10—19	11	107.7	6	108.3	17	107.9
20—29	14	97.1	14	89.3	28	93.2
30—39	22	102.3	23	98.9	45	100.6
40—49	28	103.6	17	100.3	45	102.3
50—59	22	105.0	24	110.8	46	108.0
60—69	17	104.4	26	105.0	43	104.8
70—79	9	108.3	13	102.7	22	105.0
80—89	9	98.3	17	105.6	26	103.1
90—99	9	109.4	10	101.0	19	105.0
100—109	3	98.3	8	96.3	11	96.8
110—119	2	80.0	3	95.0	5	89.0
120—129	2	95.0	—	—	2	95.0
130—139	—	—	—	—	—	—
140—149	1	75.0	—	—	1	75.0
M	163	102.9	163	102.1	326	102.5
± m		± 1.8		± 2.0		± 1.3

It has been possible to include comparatively few observations in the calculation because the yield data of the first three lactations have been inadequate. The results also vary to such a degree that it is very difficult to get a clear picture of the direction of the correlation on the basis of Table 1 and Figure 1. A clearer conception of the correlation is to be had by surveying the mean relative yields of the second and third lactations which are given in the last column of the table and are marked in the figure with an unbroken line. According to this the correlation in question seems to be slightly curvilinear in this material too. The milk yield of lactation increases a little as the dry period lengthens up to about sixty days, after which the dry period no longer has any effect on the milk yield. As a matter of fact from 100 dry period days upwards the milk yield does

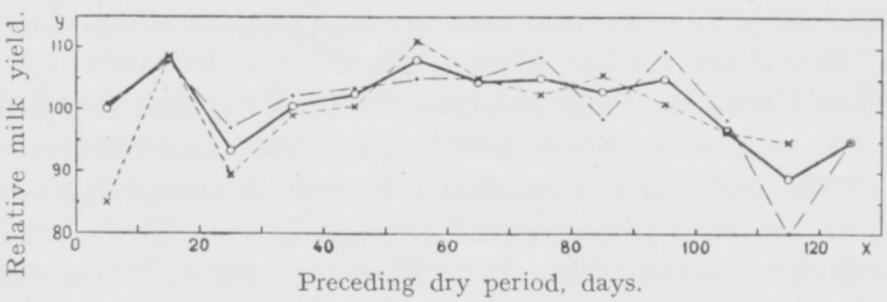


Figure 1. Regression of the relative milk yield on the preceding dry period.

• — — — • II lactation, × - - - × III lactation,
O——O II and III lactations.

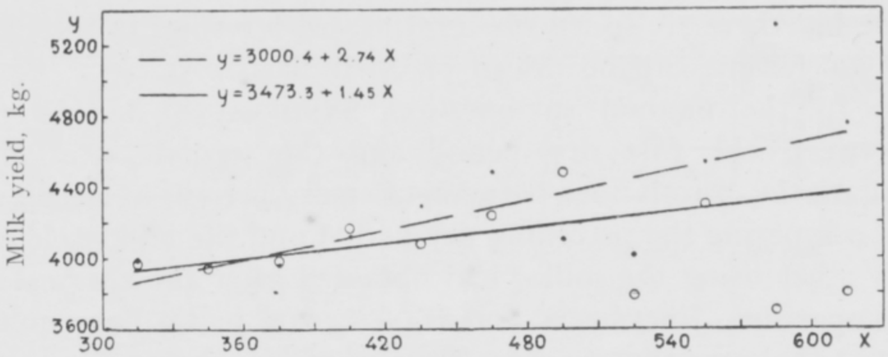
indeed decrease but there are so few observations with respect to these classes that no significant conclusions can be drawn on their basis.

According to the method in question SANDERS (8) has determined the correlation between the first dry period and the second lactation. Whereas he has determined the correlations between later dry periods and their subsequent milk yields by comparing the preceding dry period and the milk yield of the same cow with each other using the milk yield obtained after the shortest dry period as basis of comparison. JOHANSSON and HANSSON (2, p. 43) have quite correctly remarked that at the same time as short dry periods are chosen when applying this basis of comparison low relative yields of lactation are also chosen. And it is natural that the result of this is that the correlation estimated between the preceding dry period and lactation is greater than what it is in reality.

In treating conditions previous to lactation only the effect of preceding dry period is in general spoken of. Some investigators, MATTSON (6), GAINES and PALFREY (1), KRÜGER (3, 4), JOHANSSON and HANSSON (2), have however also paid attention to the effect of the preceding calving interval on the milk yield of lactation. Results differ from one another somewhat but in general it has been observed that the milk yield of lactation is dependent upon the preceding calving interval so that, as it lengthens, the milk yield increases and vice versa. On the other hand, as may be seen later (page 153) there is a positive correlation between the calving interval and the dry period, wherefore a long preceding calving interval joins to a long preceding dry period and vice versa. Thus when the length of the preceding dry period is compared with the yield of lactation also a part of the effect of the preceding calving interval is included. Therefore in applying such comparisons the effect of the preceding calving interval must at first be eliminated in one way or another before the effect of the dry period can be estimated. KRÜGER (3, 4) has held the calving interval constant and studied the effect of the dry period on different lengths of calving intervals separately. He has also held the dry period constant in studying the effect of the calving interval. This is probably the only way in which the effects of preceding calving interval and the dry period can be separated from each other. The results obtained above would not, practically viewed, change although this method were used. In the

Table 2. Covariance between milk yield per lactation and the preceding calving interval (P.C.I.). (Milk yield is corrected for number of previous lactations and current calving interval).

Correlated	Number of lactations	M_x, days	M_y, kg	Coefficients of correlation	Coefficients of regression $\frac{y}{x}$
I P.C.I. (x) —II lactation yield (y)	345	394 ± 3	4086 ± 50	$+0.17 \pm 0.05$	$+2.74$
II » —III »	513	376 ± 2	4066 ± 38	$+0.06 \pm 0.04$	$+1.21$
III » —IV »	502	375 ± 2	3948 ± 39	$+0.08 \pm 0.04$	$+1.52$
IV » —V »	411	374 ± 2	4038 ± 43	$+0.08 \pm 0.05$	$+1.61$
II—IV » —III—V »	1426	375 ± 1	4017 ± 23	$+0.07 \pm 0.03$	$+1.45$



Length of preceding calving interval, days.

Figure 2. Regression of the milk yield per lactation period on preceding calving interval (P.C.I.).

——— II lactation, ——— III—V lactations.

first place it seems that the lactation yield is not to any extent dependent upon the length of the calving interval as it can be seen from the Table and Figure 2. This is the case particularly with regular cows, i. e. cows whose calving intervals are 450 at the most.

In addition an insignificantly small correlation has been observed to exist between the preceding dry period and milk yield, and if Krüger's method were applied it would not by any means increase but in so far as the correlation changed it would decrease. *Therefore, the conclusion may be drawn that at least as to Finnish Ayrshire cows the length of the preceding dry period and as well of the preceding calving interval has such a smal effect on the milk yield of lactation that they need not be taken into consideration in breeding selection.*

The Current Dry Period.

Non-genetic Causes of Variation.

Many non-genetic factors cause variation in the length of the dry period, the most important of them being the calving interval. It has already been mentioned above that there is a positive correlation between the length of the dry period and the calving interval. TERHO (9, p. 53) has obtained the correlation coefficient $+0.28 \pm 0.05$ between these characteristics. The correlation got by JOHANSSON and HANSSON (2, p. 77) is closer, for their correlation coefficient between the first dry period and the calving interval is $+0.441$ and between the third and the fourth dry period and calving interval $+0.376$. According to KRÜGER's (3, 4) investigations too the correlation seems to be relatively close. The corresponding results obtained by the author for the Ayrshire cattle are presented in Table and Figure 3.

Correlation coefficients have been calculated separately from the first, second, third, fourth and fifth dry periods and milk yields and in addition according to the totals. The values touching the first dry period and calving interval have however been omitted from the total results because the length of the first dry

Table 3. Correlation between the dry period (D.P.) and calving interval (C.I.).

Correlated	Number of lactations	M_x, days	M_y, days	Coefficients of correlation	Coefficients of regression $\frac{y}{x}$
I C.I. (x) — I D.P. (y)	956	386 ± 1.6	54.3 ± 1.0	$+0.23 \pm 0.03$	+0.14
II » — II »	991	373 ± 1.4	67.8 ± 1.0	$+0.28 \pm 0.03$	+0.20
III » — III »	1011	378 ± 1.4	68.7 ± 1.0	$+0.27 \pm 0.03$	+0.18
IV » — IV »	780	372 ± 1.5	69.9 ± 1.1	$+0.34 \pm 0.03$	+0.24
V » — V »	521	376 ± 2.0	67.4 ± 1.3	$+0.38 \pm 0.04$	+0.25
II—VII » — II—VII »	3631	375 ± 0.7	68.7 ± 0.5	$+0.30 \pm 0.02$	+0.21

period essentially differs from the length of the later dry periods. Further, the figures indicating the total result of the first dry period and calving interval and of the later dry periods and their corresponding calving intervals are separately marked in Figure 3.

As it can be seen from Figure 3, the regression is linear, wherefore the correlation coefficient gives the right picture of the correlation in question. As the correlation coefficients given in Table 3 are about equal, the number of previous lactations does not seem to have any considerable effect on this correlation and it also follows from this that the different dry periods — without respect to sequence — may be corrected to correspond to a year i. e. 365 days long calving intervals by using the same correction factors. For this purpose the correction factors in question, which are given in Table 6, have been computed on the basis of the equation $y = 0.21\,x - 10.1$ obtained from the total results. Thus when the dry periods are multiplied by these correction factors values of the dry period are obtained which on the average correspond to the year long calving interval.

According to Table 3 the first dry period is considerably shorter than the later dry periods. When in addition the first calving interval has been ten days

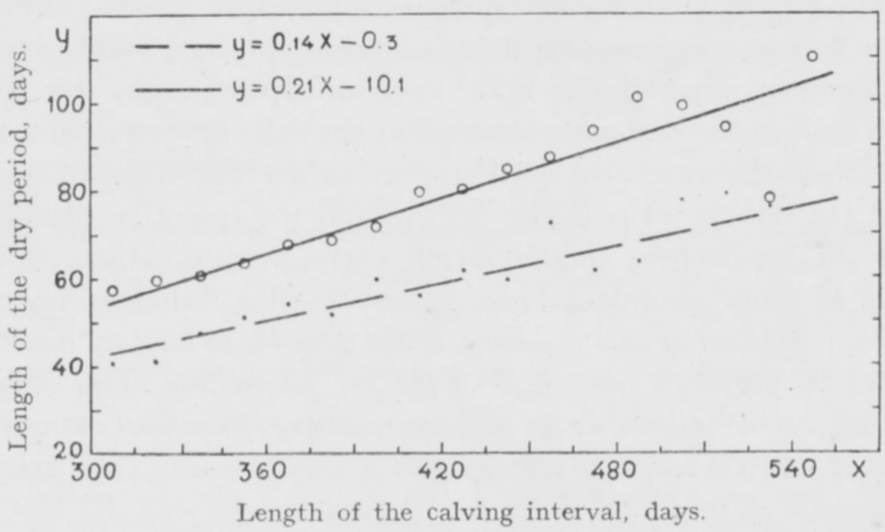


Figure 3. Regression of dry period (D.P.) on calving interval (C.I.).

— — — I calving interval, ——— II—VII calving intervals.

Table 4. Correction factors of dry period for the length of calving interval.
(Correction factors computed according to the equation $y = 0.21\,x - 10.1$ so that the corrected values correspond to a 365 days long calving interval).

Calving interval, days	300	315	330	345	360	375	390	405	420	435	450	465	480	495	510
Coefficients of correction	1.22	1.16	1.10	1.04	0.99	0.95	0.91	0.87	0.84	0.80	0.77	0.75	0.72	0.70	

longer than the others on an average, the first dry period would have been still shorter, if the calving intervals of the first lactations had been on an average as long as during later lactations. When the dry periods are corrected by means of the correction factors given in Table 4 to correspond to the year long calving interval the following mean lengths of dry periods are obtained:

Sequence of dry period	I	II	III	IV	V
D. P., days....	50.8	66.2	65.0	68.3	64.7

Thus the first dry period is fifteen days shorter than the later dry periods, whereas the latter are about equal in length with each other. This being the case the effect of the sequence of the calving does not seem to extend farther than the first dry period. This result conforms with JOHANSSON's and HANSSON's (2, p. 21 and 82) results. According to their tables the first dry period is almost a month shorter than the later dry periods. Whereas the later dry periods are equal in length with one another as is the case above.

The length of the dry period is in a great measure dependent upon the quantity and quality of nutrition. Naturally wellfed cows are of longer persistency than scantily fed ones. As the quantity and quality of feeding varies on different estates and in different seasons very greatly, it causes great variation in the lengths of dry periods. It is probably impossible to make even an approximate estimate of the variation in the length of the dry period caused by the difference in feeding on different farms. The same is the case also with respect to the variation in feeding which is the result of the change of seasons. In Finland the quantity of indoor feeding and pasture feeding as well as their relation varies very greatly. On some farms pasture feeding is more abundant than indoor feeding, whereas on other farms it is quite the opposite. *For this reason it is not possible to level by means of average correction factors the variation in length of the dry period due to the varying feeding on different farms or the difference in feeding resulting from the change of seasons, in spite of the fact that the length of the dry period may to a very great extent be dependent upon feeding.*

The dry period of cows of very long persistency very often becomes longer than their genotypes presuppose for the reason that such cows are frequently forced to dry off. This results from the generally prevailing opinion that a cow needs at least 4 to 6 weeks' rest previous to the next lactation in order to give a yield corresponding to her production capacity. If the cow herself before that does not dry off in a natural way it is forced to do it either by decreasing nutrition or actually by not milking it. In this way in determining the length of the dry period of such cows errors are made which are taken into consideration with difficulty. These errors are however doubtless small compared to those resulting from other factors.

Dry Period as a Measure of Persistency.

In Finland cattle owners in general consider the dry period as a measure of persistency. Although the length of the dry period does not indicate the shape of the whole lactation curve this practice is easy to understand. First, it is proved to be very difficult to find a method by which the shape of lactation curve characteristic to a cow could be simply and sufficiently precisely determined. Secondly, the many methods by means of which an effort has been made to determine the shape of lactation curve are very complicated. In addition the dry period expresses a very important if not the most important part of the shape of the lactation curve. This is for instance indicated by the fact that the total milk yield of Finnish Ayrshire cattle seems to a very great extent to be dependent upon the length of the dry period. There is a very distinct, positive and at the same time straight-lined correlation between the dry period and milk yield, as can be seen from Table 5 and Figure 4. In calculating these results the dry period was corrected according to the calving interval by using correction factors given in Table 4. The milk yield of the lactation period has also been corrected on the basis of the number of previous lactations and calving interval just as in earlier comparisons.

Perhaps the reader's attention will be drawn to the fact that information as regards the first dry period and the milk yield is presented with respect to 184 cows and with respect to the second dry period and milk yield with respect to only 357 cows, whereas as regards the later dry periods and milk yields there is

Table 5. Correlation between the current dry period and milk yield during lactation period. (Dry period is corrected for current calving interval and milk yield for number of previous lactations and current calving interval).

Correlated	Number of lactations	M_x, days	M_y, kg	Coefficients of correlation	Coefficients of regression $\frac{y}{x}$
I C.D.P. (x) — I lactation yield (y)	184	47.5 ± 2.0	4201 ± 74	−0.50 ± 0.06	−18.5
II » — II »	357	62.5 ± 1.4	4068 ± 49	−0.35 ± 0.05	−12.0
III » — III »	527	64.6 ± 1.2	4066 ± 37	−0.37 ± 0.04	−11.3
IV » — IV »	512	68.2 ± 1.3	3951 ± 39	−0.45 ± 0.04	−13.9
V » — V »	425	64.8 ± 1.4	4031 ± 42	−0.41 ± 0.04	−12.8
II—V » — II—V »	1821	65.2 ± 0.7	4026 ± 21	−0.40 ± 0.02	−12.6

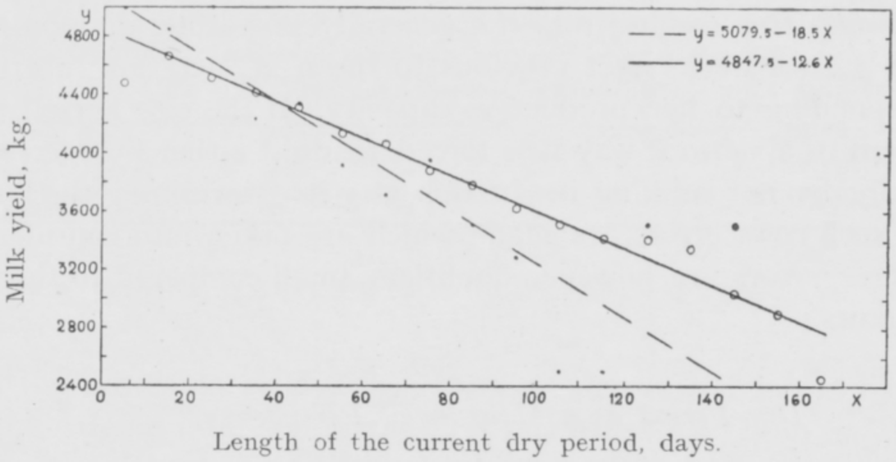


Figure 4. Regression of the milk yield during lactation period on the current dry period.

— — — I lactation, ——— II—V lactations.

information in respect of a much greater number of cows. This is due to the inadequacy of the material at our disposal. Data of the milk yield of lactation periods were not available during the first years of the time embraced by this investigation (1929—39) but only of the yields of the control years (1. 7.—30. 6). Thus, the data of the milk yields of the first lactation periods have not been obtained of the cows whose first lactations have happened to be during the beginning of the period in question. In spite of this also these cows have been included in the calculations because the number of observations with regard to later lactation periods has increased considerably in this way.

This should not, however, have any effect on the correlation between the dry period and milk yield. There is no reason to believe that a different correlation should exist between the milk yield and dry period of cows which were born earlier than that existing between corresponding characteristics of cows born later. Whereas the fact in question seems to have an effect on the mean length of the dry period. The means of the first and second dry periods are smaller than the means obtained from the whole material which are presented on page 154 and which were also calculated from the dry periods corrected on the basis of calving interval. This is due to the fact that at the end of the period covered by the investigation, from which the data of the first and second lactations mainly date, the cattle feeding has been more abundant than at the beginning. The data concerning the third, the fourth and the fifth dry period have covered the whole period, wherefore they indicate the mean result of the whole period and are equal to the whole material, whereas the mean of the first and second dry period indicates the mean result obtained from the feeding conditions of the last years, and the dry period is, owing to better feeding, shorter than during the whole time covered by the investigation on an average.

During the first lactation the number of lactation days seems to have a somewhat greater effect on the amount of the yield than in later lactations. As it may be seen in Table 5, the correlation coefficient between the first dry period and lactation yield is —0.50±0.06, whereas the correlation coefficient during later lactations varies from —0.35 to —0.45. Similarly the regression coefficient between the first dry period and the milk yield is distinctly greater than the others.

The correlation between the dry period and the milk yield shows that under our feeding conditions cows of a great persistency have considerably greater possibilities of attaining great lactation yields than cows of smaller persistency. Naturally it also follows from this that in selecting high yielders for breeding such individuals are at the same chosen which have a shorter dry period on an average than others or, to be more exact, the shape of lactation curve most suitable to our conditions. This rule of course holds good only on an average, for individual cases may diverge from it even to a very great extent.

The utility of the dry period as a measure indicating the shape of lactation curve is naturally dependent also upon the fact, how exactly the length of the dry period characteristics of the cow can be determined. Above we have already noted that several non-genetic factors cause variations in the length of dry period. Of these only the effect of the calving interval was considered possible to eliminate using mean correction factors, whereas there do not seem to be any possibilities in breeding selection to level the variation caused by the different feeding on various farms and the several seasons. From the calculations in question we cannot, however, draw any conclusions as to what possibility there are to judge the genetic differences of different animals with respect to dry period on the basis of the number of days of dry period. It can be discovered only by a comparison between parents and progeny (5, p. 162—164). The material, however, has not been extensive enough for making comparisons between sires and sons wherefore comparisons between dams and daughters only have been made. In these the correlation and regression coefficients betveen the dams' and daughters' dry periods have been determined. The results are given in the Table 6.

In calculating the results of the table the shortest dry period available has been given as the figure denoting the dry period of the individual cows. When the dry periods have been corrected on the basis of calving interval, the shortest dry period has been chosen after correction. The author has held that the shortest dry period gives a more exact picture of the charasteristic in question for the following reason.

Table 6. Dam-daughter correlations for dry period.
(Dry period is corrected for variations in length of current calving interval. Shortest dry period has been chosen after corrections.)

Correlated	Number of pairs	Daughters (x)		Dams (y)		Coefficients of	
		M	σ	M	σ	correlation	regression $\frac{x}{y}$
1. Uncorrected, shortest dry period	738	48.3	23.4	51.4	26.8	$+0.21 \pm 0.04$	+0.19
2. Corrected, shortest dry period	738	49.4	24.5	50.4	25.9	$+0.23 \pm 0.03$	+0.21
3. Calving interval under 450 days, shortest dry period (uncorrected)	612	47.9	23.6	50.8	25.9	$+0.24 \pm 0.04$	+0.22

The shortening of the dry period caused by non-genetic factors is extremely much more limited than its lengthening. Thus when the shortest dry period available is chosen, the variation between different animals caused by non-genetic factors should be smaller than e. g. when using the mean of all the dry periods available. In this method the number of lactations does not have to be taken into consideration either, or in other words the fact mentioned above that the first dry period is shorter than the orthers.

The correlation coefficients between dam and daughter have been computed from three different kinds of dry periods, i. e. first, the uncorrected, second, those corrected according to calving interval and third, the dry periods of so-called normal lactations. The last mentioned value for a single cow has been got by choosing the shortest dry period from among such dry periods whose corresponding calving interval has been under 450 days.

About the same results have been obtained from uncorrected dry periods as from those corrected by correction factors; the correlation coefficient computed from the former is $+0.21 \pm 0.04$, and that from the latter $+0.23 \pm 0.03$. Thus correction on the basis of calving interval has not to any extent improved possibilities of judgment, although the dry period according to above presented results is in a considerable measure dependent upon the length of the calving interval. This result is not in any way unexpected, for according to earlier investigations (5, 2, p. 105) the use of mean correction factors in judging milk and butter- fat yield does not noticeably increase the correlations between dam and daughter. In the light of these results the foregoing result is very easy to understand. First, it shows that individual cows react in very different ways to changes in the length of the calving interval. Second, it is probable that the variation in the length of the dry period caused by the calving interval is after all only such a small portion of the variation effected by other non-genetic factors, that its elimination does not to any great extent improve the possibilities of determining individual dry period.

In recording animals in herd-book the effect of the calving interval on the milk and butter-fat yield is not taken into consideration otherwise than that only the yields of normal lactations are accepted as results qualifying an animal for the herd-book. This means that the calving interval between lactations taken into consideration may be 450 days at the most. If the dry periods of such lactations only are used also in determining the length of the dry period, the result is at least as good as that obtained by using dry periods corrected by correction factors. As can be seen from Table 6 the correlation coefficient in question is $+0.24 \pm 0.04$ and the regression coefficient $+0.22$. *As only normal lactations are accepted in Finnish herd-book qualification and there seems to be no reason to relinquish this method, there is no reason for correction of the dry period.* Further, it is to be noted that in breeding selection it is not to the point to favour cows whose calving intervals are long because it most often is a proof of poor pregnancy capacity. In correcting dry periods on the basis of calving intervals the cows of poor pregnancy capacity are put into the same or even more advantageous position than the good ones. The case is quite the contrary when milk and butter fat yields are corrected on the basis of the calving interval, for then the possibilities of those cows whose calving intervals are long to be chosen as breeding animals are decreased.

Regardless of which of the dry period values in question are used the possibilities of breeding to increase the number of lactation days or decrease the dry period are comparatively small. The correlation coefficients of Table 6 are namely so low that no matter how strict the selection is the hereditary quality of the cattle being bred improves very slowly with respect to the dry period. The case is the same, however, also as to the milk and butter fat yield capacity, for e. g. in the author's (5) and JOHANSSON's and HANSSON's (2, p. 105) investigations correlation coefficients between the dam's and daughter's mentioned characteristics have been obtained which are of the same class as the foregoing dry period correlation coefficients. The correlation coefficients between dam and daughter are as to the whole shape of the lactation curve according to earlier investigations about equal to those obtained from dry period. In TERHO's investigation touching the native Finnish cattle his so-called five month's comparative milk yield (9, p. 46) has given the correlation coefficient $+0.14 \pm 0.07$ between dam and daughter, when this value has been determined on the basis of one normal lactation. If the value in question has been computed from the mean of two normal lactations the correlation coefficient is $+0.28 \pm 0.07$.

In the Ayrshire material on hand the five months' comparative milk yield seems to be a very undependable measure. For there is no correlation between dam and daughter, the correlation coefficient being only $+0.08 \pm 0.04$. In this case the five months' comparative yield of a single cow has usually been calculated according to the two best consecutive and normal lactations. The result obtained on the basis of one lactation has been used as a five months' yield of only young cows with respect to which only one normal lactation has been available. As it is shown by the correlation coefficients, it would not have been possible to improve the shape of the lactation curve in the material on hand if five months' comparative yield had been used as a basis of selection.

TERHO himself admits that the different non-genetic factors have such an effect on five month's comparative milk yield that it can especially in individual cases give a wrong picture of the shape of lactation curve charasteristic to a cow. Therefore, he has suggested that it should be corrected by a method based on the length of the dry period (9, p. 69). When this method is applied to our material the correlation between dam and daughter increases somewhat, the correlation coefficient obtained being $+0.16 \pm 0.04$. This figure is, however, so small that the use of this method is scarcely justifiable. In addition it is to be noted that the correction method in question increases the importance of the dry period in a five months' yield to such an extent, that the corrected value expresses particularly the length of the shape of the lactation curve or the same as the dry period too. Thus it is questionable whether it is to the purpose to use a value requiring so much calculation when the dry period as such brings to light almost as much concerning the shape of the lactation curve.

As the necessary data have not been available we have not been able to examine to what extent JOHANSSON's and HANSSON's (2, p. 68) and many other investigators' methods would have been applicable to this material. It is however not to be expected that they would lead to better correlation coefficients than those obtained from the dry period.

As we have mentioned above the dry period cannot be compared to such measures indicating shape of lactation curve in applying which the division of the milk yield among the different lactation days is taken into consideration, and not only the number of lactation days which is the case when using the dry period. The fact that a greater correlation between dam and daughter is obtained from dry period than from the five months' comparative milk yield does not justify us to consider the former the more suitable measure of the shape of the lactation curve than the latter. In Ayrshire cattle the five months' comparative milk yield, however, seems to be so uncertain that it is not possible on the basis of it to develop the shape of the cows' lactation curve in a more favourable direction. Whereas since a cow's genotype with respect to dry period is to be determined with considerably greater certainty, the use of the dry period in breeding selection is fully justifiable. Another fact supporting this method in Finland is that the length of the dry period is easily available from the reports. In addition it is so simple that all cattle owners know how to apply it in breeding selection, whereas many of the measures which different investigators have proposed are comparatively complicated.

Summary.

The relation between dry period milk yield among Finnish Ayrshire cattle has been studied in this investigation. The question has been handled particularly from the standpoint of breeding selection in weighing whether the length of the preceding dry period is to be taken into consideration in breeding selection and how exactly the length of the dry period due to genotype characteristic to each cow can be determined. The calculations made have given the following results:

I. The length of the preceding dry period has comparatively small effect on the milk yield of the next lactation. The milk yield does in fact increase somewhat as the dry period lengthens up to sixty days (Figure 1) but this effect is so slight that it has no significance in breeding selection.

II. The determination of the length of the dry period characteristic to each cow is made difficult by the fact that its length is dependent not only upon the cow's genotype but also to a very great extent upon non-genetic factors. The most important of these are: I. Feeding and care, 2. Length of calving interval, and 3. Number of previous lactations.

1. The quality and quantity of the feeding as well as the care of the cows has an apparently greater effect on the length of the dry period. In breeding selection it is especially confusing because it is very difficult to make even an approximate estimate of the effect of the different feeding and care on different farms on the

length of the dry period, and it cannot be levelled by using mean correction factors or other levelling methods. This touches also the different feeding during the several seasons.

One of the practical measures of cattle raising which brings about variation in the length of the dry period is that cows of great persistency are forced into dry period at the latest four to six weeks previous to the next calving. This variation is relatively small, however, compared to that arising from other non-genetic causes.

2. The length of the dry period is dependent upon the calving interval in that, as the calving interval increases the dry period increases also, and vice versa ($r = +0.30 \pm 0.02$, Table and Figure 3). In order to level the length of the dry period to correspond to the 365 day long calving interval, the mean correction factors have been calculated in this investigation (Table 4).

3. There is correlation between the number of previous lactations and dry period in so far that the first dry period is on an average 15 days shorter than the later dry periods.

The abovementioned and many other non-genetic factors cause so much variation in the length of dry period that it for the great part conceals the variation due to different genotypes. Thus the greatest correlation coefficient between dam's and daughter's dry period is only $+0.24 \pm 0.04$ (Table 6). In this case the shortest available dry period chosen from among the dry periods whose corresponding calving interval has been 450 days at the most has been used as the dry period of a single cow. Such a method for the elimination of variation caused in the length of the dry period by the calving interval has proved to be at least as good as the application of mean correction factors, for from the dry periods levelled by correction factors a correlation coefficient between dam and daughter has been obtained amounting to $+0.23 \pm 0.03$. On the other hand it is, however, to be noted that the effect of both the correction methods mentioned above is very small for the corresponding correlation coefficients computed from uncorrected dry period is $+0.21 \pm 0.04$.

In spite of the low values the correlation coefficients presented are on about the same level as those obtained from the Ayrshire cows' lactation milk yields between dam and daughter. As to the measure indicating the shape of the lactation curve, the so-called five months' comparative milk yield, which is in use in Finland, it is considerably much less dependable. In the material at our disposal there is hardly any correlation ($r = +0.08 \pm 0.04$) between the five months' comparative milk yields of dam and daughter. The dry period also expresses the most important and apparently the most varying part of the shape of the lactation curve, which is proved e. g. by the fact that in our feeding conditions the extent of the lactation milk yield depends to a considerable extent on the length of the dry period ($r = -0.40 \pm 0.02$, Table 5). As in addition the dry period is such a simple measure that all cattle-owners know how to apply it in breeding selection, it can well maintain its position among the measures indicating the shape of lactation curve.

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SELOSTUS.

UMMESSAOLOAIKA JA MAIDONTUOTANTO.

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Tutkimuksessa on tarkasteltu ummessaoloajan ja maidontuotannon välistä suhdetta Suomen ayrshirekarjassa. Kysymystä on selvitelty lähinnä siitosvalinnan kannalta tutkimalla onko lypsykautta edeltävän ummessaoloajan pituus otettava siitosarvostelussa huomioon sekä kuinka tarkasti voidaan määrittää kullekin lehmälle ominainen, perintöasusta johtuva ummessaoloajan pituus. Suoritetut laskelmat ovat antaneet seuraavat tulokset.

I Lypsykautta edeltävän ummessaoloajan pituudella on verraten vähän vaikutusta seuraavan lypsykauden maidontuotantoon. Maidontuotanto tosin suurenee jonkinverran ummessaoloajan pidentyessä noin 60 päivään saakka (kuvio 1), mutta tämä vaikutus on niin vähäinen, ettei sillä ole siitosarvostelussa merkitystä.

II Kullekin lehmälle ominaisen ummessaoloajan pituuden määrittämistä vaikeuttaa se, että sen pituus riippuu paitsi eläimen perintöasusta myös hyvin paljon ulkonaisista tekijöistä. Näistä ovat tärkeimmät 1. ruokinta ja hoito, 2. poikimisvälin pituus ja 3. poikimiskerta.

1. Ruokinnan laatu ja määrä samoinkuin eläinten hoito vaikuttaa ilmeisesti sangen paljon ummessaoloajan pituuteen. Siitosarvostelussa tämä on erityisen haitallista sen vuoksi, että eri tilojen erilaisen ruokinnan ja hoidon vaikutusta ummessaoloajan pituuteen on hyvin vaikea edes likimain arvioida eikä sitä voida tasoittaa keskimääräisiä korjauslukuja enempää kuin muitakaan tasoitusmenetelmiä käyttäen. Tämä koskee myös eri vuodenaikojen erilaista ruokintaa.

Hoitotoimenpiteistä aiheuttaa vaihtelua ummessaoloajan pituudessa mm. se, että pitkään lypsävät lehmät saatetaan umpeen pakkotoimenpiteillä viimeistään 4—6 viikkoa ennen seuraavaa poikimista. Näin syntyvä muuntelu on kuitenkin suhteellisen pieni verrattuna muista ulkonaisista syistä aiheutuvaan muunteluun.

2. Poikimisvälistä riippuu ummessaoloajan pituus siten, että poikimisvälin pidentyessä pitenee myös ummessaoloaika ja päinvastoin ($r = +0.30 \pm 0.02$, Taulukko ja kuvio 3). Ummessaoloajan pituuden tasoittamiseksi vastaamaan 365 päivää pitkää poikimisväliä on tutkimuksessa laskettu keskimääräiset korjauskertoimet (taulukko 4).

3. Poikimiskerran ja ummessaoloajan välillä on sikäli vuorosuhdetta, että ensimmäinen ummessaoloaika on keskimäärin noin 15 päivää myöhempiä ummessaoloaikoja lyhyempi.

Edellä mainitut sekä monet muut ulkonaiset tekijät aiheuttavat ummessaoloajan pituudessa niin paljon muuntelua, että se suureksi osaksi peittää erilaisesta perintöasusta johtuvan muuntelun. Niinpä suurin emän ja tyttären ummessaoloajan välinen vuorosuhdekerroin on vain $+0.24 \pm 0.04$ (taulukko 5). Tällöin on yksityisen lehmän ummessaoloaikana käytetty lyhyintä saatavissa olevaa ummessaoloaikaa valittuna niiden ummessaoloaikojen joukosta, joita vastaava poikimisväli on ollut enintään 450 päivää. Mainitunlainen menettely poikimisvälin ummessaoloajan pituudessa aiheuttaman muuntelun eliminoimiseksi on näet osoittautunut vähintään yhtä hyväksi kuin keskimääräisten korjauslukujen käyttö, sillä kertoimilla tasoitetuista ummessaoloajoista on emän ja tyttären välille saatu vuorosuhdekertoimeksi $+0.23 \pm 0.03$. Toiselta puolen on kuitenkin huomattava, että kummankin edellä mainitun korjausmenetelmän vaikutus on sangen pieni, sillä korjaamattomista ummessaoloajoista laskien on vastaava vuorosuhdekerroin $+0.21 \pm 0.04$.

Alhaisista arvoistaan huolimatta esitetyt vuorosuhdekertoimet ovat jotensakin samaa suuruusluokkaa kuin mitä ayrshirelehmien lypsykauden maidontuotannosta on saatu emän ja tyttären välille. Mitä taas tulee Suomessa käytännössä olevaan, lypsykäyrän muotoa ilmaisevaan mittaan, ns. viiden kuukauden suhteelliseen maidontuotantoon, se on huomattavasti epävarmempi. Käytettävissä olevassa aineistossa ei näet emän ja tyttären viiden kuukauden suhteellisen tuotannon välillä ole juuri mitään vuorosuhdetta ($r = +0.08 \pm 0.04$). Ummessaoloaika ilmaisee lypsykäyrän muodosta myös tärkeimmän ja ilmeisesti hyvin suuressa määrässä muuntelevan puolen, mitä todistaa mm. se, että meikäläisissä ruokintaoloissa lypsykauden tuotannon suuruus riippuu huomattavan paljon ummessaoloajan pituudesta ($r = -0.40 \pm 0.02$, taulukko 5). Kun ummessaoloaika lisäksi on niin yksinkertainen mitta, että sitä osaavat kaikki karjanomistajat soveltaa siitosvalinnassa, se puolustaa hyvin paikkaansa lypsykäyrän muotoa ilmaisevien mittojen joukossa.