FURTHER EXPERIMENTS ON THE EFFECT OF PRE-MILKING STIMULUS ON DAIRY COW PRODUCTION

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SUMMARY

Several experiments using identical twin cows over full lactations to study the effects of pre-milking stimulus on total milk and butterfat production are discussed. The final trial of the series compares the production of twin sets under conditions of (1) stimulus to their requirement for normal milking plus minimum milking time, and (2) a wash stimulus only, followed by slight overmilking. The result was a difference of over 30% in favour of the well stimulated group. The variation in stimulus requirement between individual cows, and over the lactation period, is also discussed.

INTRODUCTION

IN the 1958–9 milking season, an experiment was carried out, using 13 sets of identical twin cows, to compare the effect on production of two types of milking stimulus. One member of each set was given a 30 second stimulus before milking, consisting of washing and rubbing the udder with the hand, using cold running water. The other twin was given no pre-milking preparation, the only stimulus being the action of the milking machine.

The result of this trial was a difference in production of over 30% in favour of the well stimulated twins, making it quite clear that pre-milking stimulation was of major importance in the attainment of high production. While the experiment had many limitations, it did establish this very important fact. Numerous objections, however, were voiced concerning the direct application of this finding to the industry.

Some of the more important objections were the following:

(1) That the two treatments were somewhat extreme, in that the complete elimination of washing is most unusual in the industry, and also that a 30 second stimulus was probably excessive for many cows.

Both these objections were valid to some extent, but it was felt necessary, in the first instance, to attempt to obtain a difference which would be significant in spite of the expected variability in response.

(2) Nearly all the cows used in the trial had been previously accustomed to a 30 second wash and stimulus and there was the possibility that they would be conditioned to this procedure. The removal of the stimulus entirely may have had some inhibiting effect on their subsequent letdown response. Because of the limited number of first lactation cows in the trial it was impossible to answer this objection, although other work suggested that it was not likely to be an important factor.

(3) Because of the low average production of the twin sets concerned, it was possible that they did not represent a good sample of the national herd, and that the results were thus not fully applicable to the industry.

The experiments also posed many other problems, one of particular interest being the question of which of the two extremes was most important in determining the large differences in production. Was the production depressed by the complete elimination of the wash, or was the production of the co-twin increased by the application of a full half-minute of stimulation? No satisfactory answer could be given to this question, without further experimental work.

A number of investigations have been carried out in the intervening years to establish the importance of other factors in milking management which might influence the milk ejection response. These were, briefly:

(1) The effect of allowing the cow to stand for 3 minutes following the pre-milking stimulus before the cups were put on.

(2) The effects of yard management.

(3) The application of minor discomfort during milking. following the application of a 15 second stimulus. All these treatments had only a minor effect on production.

Detailed studies of the milk ejection response of a number of individual cows throughout the lactation provided a great deal of background information, and in particular led to the development of methods of estimating the threshold level of stimulus necessary for the establishment of a normal letdown response at different stages of lactation. The preliminary studies indicated that the stimulus requirement of some cows reached very high levels in the second half of the lactation, and that a stimulus level of

30 seconds was by no means excessive for many cows at this stage.

In the 1962–3 season a further full-lactation trial was made, using 19 sets of identical twins, to measure the difference in production due to the following treatments:

Control: A 30 second wash and rub with the hand, using cold running water, following by normal milking.

Treatment: Washing of the teats with cold running water followed by squirting of the teats, the entire operation taking between 5 and 10 seconds.

The production figures for the trial showed a relatively small difference of less than 10 lb of butterfat on average, in favour of the control group. Although a detailed discussion of the results is not possible here, there was one very interesting aspect which is worth noting. It was apparent that the majority of the higher producers showed a difference in production in favour of the treatment group, which almost offset the differences in favour of the control stimulus in the lower producing cows. Although there were insufficient data to establish this point definitely, there was a suggestion that the more easily stimulated cows may have been stimulated for too long. Again it was apparent that the 30 second stimulus was insufficient for many of the lower producers late in lactation, which, combined with the fact that the treatment cows were squirted, as well as being washed, may have accounted for the relatively small differences in production.

With this background of information, the trial to be discussed in this paper was conducted.

EXPERIMENTAL DESIGN

Twenty-one sets of identical twin cows were used, over a full lactation in the 1963–4 season. One set of twins was subsequently eliminated through the death of one member. The twin sets were very carefully selected on the basis of calving date, and previous history. All were milked uniformly for the three weeks following calving until lactation was fully established, and in this period careful checks were made on the uniformity of their production. Where small differences appeared in favour of either the control or treatment group, the sets were placed in a subgroup separate from the main trial, although the experimental treatment was the same. The results from each group were subsequently analysed separately.

TREATMENTS

From the experience gained in the earlier trials outlined above, it was decided to compare two types of milking management rather than a single factor, as in these earlier trials. The treatments chosen were:

Control Group: A system based on an understanding of the cow's stimulus requirements, and where milking times were minimal.

This consisted of a level of pre-milking stimulus determined monthly for each cow, and adjusted accordingly, followed by milking according to the Ruakura milk-flow indicator, the cups being removed at the true end of milking.

Treatment Group: This was the milking system common in many milking sheds, where no importance is attached to the pre-milking stimulus, and where slight over-milking commonly occurs.

It consisted of a wash only, for a period of 5 to 8 seconds, using the hand and cold running water, followed by slight over-milking occasioned by the use of the "jelly jar" sight glass currently in use in the industry.

The trial thus compared two systems of milking, one being the system practised by most farmers even today, and the other a system based on current knowledge of the milking process.

The effect of the over-milking was likely to be small on average, judging from earlier trials on the effects of milking discomfort, but might well be an important factor in certain cases, particularly when the level of stimulus was low. Since in practice, "under-stimulation" and "over-milking" generally go hand in hand, it was felt that inclusion of both factors was justified, in spite of the fact that it complicated the interpretation of the final results.

MILKING

In other respects the milking of both groups was normal, the cows being milked by a standard Ruakura machine, with the use of weights for machine stripping.

GENERAL MANAGEMENT

The farm was managed so that the level of nutrition was comparable with average commercial practice as far as possible.

The trial twins were milked in a herd of approximately 85 cows run on a self-contained farm of 88 acres with replacement stock of approximately 20 sets of identical twin calves and a similar number of rising two-year-olds. The stocking thus consisted of 85 milking cows, and about 80 head of dry stock.

Some of the twin sets included in the trial were obviously not of a good dairy type, but were included to extend the range of production levels. The final results are given later both with and without the data from these animals.

Measurements

Milk weights were taken for all cows at each milking, and tests for butterfat were made weekly. Milk flow recordings were made of normal milkings for each cow for an a.m. and p.m. milking each week, and were used to measure milking time, milking rate, amount of machine stripping, and other milking characteristics.

The duration of the letdown response was measured twice during the lactation for each cow, and an assessment of "milking temperament" was made by each milker independently for all the cows in the herd. Milking behaviour was given close attention, particularly during the first three weeks of lactation, when detailed records were kept for each cow.

Measurement of Stimulus Threshold for Normal Response

As mentioned earlier, a method had been developed for the measurement of this factor. The technique, very briefly, consisted of stimulating the cow for a measured time, followed by the commencement of milking after an interval of one minute from the start of the stimulus. This allowed time for the full milk ejection response to take place, provided it had been initiated by the level of stimulus applied. A step in the subsequent milk flow recording clearly indicated when a satisfactory response had not been established. The stimulus times were started at 5 seconds, and went to 10, 15, 30, 60 seconds, and finally to the time necessary to establish a letdown response.

These threshold times were checked for all cows at monthly intervals, and the stimulus time applied to the Control cows was set at one time interval above the threshold. In the case of the Treatment group, the tests

were taken only to 60 seconds, as it was felt to be inadvisable to stimulate them to letdown late in lactation as it might have influenced the results of the treatment.

Changes in the threshold time were apparent from the observation of the Ruakura milk flow indicator used for the Control cows, and when a break in the milking became apparent the stimulus time was increased accordingly. The daily milk flow recordings provided a positive check on these observations.

It is worth mentioning that the five bails of the dairy shed used for this herd are equipped with milk meters and automatic milk flow recording equipment, which permitted a complete recording of all milking factors to be made by the milkers at all milkings without interfering with the milking routine in any way.

PRODUCTION RESULTS

The average productions for the two groups are given in Table 1. The differences were significant ($P<0.001$). Table 2 shows the response of individual twin sets to the two treatments imposed.

It is apparent that the response to the treatment varies greatly between sets, and is greater on a percentage basis for the lower producing sets. The response of the first lactation cows is very similar to that of the remainder, indicating that previous conditioning of the cows to a higher level of stimulus is of little importance. The average results for the first lactation cows are given in Table 3. As mentioned earlier, some cows of a poor dairy type were included in the experiment. These were in fact Aberdeen Angus-Jersey cross, and could hardly be classed as a reasonable sample of the cow population. If these cows, as well as two sets of two-year-olds in which the Treatment twin lactated for less than 100 days are excluded, the average results are as shown in Table 4. The average difference for both groups is almost the same as in Table 1, although the average production is considerably higher.

The difference in production for the first lactation cows is somewhat lower than for the older cows, but this is probably due to the fact that they were very high producing cows, and, as mentioned earlier, the response is generally lower for the higher producers.

Any suggestion that the twin sets used in these trials are not a representative sample of the dairy cow population is to a large extent discounted by these data, which indicate

TABLE 1: EFFECT OF STIMULUS ON PRODUCTION AND DAYS IN MILK (ALL COWS)

	Milk	*Butterfat*	*Days*
Stimulus to requirement + short milking	5,308	281	273
Wash only + over-milking	4,210	215	214
Difference	1,098	66	58
Std. error of the difference	228	13	10

TABLE 2: EFFECT OF TREATMENT ON INDIVIDUAL TWIN SETS

2nd Lactation & Older Cows			*1st Lactation (2-yr-olds)*		
Twin Set No.	*Butterfat (lb)*		*Twin Set No.*	*Butterfat (lb)*	
	Wash Only	*Stimulus*		*Wash Only*	*Stimulus*
2101–2	399	393	343–4	348	419
059–60	315	384	351–2	269	329
051–2	175	346	341–2	353	318
275–6	230	335	339–40	230	268
785–6	189	331	337–8	132	265
295–6	243	327	349–50	246	223
293–4	221	317	325–6*	43	187
061–2	333	315	361–2[AA]	134	154
263–4	193	283	331–2*	24	80
297–8[AA]	182	232			
253–4[AA]	48	114			

[AA] Aberdeen Angus-Jersey Cross.
* Fewer than 100 days in milk.

TABLE 3: AVERAGE PRODUCTION FOR ALL FIRST LACTATION COWS (2-YEAR-OLDS)*

	Milk	*Butterfat*	*Days*
Stimulus to requirement + short milking	4,608	250	263
Wash only + over-milking	3,717	198	207
Difference	891	52	56

* 9 sets identical twins.

TABLE 4: AVERAGE BUTTERFAT PRODUCTION (LB)
(Excluding A-A Cross twin sets and twin sets where Treatment cows milked for less than 100 days)

	Wash Only	*Stimulus*	*Difference*
2nd lactation and older (9 sets twins)	255	337	82
1st lactation (2-yr-olds) (6 sets twins)	263	304	41
Average (both groups)	259	324	65

that their average dairy merit was very similar to the average for the industry, and may well exceed it for the sample of two-year-olds used.

In the case of the remainder of the herd not used in this trial, when corrections are made for age distribution, and cows which milked for less than 100 days are excluded, the average production was in excess of 325 lb of butterfat, a figure very close to the Dominion average for tested herds. This was in spite of the fact that many of the cows were used in experimental work which undoubtedly reduced production in many cases.

This, again, is an indication that the twin sets used in the trials are a good sample of the cow population and the experimental results are probably applicable to the industry generally.

CHANGES IN THE STIMULUS THRESHOLD DURING LACTATION

The twin sets differed widely in this respect, but all showed an increase as lactation progressed. In most cases, when the theshold level increased sharply, the poorly stimulated twin declined rapidly in production, indicating that lack of stimulus was the major cause of the loss in production.

Sample results are given for two sets of twins which showed a response to stimulation (Figs. 1 and 2), and one set which showed no response (Fig. 3). The graphs of stimulus threshold are given for both members of the set, the Treatment cow's curve being dotted in each case. With these graphs, are shown those of weekly milk production, and body weight. The points at which the various levels of stimulus were applied to the control cow are marked on the plot of weekly milk.

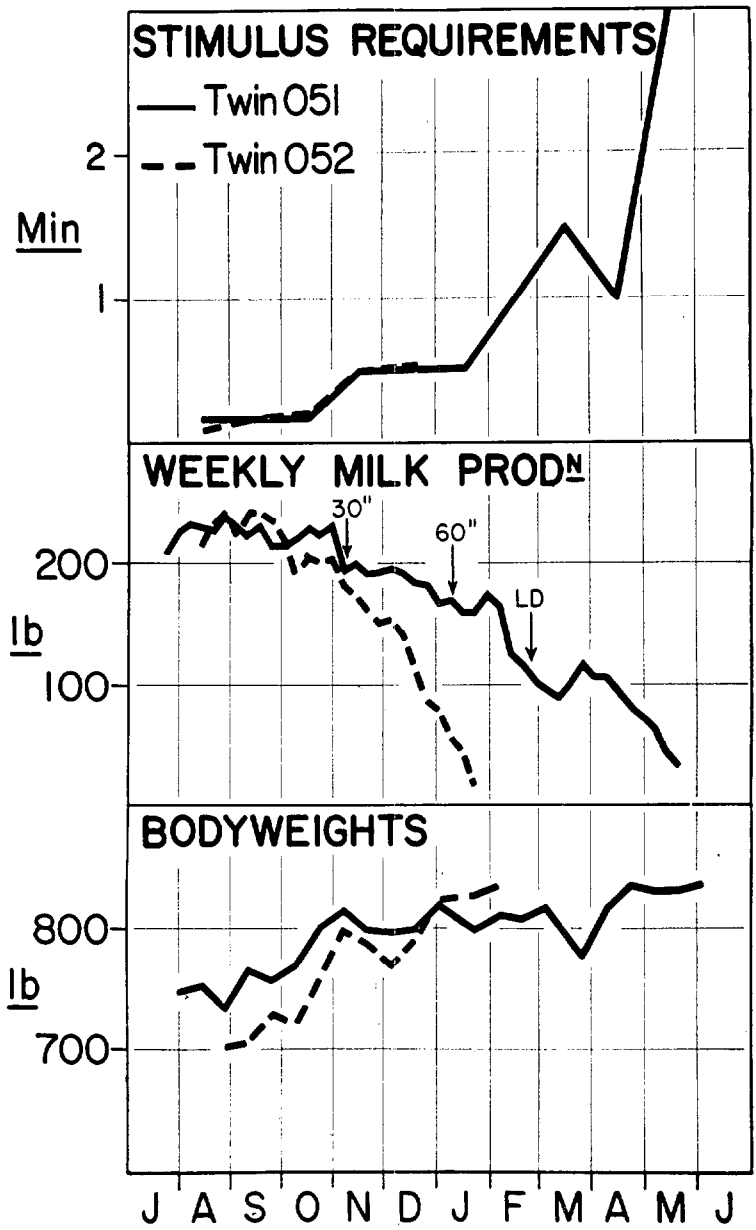
STIMULUS REQUIREMENTS
Twin 051
Twin 052
2
Min
1
WEEKLY MILK PRODN
30"
60"
LD
200
lb
100
BODYWEIGHTS
800
lb
700
J A S O N D J F M A M J

FIG. 1.

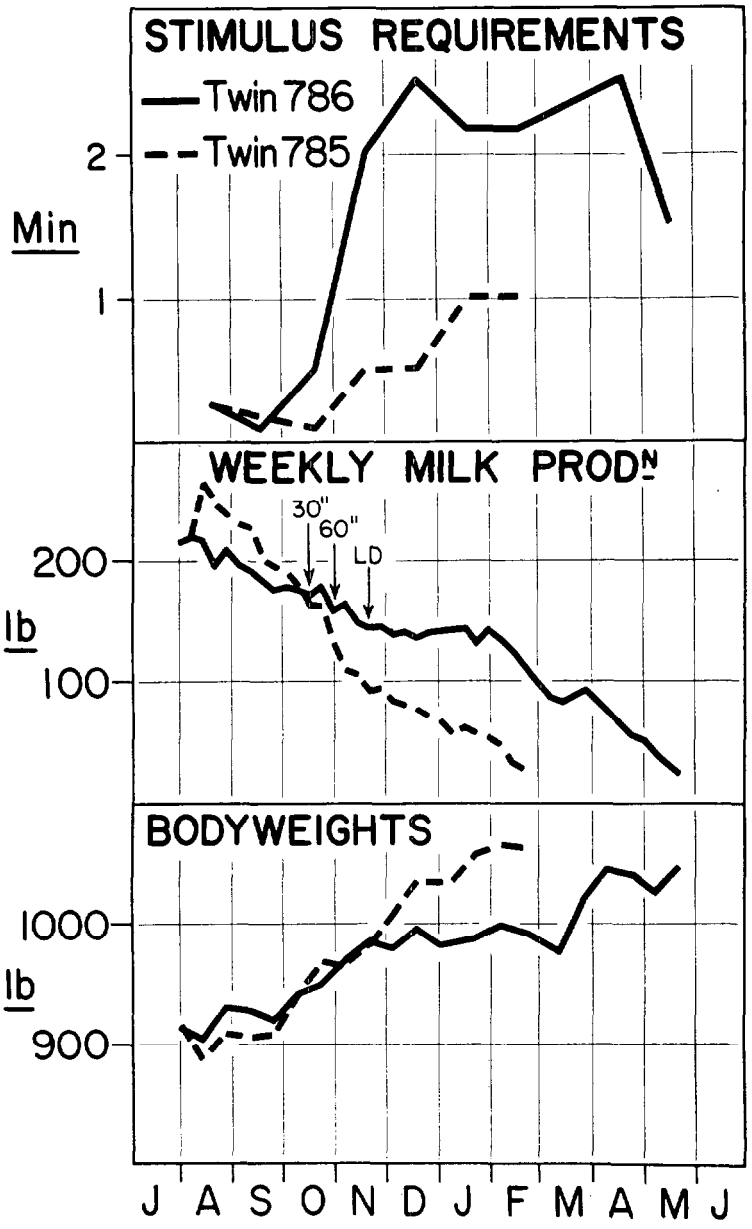
STIMULUS REQUIREMENTS
Twin 786
Twin 785
2
Min
1
WEEKLY MILK PRODN
30"
60"
LD
200
lb
100
BODYWEIGHTS
1000
lb
900
J A S O N D J F M A M J

FIG. 2.

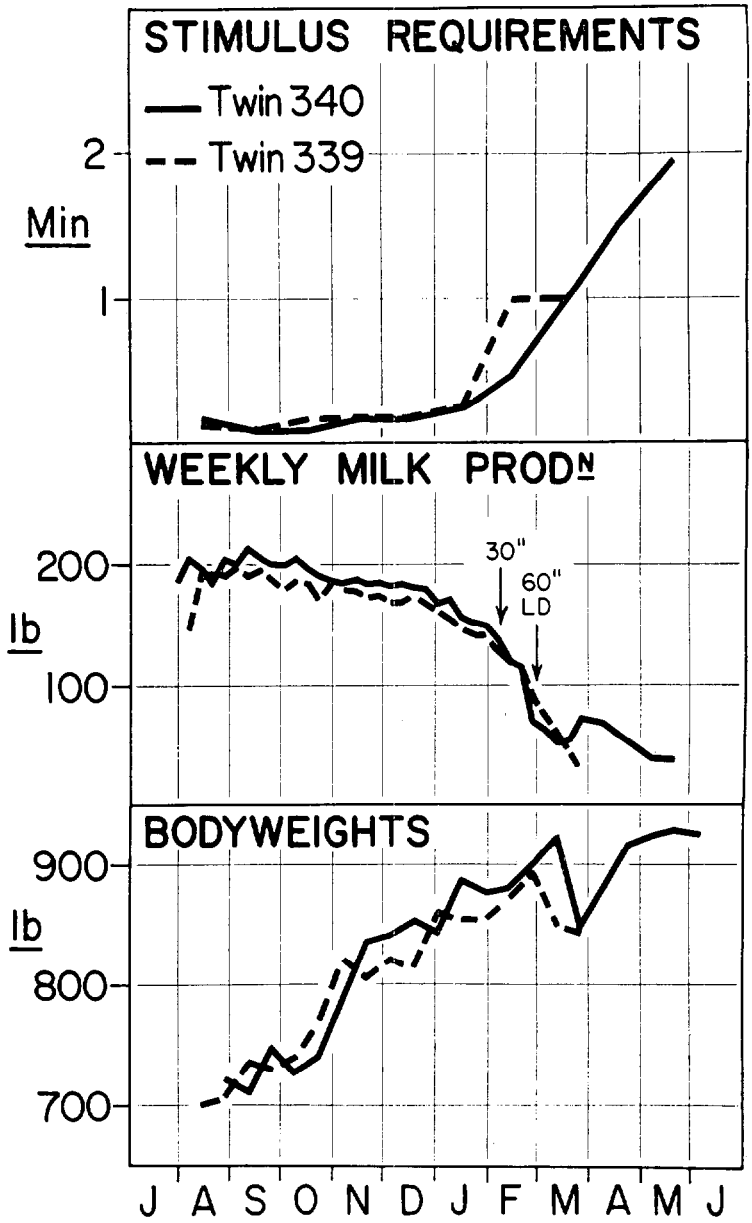
STIMULUS REQUIREMENTS
Twin 340
Twin 339
2
Min
1
WEEKLY MILK PRODN
200
lb
100
30"
60"
LD
BODYWEIGHTS
900
lb
800
700
J A S O N D J F M A M J

FIG. 3.

At the points where the level of stimulus was increased, the milk production curve shows a tendency to flatten out or rise, but whether this is due to the increased stimulus or a change in the feed intake is not clear at the moment. It could be that changes in the level of feeding have an influence on the stimulus requirement.

The changes in body weight are what might be expected, and indicate a marked change in the efficiency of the cow. This effect has been apparent in all the trials involving changes in the level of pre-milking stimulus. It is apparent that a reduction of the stimulus level below the threshold level causes a reduction in the efficiency of the cow.

CONCLUSIONS

The trial has demonstrated that a milking system in which there is a pre-milking stimulus appropriate to the cow's requirement for normal letdown, followed by milking for the minimum possible time, is greatly superior to a system which takes no account of the importance of pre-milking stimulus, or over-milking. The fact that the average production level of the herd, even under conditions of relatively high stocking, is similar to the Dominion average suggests that the results are probably applicable to the industry generally. Just how far the ideal system of the Control treatment can be applied by the practising farmer will depend largely on the farmer himself, but the implications, in terms of increased production, are quite clear.

The changes in the level of stimulus required for normal milking throughout lactation have important implications in the determination of the milking management and, since they are clearly associated with the changes in the efficiency of the cow, may well be important in determining general farm management practices.

The within-set similarity of these characteristics, and the fact that they were closely related to the response to the milking treatment as well as the total production, suggest that they will be important criteria in determining the selection of dairy cows for breeding purposes.

Practical management techniques which will permit a farmer to determine the stimulus requirement are at present under study, and many of the studies concurrent with the present trial indicate that selection of cows requiring increased stimulus can be based on behaviour characteristics readily apparent to the observant milker, using a good milk flow indicator.

ACKNOWLEDGEMENTS

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Thanks are also due to K. E. Jury of the biometrics section for his efforts in the statistical analyses of the data, and to W. W. Pryce, artist, and D. H. B. McQueen for the illustrations.

DISCUSSION

C. L. SANDBROOK: *I was impressed by results of Mr Phillips' earlier work in this field but I failed to get any practical benefit from stimulation with my own herd. I would like much more information about the experiment comparing full stimulation with a brief wash and a squirt from each teat, which gave contradictory results.*

Would Mr Phillips explain the difference between hand stimulation and the effect of placing a cup with a soft-topped inflation on the wet teats?

D. S. M. PHILLIPS: The improvement in production in any particular herd would depend on the previous history of selection. If cows have been vigorously culled under a system using a low level of stimulus, the improvement could well be small. The experiment referred to compared a ½ minute stimulus with a wash only, which gave a relatively small difference for reasons which were not obvious. A hand stimulus appears to be much more effective than the machine stimulus. This has been attributed to the undoubted discomfort associated with machine milking.

J. D. J. SCOTT: *What proportion of cows required 30 seconds or more stimulation from mid to late October?*

MR PHILLIPS: Approximately 70% of the No. 1 Dairy herd required 30 seconds stimulus or more after October.

MR SCOTT: *In view of this answer, how could it be that over-stimulation was responsible for the lower production of some cows in the trial where the average difference of production was about 10 lb butterfat?*

MR PHILLIPS: Over-stimulation is one possibility but there are a number of other possible explanations. Further analysis of the data in the light of subsequent performance may help to clear up the difficulty.

K. MOLLER: *Is there much to suggest that letdown behaviour is strongly heritable?*

MR PHILLIPS: The members of twin sets are very similar in letdown characteristics, the difference being only a small fraction of the differences between sets. This suggests that the characteristics are strongly inherited.

DR A. H. CARTER: *There seems to be a close association between treatment effect on butterfat yield and lactation length: fat per day showed little effect. This implies most of the response occurred late in lactation and hence stimulus is unimportant in early lactation. Is this so?*

MR PHILLIPS: Within-set differences were extremely small at the end of the first 50 days of lactation. Stimulus requirements were generally low during this period. It could be, however, that inadequate stimulus at this stage accelerates the decline of lactation.