University of Reading
Department of
Agricultural Economics & Management

THE PHASING OF MILK PRODUCTION FOR MAXIMUM PROFITABILITY

R. S. Cook
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I. INTRODUCTION

The differential milk prices fixed by the Milk Marketing Board are designed as part of an attempt to ensure that the demand for liquid milk is always met. This means, in effect, that farmers have to be encouraged to produce a certain amount of milk in the naturally less favourable times of the year, e.g. by being offered higher prices in the winter months.

As the following figures show, the existence of a winter milk surplus that has occurred in recent years has motivated the Milk Marketing Board to modify its price differentials slightly so as to shift the emphasis away from winter and towards summer production.

MONTHLY 'POOL' PRICES FOR MILK. 1958/1959 and 1968/1969.

SOUTHERN REGION OF ENGLAND AND WALES.

	1958/1959 (pence per gall.)	Index (May = 100)	1968/1969 (pence per gall.)	Index (May = 100)
April	34.25	132	39.45	131
May	26.00	100	29.32	100
June	26.00	100	29.35	100
July	30.25	116	33.39	114
August	35.50	137	37.91	129
September	40.50	156	40.93	140
October	42.25	162	41.82	143
November	43.00	165	42.49	145
December	46.00	177	42.88	146
January	46.00	177	43.29	148
February	45.25	174	42.21	144
March	41.25	159	43.45	148

SOURCE: Milk Marketing Board for England and Wales.

Notwithstanding the clear possibilities of producing milk relatively cheaply from grass, this inducement of relatively higher summer prices has brought about little or no real swing towards the summer period.

TOTAL SALES OF MILK OFF FARMS.

ENGLAND AND WALES 1958/59 AND 1968/69.

	1958/59 (million galls.)	Index (May = 100)	1968/69 (million galls.)	Index (May = 100)
April	161.23	85	190.85	86
May	190.22	100	220.83	100
June	173.21	91	204.81	93
July	156.19	82	189.80	86
August	144.26	76	181.86	82
September	134.97	71	173.90	79
October	137.82	72	176.44	80
November	131.58	69	164.13	74
December	132.30	70	163.82	74
January	132.65	70	166.38	75
February	124.87	66	153.53	70
March	145.91	77	176.33	80

SOURCE: Milk Marketing Board for England and Wales.

The economic possibilities of such a swing, from the farmer's point of view, have recently received increased attention,* but in general, it is clear that the majority of farmers either still consider that a fairly high proportion of winter-produced milk pays them, or more simply, they may turn their backs against 'change', with its inevitable costs.

Because of the diversity of managerial, physical and economic factors which influence the profitability of milk production in different farm situations it is difficult to isolate the effect on profit of one factor, (in this case, the seasonality of production) from other relevant factors. Moreover there is little clear evidence to demonstrate why individual farmers are geared to a particular production pattern. It may be either a result of careful deliberation or because of some more or less intuitive judgement or, again, because of some general belief which popularly identifies summer production with the freer-growing grassland parts of the country, and winter production with the drier and more arable areas. Alternatively some farmers may cling to established methods of production, either because they do not know (or do not wish to incur) the costs of change.

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* e.g. A Case for Spring Calving the Dairy Herd, by M. D. Brooke, N.A.A.S. Quarterly Review. No. 82. Winter, 1968.

Questions of seasonality of production and the associated feeding regimes are certainly not simple ones. They are mixed, more or less, with questions relating to the composition of overall farm systems and - perhaps most of all - to the level of competence in the management of those systems. The object of this particular study is the strictly limited one of considering some of the financial implications of certain related sets of calving patterns, lactation curves, yield levels, bulk potential and price conditions, uncomplicated by these wider managerial considerations. The study has been based, partly on detailed performance records for a large number of individual cows on one particular farm, and partly on synthetic data for the construction of model situations.

II. SOME CONCEPTUAL CONSIDERATIONS.

The limitations of inter-herd comparisons.

Although grass grazed in situ may be the cheapest form of food for the dairy cow, it is available at certain times of the year only and its use must be considered in the context of differential monthly milk prices and the costs of alternative foods, not to mention the alternative uses of the grass itself. Numerous attempts have been made in the past to examine the effects of seasonality on profitability, usually on the basis of survey data relating to different herds with differing proportions of 'winter' and 'summer' milk. This approach can be misleading if only because of the wide variations that may exist between cows within a particular herd. Such factors as total yield per cow, the shape of the lactation curve, the duration and timing of the lactation, the availability of grass and bulky fodder, can all combine to make a reliable inter-herd comparison difficult, if not impossible.

It was felt by the authors therefore, that in theoretical terms at least, this set of difficulties could be substantially reduced by examining the input/output coefficients of individual cows within a single herd. This would minimise the difficulties due to the various and intangible differences between herds in the form of 'management' and 'stockmanship'. By concentrating the analysis on individual cows within one herd several significant elements of the 'environment', tend to be held reasonably constant. These constant elements include:-

1. The personnel engaged in milking and in overall management.
2. The buildings and general milking routine.
3. The general climatic and other physical circumstances.
4. The quality of feedingstuffs and general rationing policy.
5. The inherent fertility of the farm.

The significant variables.

Within any single dairy herd, the important variables which exist between individual animals include:-

1. The date of calving.

2. The timing and duration of the dry period.

3. Total annual yield per cow.

4. The shape and duration of individual lactation curves in relation to potential production from bulk foods.

It is strictly the interaction of these important factors in relation to a common feeding policy and to a given set of monthly milk prices (prevailing in any one year) which this study endeavours to explore.

Unless the dairy farmer has been lucky and/or skilful enough to build up a herd with a uniform level and timing of production (i.e. a herd composed of idential or near identical cows) then each cow represents a separate production situation, and only a few of them in any given set of circumstances, are likely to be near to the optimum position in profit terms.

It follows that 'ideal' rationing programmes cannot be stipulated for a herd as a whole in anything but the most general terms. Separate production records and rationing instructions must and should be available for each separate cow. The following simple example illustrates the need for this:-

If at a particular time on a particular farm, grazing (or some other bulk food) is estimated to be providing 'maintenance plus 3 gallons' and (for the purposes of illustration) 3 cows in the herd are capable of producing as follows:-

Cow A is capable of giving 2 gallons per day

Cow B is capable of giving 3 gallons per day

Cow C is capable of giving 4 gallons per day

- then the average potential production from these 3 cows is 3 gallons per day, which, it has been assumed, bulk foods are capable of providing. On a herd basis, therefore, no concentrates are needed, but in fact, Cow C clearly requires a supplementary ration to provide for its last gallon. It is probably in these kinds of circumstances that farmers have sometimes been misleadingly accused of over-feeding.

The apportionment of production between bulk foods and concentrates - and the significance of the dry period.

In the attempt to attribute milk production either to 'bulk' foods or to concentrates only one thing is certain - namely, that the two foods, jointly, have helped to produce the observed response. Any theoretical apportionment of part of the production to one type of food is to some extent arbitrary, and leaves the residual production, only to the second food - hence the time-honoured rule of thumb that each four lbs. of concentrates has produced one gallon of milk ascribes the (often small) residual to 'bulk'. Similarly any appraisal of the potential from 'bulk' (i.e. M + 1, + 2, + 3 etc.) may under or over-rate the response to

concentrates and, as seen above, will inevitably lead to misjudgements when applied to herd averages.

Relatively few farmers may be capable of, or be prepared to, unravel this balance, especially if the existing overall state of affairs is reasonably satisfactory in terms of financial reward. Many, if not most of them, however, do approach the practical problem of rationing by making some assessment of the current contribution from grazing or other bulk foods and by then feeding concentrates (at something approximating the traditional 4 lbs. per gallon) for all subsequent production. The ability to make this kind of judgement is unlikely to be evenly spread amongst milk producers and seldom will it be methodically recorded as a basis for strategic planning, in an attempt, for instance, to obtain the maximum potential output from relatively cheap bulk feeding.

A hypothetical assessment (drawn from 'The Farm as a Business') of the daily milk production expected from non-concentrates over a twelve month period might be as follows:-

Month	Number Of Days	Gallons from non-concentrates per cow per day	Total Gallons.
April	30	2	60
May	31	4	124
June	30	4	120
July	31	3	93
August	31	$2\frac{1}{2}$	$77\frac{1}{2}$
September	30	$1\frac{1}{2}$	45
October	31	2	62
November	30	2	60
December	31	2	62
January	31	2	62
February	28	2	56
March	31	2	62
		Total	$883\frac{1}{2}$

In this case, the total productive potential per cow from non-concentrated food is assessed at $883\frac{1}{2}$ gallons. How far this potential can be achieved will depend mainly on (a) the yield potential of the cow (assuming a sufficient quality of stockmanship), (b) the duration and timing

of the dry period of the individual cow and (c) the shape of the lactation curve*.

If the potential of the cow is less than 883½ gallons then clearly there must be some 'loss' of this potential output from bulk. If, on the other hand, the cow's potential is greater than the potential contribution that bulk foods can make, there will be a maximum and minimum exploitation of this potential from bulk foods depending on the length and timing of the cow's dry period. The following figures illustrate this argument:-

Length of dry period.	Extent to which 883½ potential gallons from bulk can be exploited.	
	Maximum amount.	Minimum amount.
(Weeks)	(Gallons)	(Gallons)
7	800½	687½
8	786½	659½
9	772½	633½
10	758½	612½
11	744½	591½
12	730½	570½

Clearly both the maximum and minimum exploitation are reduced as the length of the dry period increases, while the timing of that dry period in relation to differences in the potential of bulk foods at different times of the year, (i.e. M + 1, M + 1½, etc.) will determine how much of the potential can in fact be taken up. If the dry period occurs when bulk foods can contribute 'maintenance' only then no production potential is lost at all. If, on the other hand, the dry period occurs at the height of the 'milk from grass' season then all of the potential production can be lost unless adequate conservation occurs or unless stocking densities are so adjusted as to match maintenance requirements to the grass available. In practice it is believed that such adjustments do not necessarily take place.

In principle, the calving pattern of any individual herd may range widely enough so as to 'explore' the theoretically optimum position. The achievement of the optimum position may, of course, entail a deliberate sacrifice of some of the potential from grass in favour of higher cost but higher priced milk. It is these possibilities that the individual cow records of Section IV and the model situations related to them in Section V, attempt to explore.

III. METHOD OF INVESTIGATION.

It is relatively rare to find complete farm records (over a prolonged period of time) of estimates of the potential milk production that should be obtained from grassland and from other bulky fodder. Such information has however been recorded at the Ministry of Agriculture, Fisheries and Food's Experimental Husbandry Farm (Bridget's Farm) - situated a little to the north-east of Winchester.

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* At some stages of the lactation it may be that the daily output of the cow is below the bulk contribution level.

The data have been made available for the purposes of this research together with complete details of the daily milk output of each cow and also with the feeding instructions, revised weekly, for each individual cow. The records are for a herd of some 180 cows over a four year period from April, 1963, to March, 1967. They include data on steaming up rations.

At the start of this project the herd was composed of Ayrshire cows but at the close of the four year period contained some 25% Friesian cows. The herd calves mainly in the Spring and Autumn and is fed individually in yard yokes. The recording is a permanent feature of the farm's experimental activity and will be available for further study in subsequent years.

The following table sets out the rationing policy used in 1966/67 based on a periodic assessment of grass (or bulk) potential:-

RATIONING SYSTEM FOR DAIRY COWS (BRIDGET'S FARM)*

Period	No. of Days	Estimated potential from Grass and/or Bulky Fodder per cow per day	Total Potential Gallons from Grass and/or Bulky Fodder.	Supplementary Feeding of Concentrates Affecting Potential from Grazing and/or Bulky Fodder.
1. 4.66 to 11. 4.66	11	M + 2 galls.	22	During first 6 weeks of lactation 4 lbs. Dairy Mix per day.
12. 4.66 to 30. 8.66	141	M + $5\frac{1}{2}$ galls.	$775\frac{1}{2}$	During first 8 weeks of lactation 4 lbs. Dairy Mix per day.
31. 8.66 to 14.12.66	106	M + $2\frac{1}{2}$ galls.	265	During first 6 weeks of lactation 4 lbs. Dairy Mix per day.
15.12.66 to 31. 3.67	107	M + 2 galls.	214	During first 6 weeks of lactation 4 lbs. Dairy Mix per day.
TOTAL			$1,276\frac{1}{2}$	168 lbs. = 42 galls. or 224 lbs. = 56 galls.

* A separate rationing system exists for heifers.

Details of the concentrates consumed by individual cows, together with milk production in physical and financial terms have enabled the 'Margin over Concentrates' to be computed over the four years. Attention has been confined to those records that relate to a complete twelve-month period. (The records of cows entering or leaving the herd during the twelve months have been discarded). The individual results and some selected groupings of them appear in the following section.

IV. ANALYSIS OF INDIVIDUAL COW RECORDS.

Since most farmers are usually concerned with annual financial results the analysis was based on the calendar year rather than on lactations. Lactations, of course, vary in length and in the intervals between them. It is an obvious convenience therefore, in assessing the most profitable phasing, to relate the results to a common time basis. In this case, the basis chosen was the April to March 'milk year' of the Milk Marketing Board for England and Wales.

Margins over concentrates were computed for 439 lactations from the following data:-

(a) The duration of the dry period during the year (measured in numbers of weeks).

(b) The total gallonage of milk yielded during the year (the sum of twice-daily weighings).

(c) An estimate of what part of the total gallonage of milk could be attributed to the 'bulk' foods. This calculation was obtained by dividing the total weight of concentrates fed in lbs. by 4 and subtracting this figure from the total gallonage produced. The calculation is simply a reflection of the particular rationing system in use on Bridget's Farm (as set out on page 7). The figures include an allowance for 'steaming up' and also for the additional concentrates fed at Bridget's Farm during the first six or eight weeks of the lactation. Allowance has also been made for a 'tying-up' ration amounting to 2 lbs. per cow per day of a mixture of barley and minerals fed every day to all cows that were in milk.

(d) The revenue from the milk was assessed by multiplying the yield in each week by the Milk Marketing Board's published milk price (Southern Region) for that week (1968-1969 prices) and then summing the results for the year in question.

(e) The average weight (in lbs.) of concentrates fed per gallon was arrived at by dividing the total weight of concentrates (both dairy mix and barley) by the total yield in gallons.

(f) The total cost of concentrates was calculated using two different prices. Cost of concentrates (a) was obtained by using the prices of £28 per ton for dairy mix and £21 per ton for barley. These were the prices actually paid by Bridget's Farm. Cost of concentrates (b) was based on the more usual commercial price for dairy mix - namely £35 per ton.

(g) Inevitably a calendar year is likely to include a part of two lactations for many of the cows in the analysis - i.e. the end of one lactation and the beginning of the next. Each set of data however was given only one lactation number. This number refers to that lactation in which the cow was milked for the greater number of weeks during a particular calendar year. For example, if any given year included (say) sixteen weeks in milk from lactation 2 and twenty-two weeks in milk from lactation 3 the data was then labelled as applying to the third lactation.

Admittedly this is, to a certain extent a somewhat arbitrary procedure, since it is by no means inconceivable that in some instances the greater proportion of the total yield of milk could have been produced in the shorter of the two time periods.

(h) As with lactation numbers so with calving dates - each was linked to a particular lactation on the same grounds as outlined in (g) above.

The above data were then used to calculate two sets of 'margin over concentrates' i.e. one for each of the two different prices as stated in (f). The calculations of this margin, of course, is simply the subtraction of the two sets of concentrate costs from the revenue - using the definitions as set out above.

Before considering the final computations it is of some interest to note the distribution of the 439 lactations by month of calving. The figures in Table I reflect the interest of Bridget's Farm in investigating, amongst other things, certain aspects of seasonality problems of milk production. Hence the policy, as the figures reveal, of having two main calving periods - one from January to March and the other during September and October. The much smaller numbers of calvings occurring between these two main periods may be taken as representing those cows that, for a variety of reasons (e.g. fertility troubles), have slipped away from the calving date originally intended. It should also perhaps be noted that the majority of the cows calving in January and October are in their first or second lactation. This is in contrast to the cows calving in the other months of the year - the majority of which are in later lactations. Table II shows these characteristics.

The overall results of the final analysis, showing the average margin over concentrates for all calvings in each month, are contained in Table III. It is appropriate at this stage to state that analysis of variance was used to test for significance of differences between months and that these were found to be significant for every variable that was measured.

The analyais as presented in Table III shows that the highest mean values for the 'Margin over Concentrates' occurs for the May and June calvers. The lowest mean values in this respect occurred for November, December and January calvers. This result is contrary to the usual expectation and immediately raises the question - why? A brief examination of the two columns of Table III referring to month of calving and lactation number suggests the answer. The figures show, that on average the spring calving cows are in later lactations than those in the winter calving group. In view of the fact that one expects winter calving cows to yield more on average because of, (other things being equal) the spring boost to production when they go out to grass, the higher 'margins over concentrates' can only be due to the particular distribution of lactation numbers between the spring and winter calving cows. That is to say the May and June calvers, because they are in later lactations (on average their 4th), yield more milk.

In view of the uneven distribution of lactation numbers applicable to the total 439 calvings, an attempt was made to eliminate the effect of this by analysing the results for cows which were in the same lactation.

The results are presented in Tables IV, V, VI and VII which refer to the heifer, second, third and fourth lactations respectively. Unfortunately however, as the tables themselves show, the sample size is very much reduced by this procedure. The number of replications is, in a number of instances, clearly too small for the drawing of firm conclusions. Nevertheless the main results of this particular part of the analysis may be of some interest. The figures for the heifer lactations in Table IV, for example, although the data for the summer months are rather 'thin' suggest that autumn calvers tend to show the highest yields, the lowest concentrates per gallon and the highest 'margin over concentrates'. Conversely, winter calvers show the worst results. The data for the second lactation in Table V again makes it difficult to draw firm conclusions. Clearly the low margin for May and the high margin for June cannot be accepted as reliable measures - based as they are on only 2 and 1 records respectively. The results in Table VI for the third lactation suggest that the best results are obtained with summer calving, but once more the small size of the sample must severely qualify that conclusion. The figures in Table VII relating to the fourth lactation indicate that there seems to be no clear advantage in favour of any particular season of calving.

The paucity of the data severely qualifies the conclusions emanating from the analysis and in turn suggests the desirability of a rather different approach to the whole problem. Section V contains an outline of just such an alternative.

TABLE I

DISTRIBUTION OF 439 BRIDGET'S FARM LACTATIONS

BY MONTH OF CALVING 1963 - 1967.

Month of Calving	Jan.	Feb.	Mar.	Apl.	May.	Jun.	Jly.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
No. of sets of data (frequency)	77	49	53	32	30	16	5	3	67	52	27	28	439

TABLE II

BRIDGET'S FARM 1963 - 1967

DISTRIBUTION OF LACTATION NUMBERS BY MONTH OF CALVING

Calving Month	Lactation number 1	2	3	4	5	6	7	8	9	10	Total frequency	Mean lactation number
Jan.	20	29	14	4	4	2	3	1	-	-	77	2.5
Feb	12	11	9	8	4	2	2	1	-	-	49	3.0
March	4	13	17	10	4	2	3	-	-	-	53	3.3
April	-	6	10	5	6	4	-	1	-	-	32	3.9
May	-	2	9	11	4	1	1	1	-	1	30	4.2
June	2	1	3	4	1	1	2	1	1	-	16	4.4
July	-	1	1	2	1	-	-	-	-	-	5	3.6
August	1	-	-	-	2	-	-	-	-	-	3	3.7
Sept.	10	22	18	3	4	4	2	2	2	-	67	3.2
Oct.	7	24	5	3	7	3	2	1	-	-	52	3.0
Nov.	3	5	4	3	1	6	3	2	-	-	27	4.1
Dec.	6	7	7	1	2	2	2	-	1	-	28	3.2
Total	65	121	97	54	40	27	20	10	4	1	439	3.3

TABLE III

'MARGIN OVER CONCENTRATES' BY MONTH OF CALVING[1] (MEAN ANNUAL VALUES)

BRIDGET'S EXPERIMENTAL HUSBANDRY FARM 1963 - 1967.

Month of Calving	Age at First Calving	Mean Lactation Number	No.of Weeks Dry	Total Milk Yield	Gallons Attributed to Bulk	Concentrates Fed per gallon	Revenue	Total Cost of Concentrates (a)	Total Cost of Concentrates (b)	Margin Over Concentrates (a)	Margin Over Concentrates (b)	Number of Calvings
	Weeks			Gallons		lbs.	£	£	£	£	£	
January	121	2.5	13.5	809	402	2.04	125	18	19	107	106	77
February	122	3.0	13.1	813	479	1.76	128	15	17	113	111	49
March	123	3.3	12.5	867	548	1.49	130	13	15	117	115	53
April	126	3.9	11.5	944	605	1.42	142	14	15	128	127	32
May	126	4.2	11.3	962	587	1.56	149	16	17	153	132	30
June	131	4.4	13.6	962	495	1.86	151	18	20	133	131	16
July	130	3.6	14.0	848	423	1.98	142	18	20	124	122	5
August	140	3.7	17.7	727	503	1.20	118	9	10	109	108	3
September	150	3.2	12.0	834	413	2.14	138	18	20	120	118	67
October	138	3.0	10.7	849	503	1.68	138	15	16	123	122	52
November	132	4.1	15.1	765	388	2.03	124	16	18	108	106	27
December	127	3.2	14.7	788	385	2.14	125	18	19	107	106	28
Mean	130**	3.3**	12.7*	845**	472**	1.83**	133**	16**	18**	117**	115**	
Coeff. of Variation	27%	56%	45%	24%	59%	32%	24%	36%	37%	25%	26%	

1 For an explanation of the column headings of this table see pp. 8 - 9.

** = Difference significant at 0.1% level. * = Difference significant at 1% level.

TABLE IV

'MARGIN OVER CONCENTRATES' BY MONTH OF CALVING[1] (MEAN ANNUAL VALUES)

BRIDGET'S EXPERIMENTAL HUSBANDRY FARM 1963 - 1967

1st lactation (Heifers)

Month of Calving	Age at First Calving	No. of Weeks Dry	Total Milk Yield	Gallons Attributed to Bulk	Concentrates Fed per gallon	Revenue	Total Cost of Concentrates (a)	Total Cost of Concentrates (b)	Margin Over Concentrates (a)	Margin Over Concentrates (b)	Number of Calvings
	Weeks		Gallons		lbs.	£	£	£	£	£	
January	120	13.0	746	292	2.40	117	20	22	97	95	20
February	124	13.0	691	369	1.89	106	14	16	92	90	12
March	130	12.8	766	395	1.96	116	17	18	99	98	4
April*	-	-	-	-	-	-	-	-	-	-	-
May*	-	-	-	-	-	-	-	-	-	-	-
June	140	12.5	742	280	2.35	123	20	23	103	100	2
July*	-	-	-	-	-	-	-	-	-	-	-
August	157	11.0	1007	629	1.50	162	16	18	146	144	1
September	143	12.1	831	513	1.65	134	14	15	120	119	10
October	145	9.3	892	639	1.19	145	11	12	134	133	7
November	127	12.0	814	461	1.83	129	15	16	114	113	3
December	127	14.2	680	285	2.28	109	17	19	92	90	6

* - No calvings

TABLE V

'MARGIN OVER CONCENTRATES' BY MONTH OF CALVING (MEAN ANNUAL VALUES)

BRIDGET'S EXPERIMENTAL HUSBANDRY FARM 1963 - 1967

2nd lactation Cows

Month of Calving	Age at First Calving	No.of Weeks Dry	Total Milk Yield	Gallons Attributed to Bulk	Concentrates Fed per gallon	Revenue	Total Cost of Concentrates (a)	(b)	Margin Over Concentrates (a)	(b)	Number of Calvings
	Weeks		Gallons		lbs.	£	£	£	£	£	
January	122	14.0	828	408	2.04	129	19	110	20	109	29
February	121	14.3	829	446	1.83	126	17	109	18	108	11
March	125	13.9	772	489	1.47	116	12	104	13	103	13
April	125	10.3	879	585	1.35	133	13	120	14	119	6
May	137	15.0	764	466	1.60	117	13	104	14	103	2
June	147	12.0	1009	610	1.60	165	16	149	17	148	1
July	132	15.0	688	362	1.90	118	14	104	15	103	1
August*	-	-	-	-	-	-	-	-	-	-	-
September	126	10.6	824	442	1.97	136	17	119	19	117	22
October	142	9.6	870	539	1.57	142	15	127	16	126	24
November	163	22.3	632	327	2.72	100	14	86	15	85	5
December	125	14.4	783	370	2.39	124	18	106	20	104	7

* - No calvings

TABLE VI

'MARGIN OVER CONCENTRATES' BY MONTH OF CALVING (MEAN ANNUAL VALUES)

BRIDGET'S EXPERIMENTAL HUSBANDRY FARM 1963 - 1967

3rd Lactation Cows

Month of Calving	Age at First Calving	No.of Weeks Dry	Total Milk Yield	Gallons Attributed to Bulk	Concentrates Fed per gallon	Revenue	Total Cost of Concentrates (a)	(b)	Margin Over Concentrates (a)	(b)	Number of Calvings
	Weeks		Gallons		lbs.	£	£	£	£	£	
January	121	14.8	775	436	1.78	119	15	17	104	102	14
February	123	16.0	792	439	1.88	121	15	17	106	104	10
March	123	12.9	876	578	1.38	132	13	14	119	118	16
April	128	12.6	877	569	1.39	131	13	14	118	117	10
May	128	11.1	902	574	1.46	139	14	15	125	124	9
June	137	16.6	868	449	1.87	139	17	19	122	120	3
July	147	16.0	967	438	2.20	167	23	25	144	142	1
August*	-	-	-	-	-	-	-	-	-	-	-
September	122	12.3	822	395	2.17	139	19	21	120	118	18
October	137	17.0	683	322	2.15	115	16	18	99	97	5
November	141	18.8	614	359	1.80	102	11	12	91	90	4
December	142	17.6	735	369	1.92	118	16	18	102	100	7

* - No calvings

TABLE VII

'MARGIN OVER CONCENTRATES' BY MONTH OF CALVING (MEAN ANNUAL VALUES)

BRIDGET'S EXPERIMENTAL HUSBANDRY FARM 1963 - 1967

4th Lactation Cows

Month of Calving	Age at First Calving	No. of Weeks Dry	Total Milk Yield	Gallons Attributed to Bulk	Concentrates Fed per gallon	Revenue	Total Cost of Concentrates (a)	Total Cost of Concentrates (b)	Margin Over Concentrates (a)	Margin Over Concentrates (b)	Number of Calvings
	Weeks		Gallons		lbs.	£	£	£	£	£	
January	120	11.8	934	572	1.60	144	16	18	128	126	4
February	123	13.3	873	515	1.64	133	16	18	117	115	8
March	118	11.6	943	614	1.37	142	14	15	128	127	10
April	126	16.0	867	544	1.53	129	14	15	115	114	5
May	124	11.7	930	573	1.54	144	15	16	129	128	11
June	124	14.3	844	453	1.85	137	17	18	120	119	4
July	127	12.0	845	526	1.50	138	13	14	125	124	2
August*	-	-	-	-	-	-	-	-	-	-	-
September	133	17.0	672	195	2.90	111	21	22	90	89	3
October	127	11.3	829	433	1.93	132	17	19	115	113	3
November	120	15.0	819	419	1.97	134	17	19	117	115	3
December	118	9.0	811	395	2.10	129	18	20	111	109	1

For an explanation of the column headings in Tables IV - VII see pp. 8-9

* - No calvings

V. SOME SYNTHETIC SITUATIONS.

The previous section has amply demonstrated that the economic and physical factors likely to influence the seasonal pattern of margin over concentrates per cow are so complex that they cannot be satisfactorily estimated by analysing the individual records of actual cows. Synthetic models, however, make it possible to study the effect of varying one factor whilst holding all the others constant.

A model (or rather a series of models) was accordingly constructed. Essentially they consist of 'standardised' lactation curves derived from the work of P. R. Street[1] which in turn was based on P. D. P. Wood's investigation into the factors affecting the shape of lactation curves in cattle.[2] Because, for any given yield, the actual yield is likely to vary, inter alia, with age (as also does the shape of the lactation curve), three different curves were used for the heifer, second and third lactations. It has been assumed that the shape of the curve does not vary much beyond the third lactation.

Clearly actual yields for any given yield potential, are likely to vary with, amongst other things, the season of calving because of the well known effects of the 'spring flush'. Accordingly, for each of the three lactations, thirteen different curves have been used for the different calving dates occurring during a year of 13 four-weekly periods. In turn, each of the resulting 39 different lactation curves were increased by 10% and 20% and decreased by 10% so that the analyses could include an estimate of the influence of variations in the potential yield on the results obtained.

These standardised lactation curves show yields per cow as follows:-

(i) For heifers, yields ranged from 802 gallons per cow for June/July calvers to 888 gallons for November calvers - a difference of 86 gallons between summer and winter calvers.

(ii) For cows in their second lactation, the 'standardised' yields ranged from 823 gallons for June/July calvers to 903 gallons for November calvers - a difference of 80 gallons per cow.

(iii) For cows in their third (and subsequent) lactations the minimum yield is 831 gallons for July/August calvers and the maximum is 912 gallons for November calvers, giving a difference of 81 gallons per cow.

The complete range of yields is presented in Appendix I.

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1. Street, P. R. Unpublished study. University of Reading.

2. Wood, P. D. P. Journal of the British Society of Animal Production. Vol. II Pt.3. 1969.

In addition, it should perhaps be noted, that the yield for April calvers increases over the three standard lactations from 811 to 835 to 854 gallons per cow. Likewise, the standardised yields for November calvers was 888, 903, and 912 gallons respectively.

The models also include figures for the potential production of milk from bulky foods. Four different sets of data in this respect were used. Two sets were based on the experience of Bridget's Experimental Husbandry Farm (referred to hereafter as Farm A) - one referring to a relatively 'high' total potential production from bulk of 1,274½ gallons per cow and * the other referring to a relatively 'low' potential of 1068 gallons per cow. The other two figures incorporated into the models in this respect were based on the authors' experience of a dairy farm in southern England (hereafter referred to as Farm B) and were 810 gallons and 746 gallons respectively. The distribution of these four bulk potential levels can be seen in Appendix II.

Only one set of weekly milk prices has been incorporated into the models. These were those used in the analysis of the individual cow data - namely the monthly pool prices for the Southern Region set by the Milk Marketing Board for England and Wales in the year 1968/69. The price of concentrates used in the model was again that as assumed in the subsection 'b' of the analysis of individual cow data - £35 per ton (see Section IV).

These models are really a series of simple budgets into which was built the data as defined above. Further steps in this budgeting are as follows:-

(a) For each lactation curve a series of 52 weekly milk prices together with a single price for concentrates was 'fed' into the models.

(b) Likewise the models contain 52 weekly figures for the estimated potential production of milk from bulky foods together with a single figure for the weight of concentrates fed per additional gallon (this was set at 4 lbs. per gallon throughout the analysis).

(c) 52 weekly milk yields (consisting of 44 weeks in milk plus 8 zero or dry weeks) were 'fed' into the models and total yield computed from their sum.

(d) Total revenue was then calculated by multiplying the weekly yield by the appropriate monthly price and summing.

(e) The figures for each week were checked to ascertain whether or not the potential production from bulk exceeded the yield. Where it did not, the difference between the two figures was multiplied by four so as to give a figure for the input (in lbs.)

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* The expressions 'high' and 'low' as used in this context refer to the highest and lowest estimates of bulk potential on Bridget's Farm for the period 1963/1967. Both of these levels are probably higher than would normally be encountered in practice.

of concentrates. Total concentrates were then computed by summing the above figure for each of the 52 weeks of the calendar year.*

(f) The total cost of the concentrates was then calculated by multiplying the total lbs. of concentrates (as estimated in (e) above) by the price of concentrates (namely - £35 per ton).

(g) The concentrates fed per gallon were computed by dividing the total weight of concentrates by the total yield.

(h) The gallonage of milk attributable to the bulky foods was estimated by dividing the weight of concentrates fed by four and subtracting the result from the figure of total yield.

(i) The end result - i.e. a computation of the margin over concentrates - was then computed by deducting the total cost from the revenue (as calculated in (d)).

In this way a total of 624 combinations of factors was tested in the analysis of these 'model' results. These combinations consisted of:-

(i) 13 calving periods.

(ii) 3 lactations (heifer, second and third).

(iii) 4 levels of potential production from bulks.

(iv) 4 yield levels (i.e. (a) normal.
(b) normal - 10%.
(c) normal + 10%.
(d) normal + 20%.

The results of these working models or budgets showed that, for all lactations and for all four levels of potential production from the bulky foods, it was the April - May calvers that in general made the best use of bulks. In particular the April - May calvers gave (a) the highest gallonage of milk attributable to bulks (b) the lowest quantity of concentrates fed and hence the lowest cost of concentrates and (c) the lowest weight of concentrates fed per gallon overall.

Conversely it was the Autumn calvers in these model situations that made, in general, the poorer use of bulk feeds. The following figures based on Farm A's experience of high concentrate use coupled with 'low' imputed contributions from bulks illustrate the difference between April and November calvers. (The figures are based on Bridget's Farm's third year 'low' production from bulks - i.e. 1,068 gallons per cow for cows in their third lactation).

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* It should be noted that in the synthetic data no allowance has been made in respect of 'steaming up' rations, feeding in anticipation of yield or 'tying up' rations.

	APRIL CALVERS	NOVEMBER CALVERS
Yield per cow	854 gallons	912 gallons
Gallons attributable to bulk	774 gallons per cow	649 gallons per cow
Concentrates fed per cow	320 lbs.	1,051 lbs.
Concentrates fed per gallon	0.4 lbs.	1.2 lbs.
Cost of Concentrates per cow	£4	£13
Margin over Concentrates	£124 per cow	£136 per cow

Similar results are obtained from models based on Farm B's low pattern of production from bulks (i.e. 746 gallons per cow for cows in their third lactation). As the following figures illustrate it is again the November calvers which have the highest margin over concentrates per cow.

	APRIL CALVERS	NOVEMBER CALVERS
Yield per cow	854 gallons	912 gallons
Gallons attributable to bulk	658 gallons per cow	513 gallons per cow
Concentrates fed per cow	787 lbs.	1,595 lbs.
Concentrates fed per gallon	0.9 lbs.	1.7 lbs.
Cost of Concentrates per cow	£9	£19
Margin over Concentrates	£118 per cow	£129 per cow

Both sets of figures reflect the tendency for the spring calvers (despite their ability to make the maximum use of the bulky foods) to be associated with a low margin over concentrates. This is mainly due to (i) the lower yield of the spring calvers and (ii) the seasonal pattern of monthly milk prices giving higher prices per gallon in the winter months. Conversely, the results confirm that autumn calvers, making the least use of bulk foods, tend to have the highest magin over concentrates.

VI. CONCLUDING COMMENTS.

A major objective of this enquiry has been to consider the main factors likely to affect the choice of an optimum calving period. For the purpose of these concluding comments the synthetic data analysed in Section V have been re-arranged and presented in Tables VIII, IX, X and XI. Before a final assessment is made, however, it will be as well to recall some of the main characteristics and assumptions associated with the hypothetical budgets. Thus:-

(i) As stated earlier, the analysis in Section V has not included an allowance for 'steaming up' rations or for feeding in anticipation of yield. Whilst the inclusion of such an allowance would clearly reduce the margin over concentrates, it is felt that its effects are not likely to alter substantially the main conclusions.

(ii) In view of the higher cost of conserved food (i.e. hay, silage or fodder in the form of kale) compared with grass grazed in situ, it has been assumed that a significant difference in margin over concentrates would be one that was in excess of (say) £5 per cow per year. It should perhaps be noted that the analysis is concerned with the 'production' ration rather than with the total feed requirements per cow. The cost of maintenance rations are not affected by decisions as to time of calving.

Perhaps one of the first points to be recalled in trying to select an optimum calving period, is that in practice it is difficult to maintain a 365 day calving index. Severe problems of another kind, particularly those associated with herd replacement (e.g. ruthless and expensive culling policies) are likely to be encountered with the achievement of such an index. These problems might be minimised however, if it were possible to identify a period of (say) three or four consecutive months when the margin over concentrates is relatively high. The first calving would then need to take place at the beginning of such a period. Whilst the main object would still be that of trying to maintain a 365 day calving index, (longer periods can depress annual yields as well as the annual value of calf output) a move to a later calving date within the 'identified' period of relatively high margins over concentrates would not necessarily be accompanied by so marked a fall in this margin as might otherwise be the case.

Table VIII shows that, for both levels of bulk potential, the calving period showing most consistently the best margins is, in general, to be found in the 9th period (November 5th to December 2nd inclusive). Likewise the least favourable margins are shown to be mostly those of the second period (April 23rd to May 20th inclusive). The figures show that for Farm A's 'low' contribution from bulks (1068 gallons) and using a 10% lower than normal yield, the margin over concentrates ranges from £102 for heifers to £160 per cow for those animals in their third lactation (assuming a 20% higher than normal yield) - a difference of £58 per cow. Similar figures based on Farm A's 'high' contribution from bulk (1274½ gallons) show a somewhat less marked difference - ranging from £109 to £160 per cow - a difference of £51 per cow.

Table IX contains a similar analysis based on the much lower bulk potential of Farm B. Thus, in this instance, the margin over concentrates

TABLE VIII.

DISTRIBUTION OF MARGIN OVER CONCENTRATES FOR THREE LACTATIONS BY CALVING PERIODS, BULK POTENTIALS AND YIELDS.

(Based on a 12 month calving interval)

FARM A

Bulk Potential	Lactation Number	Four-weekly Periods* 1 £	2 £	3 £	4 £	5 £	6 £	7 £	8 £	9 £	10 £	11 £	12 £	13 £	Maximum Variation £	Milk Yields
1068 gallons	1	112	(111)	112	115	119	119	118	121	[124]	122	122	118	115	13	Normal
	2	(123)	124	128	132	[136]	135	133	134	135	128	129	129	126	13	
	3	(124)	(124)	128	133	133	[137]	134	133	136	127	130	130	127	13	
	Total	(359)	(359)	368	380	388	391	385	388	[395]	377	381	377	368		
	1	120	(119)	121	124	129	130	129	133	[136]	133	133	128	124	17	+ 10%
	2	(134)	(134)	138	143	[147]	146	144	146	[147]	139	141	141	137	13	
	3	(134)	(134)	138	143	144	[148]	145	145	[148]	139	141	141	138	14	
	Total	388	(387)	397	410	420	424	418	424	[431]	411	415	410	399		
	1	129	(127)	130	133	139	140	140	143	[146]	144	143	137	133	19	+ 20%
	2	(144)	(144)	148	153	157	157	155	157	[159]	151	152	152	148	15	
	3	(144)	(144)	148	154	155	158	157	156	[160]	150	153	152	149	16	
	Total	417	(415)	426	440	451	455	452	456	[465]	445	448	441	430		
	1	103	(102)	104	106	109	109	108	110	[113]	112	112	108	106	11	- 10%
	2	(112)	(112)	116	120	[125]	124	122	123	123	116	117	117	114	13	
	3	(112)	113	117	121	122	[125]	123	122	124	116	118	118	115	13	
	Total	(327)	(327)	337	347	356	356	353	355	[360]	344	347	343	335		
1274½ gallons	1	121	(120)	123	125	[128]	127	126	127	127	125	127	124	123	8	Normal
	2	(124)	(124)	128	132	[136]	135	133	134	135	128	130	130	127	12	
	3	(126)	(126)	130	134	134	[136]	134	133	[136]	128	130	131	128	10	
	Total	371	(370)	381	391	[398]	[398]	393	394	[398]	381	381	385	378		
	1	(132)	(132)	134	136	139	138	137	138	[140]	137	139	136	134	8	+ 10%
	2	137	(136)	140	144	[148]	146	144	146	147	139	142	142	139	12	
	3	(138)	(138)	142	146	146	[148]	145	145	[148]	139	142	143	141	10	
	Total	407	(406)	416	426	433	432	426	429	[435]	415	423	421	414		
	1	143	(142)	144	146	150	149	147	149	150	149	[151]	147	146	9	+ 20%
	2	(148)	(148)	152	156	[159]	157	155	157	[159]	151	154	154	151	11	
	3	(150)	(150)	154	158	157	159	157	156	[160]	151	155	155	153	10	
	Total	441	(440)	450	460	466	465	459	462	[469]	451	460	456	450		
	1	(109)	(109)	111	114	[117]	116	115	115	116	113	115	112	111	8	- 10%
	2	(112)	(112)	116	120	[124]	[124]	122	123	123	116	117	117	115	12	
	3	(114)	(114)	117	121	122	[125]	123	122	124	116	118	118	116	11	
	Total	(335)	(335)	344	355	363	[365]	360	360	363	345	350	347	342		

* For actual dates see page 28. ( ) = lowest margins. [ ] = highest margins.

TABLE IX.

DISTRIBUTION OF MARGIN OVER CONCENTRATES FOR THREE LACTATIONS BY CALVING PERIODS, BULK POTENTIALS AND YIELDS

(Based on a 12 month calving interval)

FARM B

Bulk Potential	Lactation Number	1 £	2 £	3 £	4 £	5 £	6 £	7 £	8 £	9 £	10 £	11 £	12 £	13 £	Maximum Variation £	Milk Yields
746 gallons	1	113	(109)	(109)	112	116	119	120	123	[126]	124	124	120	117	17	Normal
	2	116	(111)	(111)	114	118	121	121	125	[128]	122	124	123	120	17	
	3	118	(112)	(112)	115	116	122	122	124	[129]	123	126	126	122	17	
	Total	347	(332)	(332)	341	350	362	363	372	[383]	369	374	369	359		
	1	123	(118)	(118)	121	126	130	131	135	[138]	135	135	130	127	20	+ 10%
	2	125	(120)	120	123	129	131	133	136	[140]	134	135	134	130	20	
	3	127	(121)	(121)	124	127	133	134	135	[141]	134	137	137	132	20	
	Total	375	(359)	(359)	368	382	394	398	406	[419]	403	407	401	389		
	1	132	(127)	(127)	131	136	140	142	146	[149]	146	145	141	137	22	+ 20%
	2	135	(129)	(129)	133	139	142	144	148	[152]	145	146	144	140	23	
	3	136	(129)	130	134	137	144	145	147	[153]	145	148	147	142	24	
	Total	403	(385)	386	398	412	426	431	441	[454]	436	439	432	419		
	1	104	(100)	(100)	103	107	108	109	112	[115]	113	113	110	107	15	-10%
	2	106	(101)	102	104	108	110	110	113	[116]	111	113	113	110	15	
	3	108	103	(102)	105	106	111	111	112	[117]	111	114	115	112	15	
	Total	318	(304)	(304)	312	321	329	330	337	[348]	335	340	338	329		
810 gallons	1	115	(111)	112	114	118	119	120	123	[127]	125	125	121	119	16	Normal
	2	118	(114)	(114)	116	119	121	121	125	[128]	123	125	125	122	14	
	3	121	(115)	(115)	117	117	122	122	124	[129]	123	127	127	125	14	
	Total	354	(340)	341	347	354	362	363	372	[384]	371	377	373	366		
	1	125	(121)	(121)	123	128	130	131	135	[138]	136	137	133	130	17	+ 10%
	2	129	(123)	(123)	125	130	131	133	136	[140]	134	136	136	133	17	
	3	130	(124)	(124)	126	127	133	134	135	[141]	134	138	139	135	17	
	Total	384	(368)	(368)	374	385	394	398	406	[419]	404	411	408	398	1	
	1	135	(130)	(130)	133	138	140	142	146	[150]	148	148	143	140	20	+ 20%
	2	138	(132)	(132)	135	140	142	144	148	[152]	145	148	147	143	20	
	3	139	(133)	(133)	136	137	144	145	147	[154]	146	150	150	145	21	
	Total	412	(395)	(395)	404	415	426	431	441	[456]	439	446	440	428		
	1	105	(102)	(102)	104	107	108	109	112	[115]	113	114	110	108	13	- 10%
	2	108	(104)	(104)	106	109	110	110	113	[116]	111	113	113	111	12	
	3	110	106	(105)	107	107	111	111	112	[117]	111	115	116	113	12	
	Total	323	312	(311)	317	323	329	330	337	[348]	335	342	339	332		

Four-weekly Periods*

* For actual dates see page 28. ( ) = lowest margins. [ ]= highest margins.

ranges from £100 for heifers (assuming a 10% lower than normal yield) to £153 per cow for animals in their third lactation (based on a 20% higher than normal yield). It is of some interest to note that the variation between the margins over concentrates for the different calving periods for a given lactation is, on average, about £5 higher for the hypotheses based on Farm B's bulk potential than it is for the hypotheses based on Farm A's bulk potential.

The range in margins over concentrates is greatest when the bulk contribution is lowest and where the yield per cow is highest. Thus the analysis shows that with Farm B's potential at 746 gallons (and with a 20% increase over normal yield) the maximum variation over the three lactations in margin over concentrates averages £23. This is in sharp contrast to Farm A's data where, when the bulk potential is 1,274½ gallons (and yields are 10% below normal), the maximum variation between the 13 calving periods over 3 lactations in margin over concentrates only averages £10 per cow. These figures clearly confirm that it is more important to maintain cows at a particular phase when the bulk contribution is low than when it is high.

If one assumes that, on average, the calving interval for herds in this country is approximately 400 days, i.e. about 13 months, then an animal calving for the first time on (say) October 1st would calve for the fourth time on January 1st. On this basis, the analysis suggests that whilst still trying to achieve a 365 day calving index, a farmer could have cows moving out of phase within an 'optimum' period with the minimum reduction in margin over concentrates.

To allow for this possibility, the total margin over concentrates for three lactations was calculated, allowing for a 13 month calving interval. The results are given in Tables X and XI.

From Table X it appears that when allowance is made for a 13 month calving interval, the optimum initial calving date is less well defined than it is for a 365 day calving index.

In the more usual situation (i.e. one in which the contribution from bulky foods is estimated to range from 746 to 810 gallons per cow) the ninth period is, as Table IX shows, the period which gives the highest margin over concentrates for the 365 day calving index. In addition,, for the 13 month calving interval (Table XI) - calving for the first time in the ninth period - the difference only amounts to £1 in total over the three lactations. Conversely, the April/May/June periods are those which, in general, give the least favourable margins over concentrates for <u>all</u> the situations of bulk potential, yield, lactation etc. that have been examined in this study. (See Tables X and XI).

These conclusions, however, are only tentative ones. The nature of this enquiry with its particular set of assumptions and restrictions clearly makes this so. Much more study is needed to evaluate how much the higher margins over concentrates are likely to be eroded by factors not specifically taken into account in this investigation. There are, for example, the financial and organisational problems of moving existing herds into the 'optimum' calving period at minimum cost; the provision of bulk tanks of appropriate capacity is also an aspect requiring further investigation in this context. Other questions for study include the likely difference in the costs of producing milk from conserved foods as

TABLE X

DISTRIBUTION OF MARGIN OVER CONCENTRATES. TOTALS FOR 3 LACTATIONS BY CALVING PERIODS, BULK POTENTIALS AND YIELDS

(Based on 13 month calving intervals)

FARM A

Calving Periods*	1,2,3	2,3,4	3,4,5	4,5,6	5,6,7	6,7,8	7,8,9	8,9,10	9,10,11	10,11,12	11,12,13	12,13,1	13,1,2	Maximum Variation Milk Yields
	£	£	£	£	£	£	£	£	£	£	£	£	£	£
Bulk Potential 1068 gallons	364	372	377	[388]	[388]	385	[388]	383	382	381	378	368	(362)	26 Normal
	(392)	400	408	419	420	419	[423]	419	416	415	412	399	(392)	31 + 10%
	(421)	429	438	448	453	451	[457]	452	450	448	444	429	(421)	36 + 20%
	332	339	346	[356]	[356]	353	355	349	347	347	344	334	(331)	25 - 10%
Bulk Potential 1274½ gallons	375	382	389	[397]	[397]	393	396	390	385	386	385	377	(373)	24 Normal
	410	418	424	[432]	430	427	431	424	421	422	422	413	(409)	23 + 10%
	445	452	457	[464]	[464]	460	[464]	459	456	458	458	448	(444)	20 + 20%
	338	346	353	363	[364]	360	362	354	350	348	348	341	(337)	27 - 10%

* The columns refer to three consecutive calving periods of four weeks each.

( ) = lowest margins. [ ] = highest margins.

TABLE XI

DISTRIBUTION OF MARGIN OVER CONCENTRATES. TOTALS FOR 3 LACTATIONS BY CALVING PERIODS, BULK POTENTIALS AND YIELDS

(Based on 13 month calving intervals)

FARM B

Calving Periods*	1,2,3	2,3,4	3,4,5	4,5,6	5,6,7	6,7,8	7,8,9	8,9,10	9,10,11	10,11,12	11,12,13	12,13,1	13,1,2	Maximum Variation	Milk Yields
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	
Bulk Potential 746 gallons	336	(335)	339	352	359	364	[374]	[374]	[374]	[374]	369	358	345	39	Normal
	364	(362)	368	383	391	398	408	[409]	[409]	407	401	387	373	47	+ 10%
	391	(390)	397	414	423	431	[443]	[443]	442	439	431	417	401	53	+ 20%
	(307)	(307)	310	322	328	330	339	339	340	[341]	338	328	316	34	- 10%
Bulk Potential 810 gallons	344	(342)	345	355	361	364	374	374	[377]	[377]	375	364	352	35	Normal
	372	(370)	373	386	393	398	408	409	410	[411]	408	396	383	41	+ 10%
	400	(398)	402	417	425	431	444	444	445	[446]	440	425	411	48	+ 20%
	314	(313)	315	324	328	330	339	339	341	[342]	340	331	322	29	- 10%

* The columns refer to three consecutive calving periods of four weeks each.

( ) = lowest margins. [ ] = highest margins.

compared with that produced from grass grazed; the differing costs of concentrates at different times of the year; the effect of changing calf prices; the most appropriate herd replacement policy and so on. Interesting and instructive though this study has been, its findings therefore are clearly subject to modification arising from the results of further work on this fascinating but complex subject.

APPENDIX I

CLASSIFICATION OF STANDARDISED YIELDS BY CALVING PERIOD AND LACTATION NUMBER

AVERAGE YIELDS (gallons)

Lactation No. \ Calving Period	1	2	3	4	5	6	7	8	9	10	11	12	13
1	811	803	803	802	823	836	846	869	888	876	881	852	832
2	835	827	825	823	841	853	861	883	903	857	873	876	855
3	854	846	843	841	831	864	870	877	912	859	885	891	873

All lactations are standardised at 44 weeks

APPENDIX II

DISTRIBUTION OF POTENTIAL GALLONS FROM BULK BY 13 FOUR-WEEKLY PERIODS

Period	Dates	Farm A		Farm B	
		'LOW' (galls.)	'HIGH' (galls.)	'LOW' (galls.)	'HIGH' (galls.)
1	Mar. 26 - Apl. 22	76	101½	140	140
2	Apl. 23 - May 20	112	154	140	140
3	May 21 - June 17	112	154	102	124
4	June 18 - July 15	112	154	67	95
5	July 16 - Aug. 12	112	154	56	70
6	Aug. 13 - Sep. 9	104½	118	45	45
7	Sep. 10 - Oct. 7	70	70	28	28
8	Oct. 8 - Nov. 4	70	70	28	28
9	Nov. 5 - Dec. 2	70	70	28	28
10	Dec. 3 - Dec 30	61½	61	28	28
11	Dec 31 - Jan. 27	56	56	28	28
12	Jan. 28 - Feb. 24	56	56	28	28
13	Feb. 25 - Mar. 24	56	56	28	28
	Total	1068	1274½	746	810

The computational basis has been for 13 four weekly periods. This amounts to 364 days (not the 365 calendar days) and accounts for the small discrepancy between this table and that on page 8 (e.g. Bridget's 'high' totals of 1274½ gallons compared with 1276½ gallons).