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Dairy Herd Replacements:

Using High Quality Silage to Replace the Concentrates in the Ration

A Case Study

by

D. P. TOWNSEND, B.Sc. (Agric.)

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May, 1958

Acknowledgement

In publishing this Report we would like to acknowledge our deep appreciation of the co-operation of Mr. E. M. Owens, Stepstones Farm, Langford. We have relied entirely upon his patience and interest throughout the investigation. Indeed the data in this report have been entirely furnished from records kept on Mr. Owens' farm.

Part I. Introduction

MANY British farmers can produce a silage which has a relatively high protein content yet which at the same time, if compared with concentrates, has a fairly low cost per unit of Starch Equivalent and Protein Equivalent. Such silage should be a very suitable food for rearing young cattle.

The object of this investigation was to discover whether, in fact, young dairy calves could grow well when fed mainly on silage, and, if so, whether the more general use of silage could reduce the cost of rearing cattle.

During the first six months of life, when bone and muscles are developing rapidly, the young calf requires a high proportion of minerals and protein in its diet. The following table, Table I, shows the comparative composition and cost of several of the more common farm feedingstuffs.

Home-made grass silage compares in cost per ton of Protein Equivalent, very favourably with other foods, Kale being the only cheaper one. It is also a relatively cheap form of Starch Equivalent. Its disadvantage, though, when compared with compound cakes, is in its wider Starch: Protein ratio:

Calf cake	3·3:1
1st Quality Silage . . .	6·9:1
2nd Quality Silage . . .	7·7:1

A Starch:Protein ratio of 4:1 is necessary for rapid growth or high milk production and one of 6:1 is desirable for normal growth in a young calf. Good quality silage approaches this 6:1 ratio.

If a calf could eat a sufficient bulk of silage to obtain the necessary protein for growth such a ration would probably cost less, although some of the starch would be wasted, than a ration using calf cake, where some of the protein would be unused. For instance, the amounts of each food needed to supply 120 lb. Starch Equivalent and 20 lb. Protein Equivalent would, (in theory), be:

1st Quality Silage

Starch Equivalent supplied by 937·5 lb. food
Protein Equivalent supplied by 1,081·1 lb. food
Cost of 1,081·1 lb. food, at 1955 prices, £1·207

TABLE I

A Comparison of the Nutritive Value and Cost of Various Foods

Crop	Composition of Food				1955			1956		
	Dry Matter	Percentage of Dry Matter			Cost per Ton	Cost per Ton S.E.	Cost per Ton P.E.	Cost per Ton	Cost per Ton S.E.	Cost per Ton P.E.
	%	Starch Equiv.	Protein Equiv.	Ash	£	£	£	£	£	£
Grazing	20·0	56·0	10·5	10·0	—	—	—	—	—	—
Kale	14·9	65·1	9·4	12·1	1·6	16·5	114·2	1·5	15·5	107·1
Grass Silage (1st Quality)	21·0	61·0	8·8	10·0	2·5	19·5	135·3	2·7	21·1	146·1
,, ,, (2nd Quality)	24·5	51·4	6·7	9·0	2·5	19·9	152·3	2·7	21·4	164·5
Dried Grass	90·0	70·0	14·8	8·9	23·1	36·7	173·4	—	—	—
Oats	86·7	68·6	8·8	3·6	14·5	24·4	190·0	22·2	37·3	291·0
Arable Silage	30·9	41·7	7·3	8·7	4·3	33·4	190·6	4·2	32·6	186·2
Hay (Medium Quality)	85·0	37·6	3·7	7·1	6·0	18·8	190·8	8·6	26·9	273·4
Mangolds	12·0	45·8	3·3	5·8	3·1	56·4	782·8	2·4	43·7	606·1
Dairy Cake (approx.)	88·0	71·0	17·0	N.A.*	35·0	56·0	234·0	35·0	56·0	234·0
Calf Cake (approx.)	87·7	79·8	23·9	7·9	37·1	53·0	177·0	37·1	53·0	177·0

* Not available.

Figures for Composition taken from *Rations for Livestock*, Bulletin No. 48, Ministry of Agriculture.

Crop Cost figures from 54 farms in Bristol 1 Province.

Calf Cake

Starch Equivalent supplied by 171·4 lb. food
Protein Equivalent supplied by 95·2 lb. food
Cost of 171·4 lb. food, at 1955 prices, £2·839

Thus if a calf can be reared satisfactorily on silage, there could be quite a considerable saving in cost.

One other advantage that might result from rearing dairy calves on silage could perhaps be seen when the animals started milking. It might be that animals reared on silage develop the capacity to eat large amounts of it, to digest it efficiently and to convert it into milk.

At the moment on most farms breeding is based upon the higher-yielding cows. These cows almost certainly receive a fair amount of cake and those that can deal most efficiently with it give the highest yields. Thus the herd is often developed by selecting the cows that are the most efficient at cake-conversion. If a cow is accustomed to silage it might be that she would convert it to milk more efficiently than one unaccustomed to it. It might then be possible to select and breed a strain of cows efficient at converting silage and adapted for the mainly grass farms.

A system of rearing based on the feeding of silage is only likely to be successful when applied to young dairy heifers. This is because a young beef animal, during its first six months of life would not be able to digest sufficient silage to give it the rapid rate of growth that is necessary. In a dairy heifer, this rapid rate of growth is not so important because it will have a second growth phase, that is, an ability for good food utilisation and rapid body growth, during pregnancy, and may continue to grow until the fourth or fifth lactation.

Also it has been shown by Dr. Hansson* of Sweden, using identical twins, that animals reared on a low plane of nutrition, provided they were well fed during the last few months of pregnancy, when compared with those reared on a high plane,

1. Have an increased length of life, on average.
   Low plane, average of 95 months.
   High plane, average of 75 months.
2. In their early lactations at least, gave milk yields that were themselves higher than those of the high plane group and were also higher in relation to the amounts of food that were fed.

* "New Theory of Nutritional Planes." A. Hansson, British Cattle Breeders Club Conference, 1952.

One possible disadvantage of an all-silage diet is that it may be lacking in some of the essential amino-acids. Plant proteins are in general of a lower biological value than animal proteins and a diet of only one type of food is much more likely to be low in one or more essential amino-acid than a mixed diet. This all-silage diet may indeed be quite risky from this point of view. However, in New Zealand calves are regularly reared on pasture from birth so this suggests that the fresh grass at any rate cannot be of too low a biological value.

If however, the effect of rearing dairy cattle on silage should be to delay breeding or to cause a reduction in the milk yields, these losses might more than outweigh any advantage in the cheaper rearing.

Bearing in mind these possible advantages and disadvantages of using silage, the resulting trial was:

"to see whether calves would live and grow on a diet where the concentrates were replaced by silage, and, if so, how they would milk when fed on a ration largely of bulk foods."

A comparison of the precise effects of two different rations would need the equipment and knowledge found only in centres of animal research, so instead this trial was designed to find out how such a system of rearing could be applied to a commercial farm.

There were several difficulties in finding a suitable farm; these were mainly,

1. Finding a farmer willing to risk his calves on a new idea, especially as these calves would be his future dairy cows.
2. Finding a farm with a large enough milking herd to supply eight heifer calves all born within two or three weeks of one another to be reared in two groups for comparison.
3. Also that such a farm should have sufficient accommodation and labour to look after these two small trial groups.
4. And that the silage made on the farm should be of sufficiently good quality for feeding the calves.

One farm did fulfil these requirements and Mr. E. M. Owens of Stepstones Farm, Langford, Somerset, agreed to run a trial of eight calves during the winter of 1955/56. He also ran a second batch of calves during the following winter, 1956/57.

Before going on to discuss the calves themselves, it might be interesting to explain how the silage is made on Stepstones Farm.

About 100 acres of grass are cut each year, and the silage is

made in a pit having a concrete floor and sides, and roofed over with a Dutch barn. The pit stands in the group of farm buildings, convenient both for the cowhouses and loose boxes.

In making the silage a more than average effort is made to get the grass as dry as possible, that is, to produce a silage of near 30 per cent Dry Matter. The grass is usually cut early in the morning, turned with a hay turner two hours later and then hauled two or three hours after that. Molasses are added at about 24 cwt. among 800 tons of silage (i.e. approx. 1,000 tons fresh grass). The silo gets all the "tractoring" that can be arranged and the best quality silage is always found at the entrance end of the pit.

About 800 tons of silage were made in the summer of 1955 and stored in the pit, being covered with baled straw. Some of the silage was made with a silorator, and this, from observations, was definitely the wettest made on the farm. Some analyses of the silage quality were made by the National Agricultural Advisory Service, and their results showed the silage to be of medium protein quality. These results, however, also showed the silorated silage to have a *high* dry matter, and the unchopped silage to have an unusually low dry matter. Consequently the National Agricultural Advisory Service figures have not been used when estimating the quality of the silage fed to the calves, but instead, for purposes of comparisons, those from the Ministry of Agriculture bulletin *Rations for Livestock* have been used.

Part II. 1955/56 Trial

In this first attempt to rear heifer calves using silage to replace the concentrates part of the ration, the method was to take eight calves, born within as short a time as possible, and divide them into two groups of four. One group was to be reared by the method normally used on the farm and the other under similar conditions but having the concentrates and hay of the ration replaced by good quality silage. The intention was that the two rations should be approximately equal in the amount of food that they supplied for growth, i.e. in their net energy values.

These values, of course, are very difficult to determine and for comparisons between the two rations, values for Starch Equivalent and Protein Equivalent have been used. These

values have been computed from those given in *Rations for Livestock*.*

During the first winter of the trial a visit was made to the farm every month whilst the calves were being hand-fed to record details of feeding, labour, etc., and to weigh and measure the calves.

The eight calves in this trial were all Friesians, four pedigree and four grading-up, born between 17th October and 4th November, 1955. They were, however, born on different, though neighbouring farms. Thus they were, for the first few weeks, in different buildings and under different cowmen. The two groups of four calves are referred to as the silage group, Group A, and the concentrates group, Group B.

Group A. (Silage). Born at Stepstones Farm

These calves were:

Violet	born 1.11.1955
Tubbs	born 4.11.1955
Lavender. . . .	born 31.10.1955
Tulip	born 1.11.1955

Group B. (Concentrates). Born at Legge's Farm

These calves were:

Susie	born 3.11.1955
Nancy	born 29.10.1955
Alida	born 17.10.1955
Agnes	born 27.10.1955

Thus there was a difference of eighteen days between the oldest and youngest calves. Recording started on 11th November, 1955, when the youngest calf was one week old.

RATIONS

The rations supplied to the two groups during the trial were as follows:

GROUP A. The silage group received whole cow's milk at the rate of 1 gallon per calf per day for six weeks after recording started and then at ½ gallon per calf per day for one further week. Hay was provided, from one week old until the calves were weaned, at approximately 6 lb. per day between the four calves.

Silage was introduced when the youngest calf was 31 days old and for the first week was fed at 6 lb. per day between the four calves, increasing over four weeks to 28 lb. per day to each

* Bulletin No. 48. Ministry of Agriculture.

calf. For the next eight weeks it was fed at 35 lb. per head per day and then for the last three and a half weeks before the calves were turned out to grass, at five months old, at about 42 lb. per head per day. This is considerably more than is normally fed to calves. Rates recommended in *The Calf* by J. H. B. Roy are:

At three months old—2–5 lb. per day.
At six months old—not more than 10 lb. per day.

After the calves were weaned, at eight and a half weeks old, they received only silage until they went out to grass on 1st April, 1956.

When the calves were turned out to grass, they were joined by others reared on the farm over the winter and with these received some concentrates for their first three weeks at grass. The amounts fed were:

1·23 lb. per calf per day for ten days
2·55 lb. per calf per day for nine days

These were the only concentrates that this group received.

GROUP B. Although the intention was that both groups should receive the same amounts of milk, the concentrates group received wholemilk at the rate of 1 gallon per calf per day for only two and a half weeks after recording started, i.e. until the youngest calf was only three and a half weeks old, and then at ½ gallon per calf per day for one week more. They were weaned as early as this because the cowman on this farm got a bonus on the amount of milk that was sold. When it was realised that these calves had been weaned so much earlier than the other group, the milk was restarted, after a break of one week, at 1 gallon per calf per day for a further fortnight. On average, therefore, this group received milk, not counting the break, for a total of seven and a half weeks, whereas Group A had received milk for a total of eight and a half weeks.

Hay was fed from birth throughout the winter, being increased from 1 lb. per head per day when recording started to 25 lb. per day between the four calves (i.e. 6¼ lb. per calf per day) eaten by the time they went out to grass.

The concentrates being fed were mixed on the farm, the mixture being altered slightly as the calves grew older. For details of the different mixtures see the Appendix. The ration was 1 lb. per head per day at the beginning of November and 2¼ lb. per head per day from the third week of concentrate feeding until the calves went out to grass in April. They then received the same as the other group, being fed in the field.

TABLE II

Summary of Foods Received by Silage and Concentrates Groups
11th November, 1955 – 20th April, 1956

SILAGE GROUP

		Per Calf
Milk		
11th November–25th December	1 gallon per day . .	44 galls.
25th December–1st January.	½ gallon per day . .	3½ ,,
		47½ ,,
Hay		
11th November–31st December.	6 lb. per day between 4 calves	75 lb.
Silage		
5th December–12th December.	6 lb. per day between 4 calves	10½ lb.
12th December–11th January.	Increased to 28 lb. per calf per day	469 lb.
11th January–9th March.	35 lb. per head per day .	2030 lb.
9th March–1st April	42 lb. per head per day .	924 lb.
		3,433½ lb.
Concentrates whilst at grass		
1st April–11th April.	Mixture IV at 1¼ lb. per day.	12½ lb.
11th April–20th April.	Mixture IV at 2½ lb. per day.	22½ lb.
		35 lb.

CONCENTRATES GROUP

		Per Calf
Milk		
11th November–30th November.	1 gallon per day . .	19 galls.
30th November–6th December.	½ gallon per day . .	3½ ,,
Restarted 2 weeks at 1 gallon per day		14 ,,
		36½ galls.
Hay		
11th November–12th December.	1 lb. per calf per day . .	31 lb.
12th December–11th January	Increased to 6¼ lb. per head per day	108½ lb.
11th January–1st April.	6¼ lb. per head per day .	500 lb.
		639½ lb.
Concentrates		
Mixture I. 13th November–9th January.	1–2·4 lb. per day .	119 lb.
Mixture II. 9th January–25th January.	3¾ lb. per day . .	60 lb.
Mixture III. 26th January–1st April.	2¼ lb. per day . .	146¼ lb.
Mixture IV. 1st April–11th April.	1¼ lb. per day . .	12½ lb.
11th April–20th April.	2½ lb. per day . .	22½ lb.
		360¼ lb.
Bone Meal. 20 days at ¾ lb. per day between 4 calves . . .		3¾ lb.

TABLE III

A Comparison of the Starch and Protein Equivalents of the Two Rations—Group I, 1955/56

Based on Analysis of Foods in *Rations for Livestock*, Bulletin 48, Ministry of Agriculture.

Food			11th Nov.–12th Dec. 31 days		12th Dec.–11th Jan. 30 days		11th Jan.–10th Feb. 30 days		10th Feb.–9th March 28 days		9th March–1st April 22 days	
GROUP A												
Milk			31 galls.		16½ galls.		—		—		—	
Hay			46½ lb.		28½ lb.		—		—		—	
Silage			10½ lb.		469 lb.		1,050 lb.		980 lb.		924 lb.	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Milk	1·7442	0·3366	54·0702	10·4346	28·7793	5·5539	—	—	—	—	—	—
Hay	0·3700	0·0460	17·2050	2·1390	10·5450	1·3110	—	—	—	—	—	—
Silage (1st quality)	0·1280	0·0185	1·3440	0·1943	60·0320	8·6765	134·4000	19·4250	125·4400	18·1300	118·2720*	17·0940*
Average per day			2·3426	0·4119	3·3119	0·5181	4·4800	0·6475	4·4800	0·6475	5·3760*	0·7770*
GROUP B												
Milk			22 galls.		14 galls.		—		—		—	
Hay			31 lb.		108½ lb.		187½ lb.		175 lb.		137½ lb.	
Concentrates, Mixture I			51¾ lb.		67½ lb.		—		—		—	
II			—		7½ lb.		52½ lb.		—		—	
III			—		—		33¾ lb.		63 lb.		52 lb.	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Milk	1·7442	0·3366	38·3724	7·4052	24·4188	4·7124	—	—	—	—	—	—
Hay	0·3700	0·0460	11·4700	1·4260	40·1450	4·9910	69·3750	8·6250	64·7500	8·0500	50·8750	6·3250
Mixture I	0·6556	0·1271	33·9273	6·5774	44·2530	8·5793	—	—	—	—	—	—
II	0·6958	0·1661	—	—	5·2185	1·2458	36·5295	8·7203	—	—	—	—
III	0·6989	0·1700	—	—	—	—	23·5879	5·7375	44·0307	10·7100	36·3428	8·8400
Average per day			2·7022	0·4971	3·8012	0·6510	4·3164	0·7694	3·8850	0·6700	3·9644	0·6893

* These values probably overestimated.

Summaries of the ration fed to the two groups are found in Table II.

Using the figures given in *Rations for Livestock*, the Starch and Protein Equivalents of the foods have been calculated and the two rations are shown for comparison in Table III. The values given to the silage during March are probably over-estimated as this silage came from the end of the pit and was of poorer quality.

OTHER CONDITIONS

At the start the two groups were housed, each group in a separate loose box, on different farms, and were therefore looked after by different people. After the calves had been weaned about one week, they were brought together into one house at Stepstones and separated only by a fence down the middle. They then had common conditions of housing and watering and were looked after by the same person. A check was kept on the time taken to feed each group.

RESULTS

At the monthly visits the weighing of the calves was done in a pig crate for the first few months but at six months old and after, they were weighed on a weighbridge. Various measurements of the calves were also taken with a tape-measure. The intention was to be able to compare the skeletal growth of both groups as well as their liveweights, as these latter may be affected by the weight of food ingested. The measurements taken were:

1. Height at shoulders.
2. Length and diameter of "Cannon Bone".
3. Length of back, from shoulder to pin bones.
4. Girth, measured at last rib.

1. *Growth*

(*a*) LIVEWEIGHT. The results of the monthly weighings are shown in Table IV.

These figures show that up to the third weighing the two groups gained weight at a comparable rate. This was over the period when both groups were receiving whole milk. During the third month, however, Group B, on concentrates, all scoured fairly badly and developed swollen joints and jaws and rough coats. The vet. diagnosed this as phosphate deficiency. It was overcome by drenching, and the feeding of an

TABLE IV

Liveweight Gain, 1955/56—Measured in pounds

OUT TO GRASS 1ST APRIL, 1956

Calf	11th Nov.	12th Dec.	11th Jan.	10th Feb.	9th Mar.	11th Apr.	20th Apr.	2nd Oct.
				GROUP A				
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Violet	120	148	168	182	189	207	222	424
Tubbs	108	130	158	174	175	194	203	433
Lavender	110	139	173	181	179	197	213	394
Tulip	104	135	158	171	164	183	203	364
Average	110	138	164	177	177	195	210	404
				GROUP B				
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Susie	102	128	153	120	150	176	207	401
Nancy	110	141	154	178	204	230	262	459
Alida	103	136	161	206	210	264	287	464
Agnes	99	130	154	184	220	266	288	490
Average	104	134	156	172	196	234	261	454

emergency supplement of bone meal, at the rate of $\frac{3}{4}$ lb. per day between the four calves for twenty days. One calf, Susie, was very weak and was injected by the vet. and also given extra milk (7 gallons) and some raw eggs. After the calves had recovered from this set-back, they continued to grow normally, without any further checks.

During the third and fourth months, Group A, on silage alone, seemed to be rather underfed, resulting in a considerably reduced rate of growth. Indeed, during the fourth month there was no average gain at all, two of the calves having lost weight. The level of feeding was increased during the fifth month and the calves began to grow again, although the silage was then of a poorer quality. The silage-fed calves did not show any signs of a phosphate deficiency.

When the calves were turned out to grass, which was later than usual for the farm because of the cold spring, there was a difference of about 33 lb. between the average weights of the two groups, the concentrates group being the heavier.

It had been wondered whether the calves that had been receiving silage would, when turned out, be better able to digest the fresh grass and so suffer less of a check than the hay-and-concentrates fed group. However, this did not seem to be so. The calves were weighed on 11th April, 1956, having then been

at grass for nine days, and then again, another nine days later on 20th April. During this second period of nine days, the average gain in weight of the silage group was 15 lb. per calf, whereas the concentrates group had gained an average of 27 lb. per calf—i.e. almost twice as much. This gave a total difference in the average weights of the two groups of 51 lb.

Both groups were weighed again after they had been at grass for exactly six months, when it was found that since their last weighing in April they had each gained at an almost equal rate. (Group A averaged an increase in liveweight of 194 lb. per calf and Group B an increase of 193 lb. per calf.) Thus a difference in weight of 50 lb. was maintained between the two groups.

The first noticeable fact in looking at these results and the weighings is that the average rate of gain of both groups was very much less than that usually considered desirable.

11.11.55–20.4.56. 161 days. *Group A*. Average liveweight gain. 0·621 lb. per day

Group B. Average liveweight gain. 0·975 lb. per day

11.11.55–2.10.56. 326 days. *Group A*. Average liveweight gain. 0·902 lb. per day

Group B. Average lightweight gain. 1·074 lb. per day

Figures usually quoted for Friesian calves are between 1·4 and 1·6 lb. per day for the first six months, with an average of 1·5 lb. per day over the first year. Even the greatest gains by the two best individual calves of the groups were below this:

11.11.55–2.10.56. Tubbs. Average liveweight gain. 1·0 lb. per day

Agnes. Average liveweight gain. 1·2 lb. per day

As these gains are less than might be expected, a comparison of the rations that were fed with a ration recommended for "normal" gain, might explain the difference. The "recommended" ration suggests what might be needed to rear a calf up to six months old. At 20.4.56, the rations received by the two groups are shown and the calves were then: Group A, 24½ weeks old, Group B, 25 weeks old.

This is only a rough check, but it seems that part, at least, of the reduced rate of growth would be due to the lower level of protein feeding. The difference in Protein Equivalent between the Recommended Ration and Group A Ration is 20·9 units Protein Equivalent. A daily ration of 3 lb. concentrates and 8 lb. hay supplies 0.997 units Protein Equivalent per day. 20·9 units of Protein Equivalent therefore represents 21 days

growth. At 1·5 lb. liveweight gain per day this becomes 31·5 lb. liveweight increase.

	Recommended Ration*			Group A Ration			Group B Ration		
		Starch Equiv.	Protein Equiv.		Starch Equiv.	Protein Equiv.		Starch Equiv.	Protein Equiv.
Milk .	40 galls	69·8	13·5	57½ galls	100·2	19·4	53¼ galls	93·1	17·9
Hay .	4 cwt.	165·8	20·6	75 lb.	27·8	3·5	639 lb.	236·4	29·4
Concs.	3 cwt.	268·1	80·3	35 lb.	28·4	5·1	360 lb.	252·3	55·5
Silage	—	—	—	3433½ lb.	439·5†	65·5†	—	—	—
		503·7	114·4		595·9	93·5		581·8	102·8

* Taken from *The Calf* by J. H. B. Roy. Farmer & Stockbreeder Publication.

† These values are probably overestimated.

Even, therefore, if the silage-fed calves received supplementary feeding to bring the total Protein Equivalent received up to the "recommended" level, they would still be very much underweight. They are not, therefore, receiving the full food values that could be expected if the silage were of 1st quality.

As regards the concentrates group, the home-mixed concentrates averaged about 15½ per cent Crude Protein, whereas the recommended calf cake would have a Crude Protein percentage of about 22½ per cent. This explains why, although a greater quantity of cake was fed, the amount of Protein Equivalent supplied to the calf was less.

A month-by-month comparison of the Starch Equivalent and Protein Equivalent values of rations A and B is shown in Table III where it can be seen that, during the early months of feeding, Group A received less nutrients than Group B. At the end of the period, in March, although Group A appeared then to be receiving more, the values attributed to the silage, namely, first quality silage, would certainly be overestimated.

The reduced rate of growth of the two groups when compared with the "average" has, of course, a big effect on the actual weights of the calves, which were also very much less than the averages quoted for Friesian calves.

"Average"	Group A	Group B
13 weeks—200 lb.	14½ weeks—177 lb.	15 weeks—172 lb.
26 weeks—365 lb.	24½ weeks—210 lb.	25 weeks—261 lb.

These differences from the expected weights appear to be very great, but it should be mentioned that despite the bedraggled appearance of Group A and Susie, the calves did not look unduly small when seen on the farm.

TABLE V

Tables and Graphs of the Liveweight Gains and Body Measurements of Groups A and B, 1955/56

ALL MEASUREMENTS IN INCHES

LIVEWEIGHT

GROUP A	11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	20 Apr.
Violet .	120	148	168	182	189	207	222
Tubbs .	108	130	158	174	175	194	203
Lavender	110	137	173	181	179	197	213
Tulip .	104	135	158	171	164	183	203
Average .	110·50	137·50	164·25	177·00	176·75	195·25	210·25

GROUP B	11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	10 Apr.
Susie .	102	128	153	120	150	176	207
Nancy .	110	141	154	178	204	230	262
Alida .	103	136	161	200	210	264	287
Agnes .	99	130	154	184	220	266	288
	103·50	133·75	155·50	170·50	196·00	234·00	261·00

LENGTH OF CANNON BONE

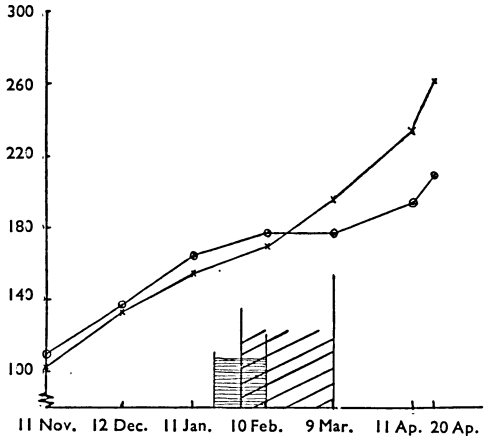
GROUP A	11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	20 Apr.
Violet .	9¼	9½	9½	9½	9½	10	—
Tubbs .	8	8½	9	9½	9½	10	—
Lavender	7½	9	9¼	9¼	10	10	—
Tulip .	8¼	9¾	9¾	9¾	10	10¼	—
Average .	8·25	9·19	9·40	9·50	9·75	10·06	—

GROUP B	11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	10 Apr.
Susie .	8½	8¾	9½	9½	9½	10	—
Nancy .	8¼	9	9	9½	9¾	10¼	—
Alida .	8¼	8¾	9	9½	9¾	10	—
Agnes .	9	9¼	9¼	9¼	10	10	—
	8·50	8·94	9·19	9·44	9·78	10·06	—

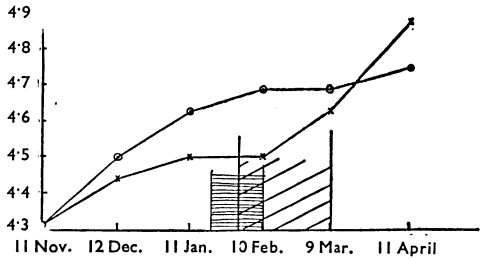
DIAMETER OF CANNON BONE

GROUP A	11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	20 Apr.
Violet .	4½	4¾	4¾	4¾	4¾	5	—
Tubbs .	4½	4½	4¾	4¾	4¾	5	—
Lavender	4	4¼	4½	4½	4½	4½	—
Tulip .	4¼	4½	4½	4¾	4¾	4½	—
Average	4·31	4·50	4·63	4·69	4·69	4·75	—

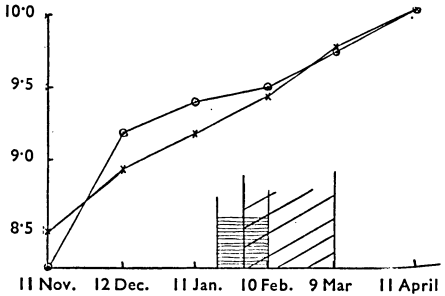
GROUP B	11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	10 Apr.
Susie .	4¼	4½	4½	4½	4¾	4½	—
Nancy .	4¼	4¼	4½	4½	4½	5	—
Alida .	4¼	4½	4½	4½	4½	5	—
Agnes .	4½	4½	4½	4½	4¾	5	—
	4·31	4·44	4·50	4·50	4·63	4·88	—



Liveweight Growth



Diameter of Cannon Bone



Length of Cannon Bone

KEY

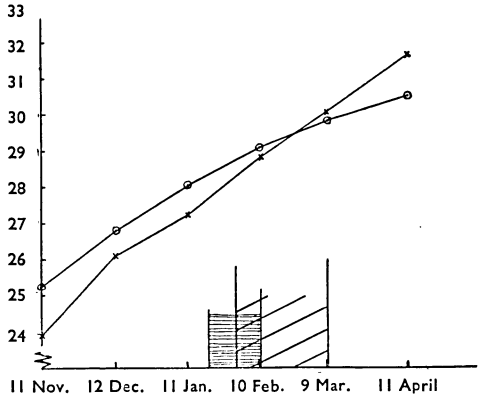
Group A ⊙—⊙ Group B X—X

Period of Phosphate Deficiency (Group B)

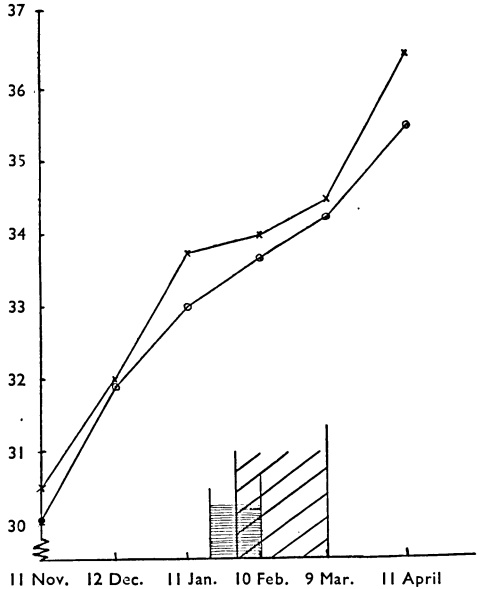
Period of Under-feeding (Group A)

TABLE V—*continued*

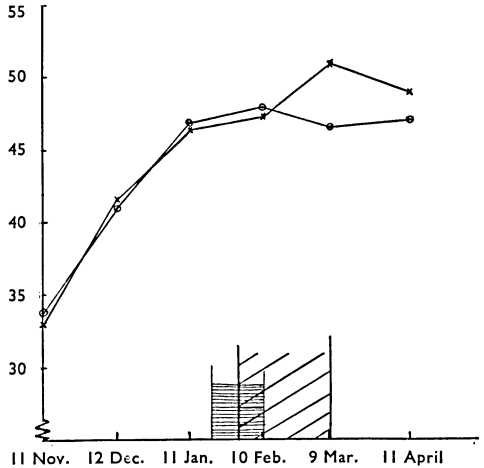
GROUP A								GROUP B							
LENGTH OF BACK—SHOULDER TO PIN BONES															
	11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	20 Apr.		11 Nov.	12 Dec.	11 Jan.	10 Feb.	9 Mar.	11 Apr.	20 Apr.
Violet .	28	28½	29¼	29½	30	30½	—	Susie .	23½	25½	25½	27	27	27½	—
Tubbs .	23½	25	27½	29	30	30½	—	Nancy .	24½	26	29	29	31½	32½	—
Lavender	24	26¾	27	29	29	29½	—	Alida .	24	27½	28	29½	32	33	—
Tulip .	25½	27	28½	29	30½	31½	—	Agnes .	23½	25½	26½	29½	30	33½	—
Average .	25·25	26·81	28·06	29·12	29·81	30·50	—		23·90	26·12	27·25	28·75	30·12	31·62	—
HEIGHT OF SHOULDERS															
Violet .	31¼	32¾	33	34	35	36	—	Susie .	31	32	33	33	33	35	—
Tubbs .	30	31¼	33¼	34	34	35	—	Nancy .	31½	33	34½	34½	34½	37	—
Lavender	29¼	31½	32¾	32¾	33½	35½	—	Alida .	30	31½	33½	34½	35	36	—
Tulip .	29¾	32	33	34	34½	35½	—	Agnes .	29½	31½	34	34	35½	38	—
Average .	30·06	31·90	33·00	33·69	34·25	35·50	—		30·50	32·00	33·75	34·00	34·50	36·50	—
GIRTH AT LAST RIB															
Violet .	34½	40¼	46	48½	47	47	—	Susie .	32½	41½	46	41	45½	45½	—
Tubbs .	33½	40¼	45½	46	46	47½	—	Nancy .	33½	42¾	45½	48½	52	49	—
Lavender	34	43	49	49	48	47½	—	Alida .	34	42½	48	51	54	50½	—
Tulip .	33	40½	46½	48½	45½	46½	—	Agnes .	32	40	46½	48½	52½	51	—
Average .	33·8	41·0	46·8	48·0	46·6	47·1	—		33·0	41·7	46·5	47·3	51·0	49·0	—



Length of Back



Height of Shoulders



Girth, measured at last rib

KEY

Group A ⊙—⊙ Group B X—X

Period of Phosphate Deficiency (Group B)

Period of Under-feeding (Group A)

When comparing the liveweights of the two groups, it should also be remembered that there would be quite a considerable difference in the weights of the rumen contents. For comparison, ignoring any water drunk, which would be more for the concentrates group than for the silage group, the average weight of food eaten during the last three months was

Group A. 37 lb. per day

Group B. 8·8 lb. per day

The difference in the 'net' liveweights of the two groups may therefore be even greater than is apparent. The seemingly much more rapid gain in liveweight of Group B when turned out to grass may similarly be due not to any better utilisation of the grass but merely to an increase in the weight of the rumen contents.

(*b*) BODY MEASUREMENTS. Tables and graphs of these measurements are shown in Table V. The most noticeable results of these measurements are in the effects of the checks in growth rates of the groups. The results of the different measurements are summarised below.

Length of Cannon Bone. In both groups of calves this increased at a fairly even rate.

Diameter of Cannon Bone/Height of Shoulders. The period of phosphate deficiency for Group B (concentrates) was reflected in both these measurements. The diameter of the cannon bone showed no gain during the period of deficiency but after the bone meal supplement had been fed, it increased at more than the previous rate and surpassed the measurements of Group A, which had not suffered any check. Similarly in the concentrates group the monthly gain in shoulder height was almost negligible during the period of phosphate deficiency, but although the effect here was felt for longer, the rate of increase did return to its previous levels.

In Group A (silage) these measurements also showed a check, this time to correspond with the period of underfeeding. Here the diameter of the cannon bone again showed the most severe check, but although both measurements increased again after the calves were turned out to grass, they remained less than those for Group B.

Length of the Back from shoulder to pin bone. This increased fairly steadily for both groups, showing little effect of any check. The rate of increase for the concentrates group was generally greater than for the silage group.

Girth. This was measured at the last rib. At the start of recording, and for the first two months, both measurements

were virtually the same. Each group showed a check during the period of phosphate deficiency or underfeeding but whereas the concentrates group soon recovered, the measurements of the silage group actually decreased. On being turned out to grass, the silage group showed a very slight gain in girth, while the concentrates group showed a definite decrease.

These measurements of girth can only be regarded as a rough guide to the size of the animal as they are considerably influenced by the volume of food in the rumen at any time. They do suggest, however, that the eating of large quantities of silage does not necessarily promote greater rumen capacity or the "barrel" that is often considered desirable for animals being fed large amounts of bulky foods.

As Dr. Hammond has shown*, during the development of an animal, some parts of the body develop more quickly than other parts. These more quickly-developing parts in general have a "priority" in the nutrients available for growth. If there is a shortage in the supply of nutrients, then, as long as the shortage is not too prolonged the developing part will retain its "priority" and when the supply becomes more plentiful again will resume growth to its normal limit. From this it follows that, by slowing down the growth rate, the different phases of growth take longer to be completed and that therefore a low plane of nutrition will slow down the growth of the later-developing parts of the body more than the early-developing. Since the growth gradients spread from the extremities to meet at the loin, this is the latest-developing part. In comparing the two groups of calves, therefore, it would be expected that the effects of different rations would be seen most markedly in the measurements for the length of back and conversely that there would be least difference shown by the early-developing cannon bone.

If the differences at 11.4.1956 are expressed as $\frac{Group\ B}{Group\ A} \times 100$, they become:

Length cannon bone $\frac{10{\cdot}06}{10{\cdot}06} \times 100 = 100$ per cent

Diameter cannon bone $\frac{4{\cdot}88}{4{\cdot}75} \times 100 = 102{\cdot}7$ per cent

* *Growth and Development of Mutton Qualities in the Sheep.* J. Hammond. 1932. Edinburgh.

Height of shoulders $\frac{36 \cdot 5}{35 \cdot 5} \times 100 = 102 \cdot 8$ per cent

Length of back $\frac{31 \cdot 62}{30 \cdot 50} \times 100 = 103 \cdot 7$ per cent

The above figures do, therefore, confirm what might have been expected. However, when the figures for the length of the back were analysed, it was found that there was no statistical significance in the difference between them so that this result cannot be said to be the direct outcome of the different rations.

With regard to the checks that both groups of animals received, the cannon bones were the first to show them, when the calves were about two months old. The height of the shoulders showed the check a little later, which is rather surprising as it might be thought that this height was partly dependent upon the growth of the cannon bone. The measurements of the length of back showed hardly any effect of a check.

From this it would seem that if there is any check it will generally be reflected most markedly in that part of the body which is developing most rapidly at the time. This despite the fact that whilst later-developing parts may not show the check as obviously they may themselves be more seriously retarded.

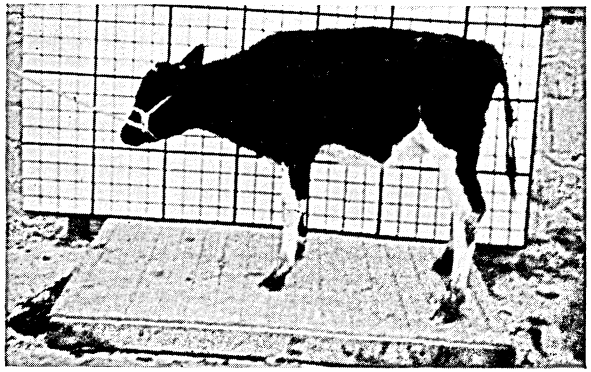
In general, as can be seen from the graphs, there was no dissimilarity in the measurements of the two groups. The only ones that did show a big divergence both in absolute measurements and in trend were those for the diameter of the cannon bone. For the silage group the measurements for both the length and diameter of the cannon bone, when plotted, closely followed the shape of the general liveweight curve. In the concentrates group, however, although the length was again fairly closely related to the liveweight curve, the diameter showed a very definite and serious check. This suggests that the phosphate deficiency which caused the check, although being very serious for the animal's general health, had relatively no effect on the growth in length of the bone but only on its thickening out.

2. *Health*

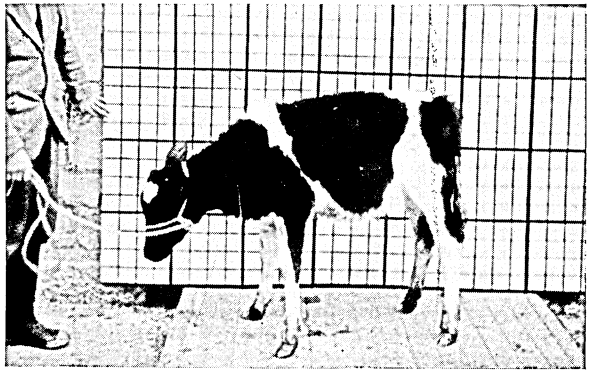
As each group received a check to growth, it is hard to compare their general health. Only the group on concentrates showed any signs of phosphate deficiency and although these four calves were all fairly ill and very weak, they soon recovered after treatment and went ahead as before.

The Trial Groups of Calves at About Six Months Old, Before Being Turned Out to Grass

GROUP C—SILAGE

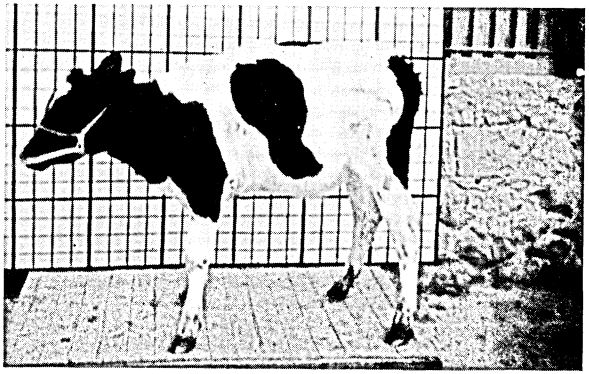


Connie

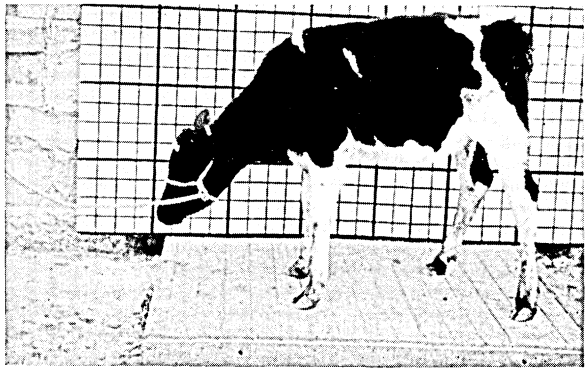


Dolly

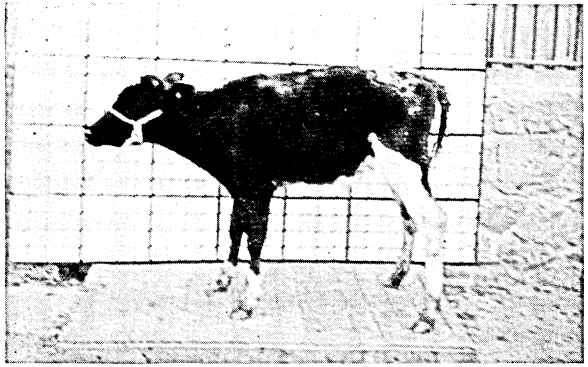
GROUP D—CONCENTRATES



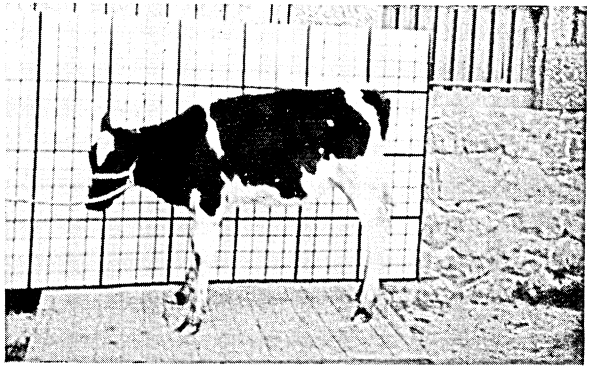
Betty



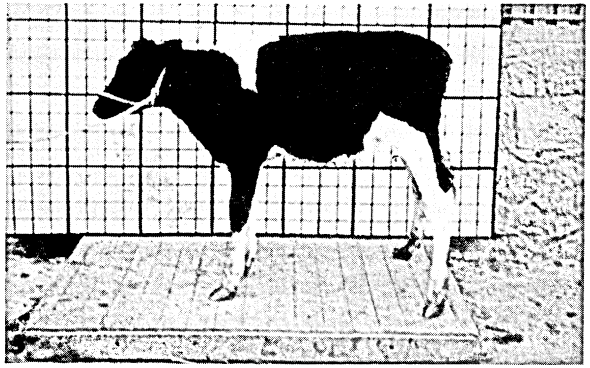
Clare



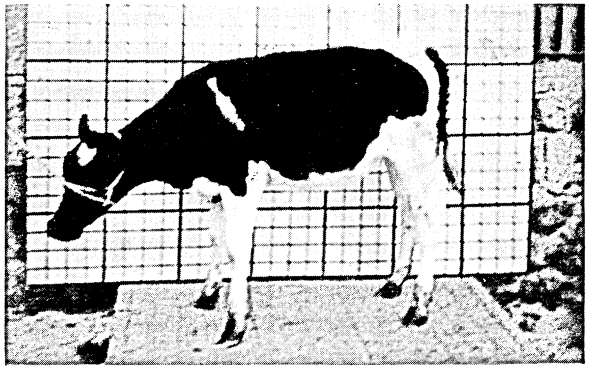
Violet



Pansy



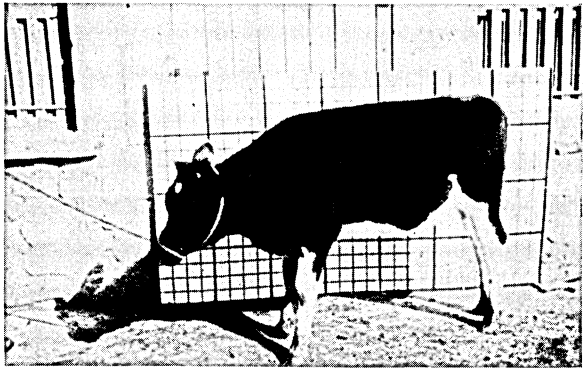
Winnie



Tulip

The Trial Groups of Calves at About One Year Old, After Six Months at Grass

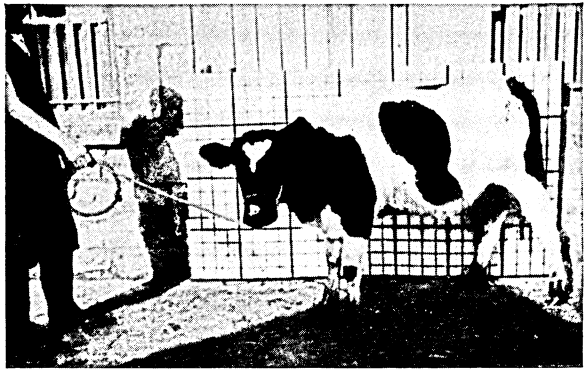
GROUP C—SILAGE



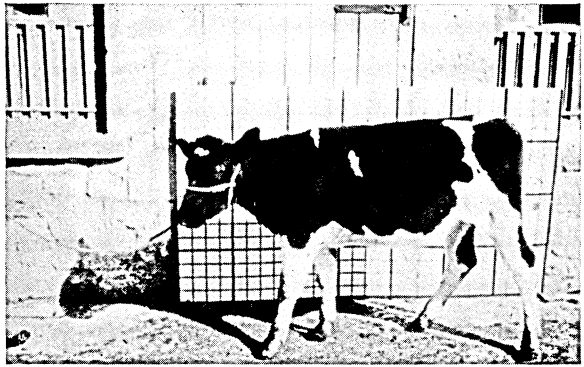
Connie

Dolly

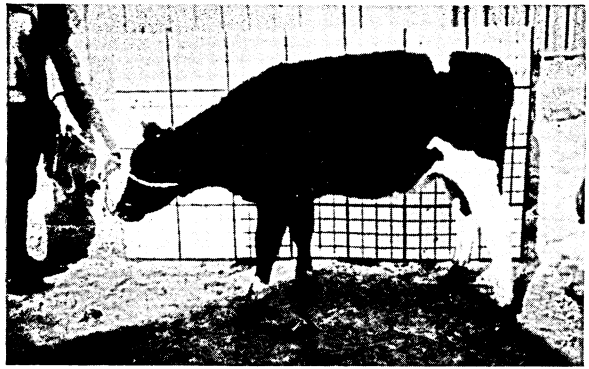
GROUP D—CONCENTRATES



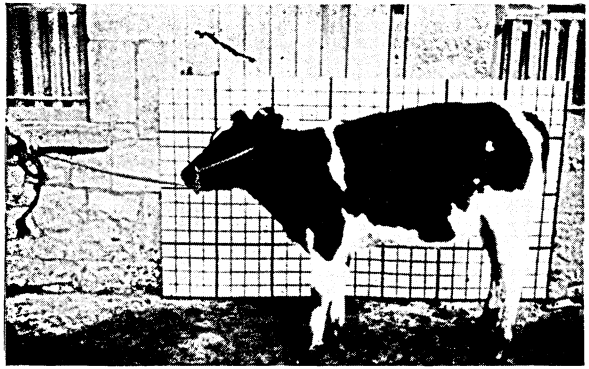
Betty



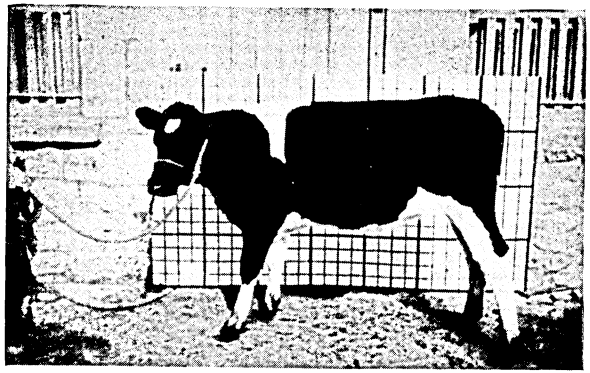
Clare



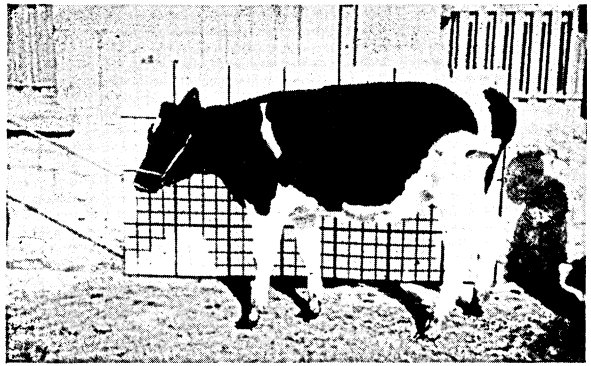
Violet



Pansy



Winnie



Tulip

With the silage group it is more difficult to determine how much this check was the result of underfeeding and how much it was because they could not digest the silage sufficiently well for normal growth. Certainly, when the ration was increased they cleared up the troughs and did begin to grow again. This group did not show any signs of either nutritional scour or worms although it had been suggested that these might result from the feeding of silage in large quantities to young calves.

3. *Costs*

The following table, Table VI, shows the costs of rearing the eight calves from the beginning of the trial up to the time that hand-feeding was stopped. That is, until they had been at grass for three weeks. It is assumed that thereafter all the calves in the bunch that were running together received equal shares in the costs of the bunch.

The costs that have been used for comparison are not those actually incurred on this particular farm but are based on the average costs for the Province. To determine the actual costs of production of hay, silage and milk on this farm would have been beyond the possibility of the trial. As the costs used are averages, they give an idea of what could be expected on any farm where this system of rearing is being tried. The figures that have been used are as follows:

MILK. The cost of 3·211 shillings per gallon is the average net cost of production of winter milk (October–March) on fifty-six farms for the winter of 1955/56.

HAY. Similarly the cost of hay, £0·3318 per cwt. is the average cost of production on 52 farms for the summer of 1955.

SILAGE. Again the cost of £0.1136 per cwt. is the average cost of production for the summer of 1955 on 24 farms.

CONCENTRATES. The costs of the various mixtures have been worked out from the prices paid on the farm for the straight ingredients, plus the cost of rolling where this was incurred.

LABOUR. This has all been charged at 2·8 shillings per hour, the average adult male rate for the period.

Comparing first the actual results obtained from the two groups during the period of the trial when the foods are charged at average costs of production, the amounts consumed by Group A work out at £11 18*s*. 0*d*. per head and by Group B at £13 6*s*. 6*d*. per head, giving a difference of £1 8*s*. 6*d*. per calf. When manurial values are allowed these total costs are reduced by £0.571 for Group A and £0·380 for Group B, making the difference between the two groups £1. 10*s*. 4*d*. This

TABLE VI

A Comparison of the Costs of Rearing Groups A and B—Out to Grass 1st April, 1956

11th November, 1955, to 20th April, 1956

GROUP A

Foods	Quantity per Calf	Cost/Unit	Total Cost	
			£	£ s. d.
Milk	47½ galls.	3·211s./gall.	7·6261	7 12 6
Hay	75 lb.	£0·3318/cwt.	0·2222	4 5
Silage	3433½ lb.	£0·1136/cwt.	3·4826	3 9 8
			11·3309	11 6 7
At Grass: Concentrates, Mixture IV	35 lb.	3·89d./lb.	0·5673	11 4
				£11 17 11

Labour	Time/Day	No. Days	Total Hours	Total Cost
Milk Feeding	20 minutes	52	17′ 20″	
Hay Feeding	10 ,,	51	8′ 30″	
Silage Feeding	5 ,,	7	35″	
	10 ,,	110	18′ 20″	
Concentrates Feeding	2½ ,,	20	50″	
			45′ 35″	
			45′ 35″	
At £0·14 per hour			£6·3817	
Per Calf				£1 11 11
Total Foods Plus Labour per Calf				£13 9 10

GROUP B

Foods	Quantity per Calf	Cost/Unit	Total Cost	
			£	£ s. d.
Milk	38¼ galls.	3·211s./gall.	6·1410	6 2 10
Hay	639½ lb.	£0·3318/cwt.	1·8945	1 17 11
Concentrates, Mixture I	119 lb.	3·20d./lb.	1·5866	4 13 6
II	60 lb.	3·31d./lb.	0·8275	
III	146¼ lb.	3·71d./lb.	2·2608	
Bone Meal	3¾ lb.	3·11d./lb.	0·0486	11
			12·7590	12 15 2
At Grass: Concentrates, Mixture IV	35 lb.	3·89d./lb.	0·5673	11 4
				£13 6 6

Labour	Time/Day	No. Days	Total Hours	Total Cost
Milk Feeding	20 minutes	40	14′ 30″	
do.	10 ,,	7		
Hay and Concentrates Feeding	7 ,,	31	3′ 37″	
	10 ,,	30	5′ 00″	
	5 ,,	80	6′ 40″	
Concentrates Feeding	2½ ,,	20	50″	
			30′ 37″	
Plus time for mixing Concentrates at 1 hour per Month			4′ 0″	
			34′ 37″	
At £0·14 per hour			£4·8463	
Per Calf				£1 4 3
Total Foods Plus Labour per Calf				£14 10 9

£1 10*s*. 4*d*. is equivalent to an extra 1,500 lb. of silage. The silage-fed calves first showed signs of underfeeding in the middle of February and had more silage then been made available to them they may have eaten an extra 5 lb. per head per day between then and 1st April; that is, an extra 225 lb. costing 4*s*. 7*d*. This would reduce the difference in the net costs of food between the two groups to £1 5*s*. 9*d*.

The cost of labour is based on the number of hours that were spent directly on the feeding of the two groups. This has all been charged at a man's agricultural rate although the work was actually done by a boy. During the time of silage feeding the silage group required a third as much labour again as the concentrates group.

Silage feeding—18 hours 55 minutes.

Concentrates feeding—14 hours 40 minutes.

Over the whole period of the trial though—that is, including milk feeding and the concentrates fed at grass—the hours spent on the two groups were:

Silage Group—45 hours 35 minutes.

Concentrates Group—34 hours 37 minutes.

A large part of this additional difference derives from the time that the calves were receiving milk. During the trial Group A received milk for twelve days longer than Group B.

In total cost the labour of feeding Group A was £6 7*s*. 8*d*., an average of £1 11*s*. 11*d*. per calf and for Group B £4 16*s*. 11*d*., or £1 4*s*. 3*d*. per calf; this is a difference of 7*s*. 8*d*. per calf between the groups.

Other costs, such as the labour of littering, watering and dehorning have not been included in the comparison where they apply equally to both groups. They would amount to about 7*s*. 6*d*. per calf.

No account has been taken in the above figures of the extra cost involved in the illness of the four calves on concentrates—vet's attention, worm drenches, eggs and three injections to Susie. An estimate of £1 to the group is allowed for these.

During the trial, therefore, the total costs for the two groups might be £13 17*s*. 6*d*. per calf for the silage-fed group and £15 3*s*. 3*d*. per calf for the concentrates-fed group.

However, when the two groups are compared from birth, there is the milk-feeding before recording started to be included. The costs of the extra milk and labour amount to:

Group A.	10 gallons milk per calf .	£1·605
	3 hrs. 20 mins. between 4 calves	0·117
	i.e.	£1 14*s*. 5*d*. per calf

Group B.	15 gallons milk per calf	£2·407
	5 hours between 4 calves	£0·175
	i.e.	£2 11*s*. 8d. per calf

In comparing the two groups, the initial values of the calves have not been considered and no charges have been made for the rental value of the buildings. Also the cost of straw litter has not been counted as this would be credited as F.Y.M. Overheads are charged at the standard rate of 5*s*. per £1 of labour.

In total, then, the costs for the two groups up to the age of six months might be somewhere about:

Group A.	Food	£13·5	*Group B.*	Food	£15·7
	Labour	2.1		Labour	1·8
	Miscellaneous	0·5		Miscellaneous	0·7
		£16·1			£18·2

However, since the growth rates of the two groups were not the same, this difference in costs cannot be considered as showing that it would be £2·1 per calf cheaper to rear calves on a diet of mainly silage. A reduced figure of £1·9 saved, having allowed for extra silage to the value of 4*s*., might be a better indication of the saving possible.

4. *Usefulness*

Although the setbacks that both groups of calves received made a straightforward comparison between them impossible, it was felt that the growth made by the silage group was sufficiently encouraging to suggest the possibility of some system of rearing that would allow calves to make normal growth and at the same time achieve the economies of cost that the feeding of silage offers.

Mr. E. M. Owens was, therefore, willing to repeat the trial with a second group of eight calves during the following winter to see whether, by avoiding the errors made in this trial any more definite results could be obtained.

From this first trial two or three limitations became apparent.

1. The farm must make sufficient silage not only for the cows but also to feed the calves until they can go out to grass. This aspect of *quantity* is important, particularly as silage at the end of a pit is almost always of inferior quality.

2. The quality of the silage, too, is important but not, perhaps, as important as might be imagined. According to the analysis done by the National Agricultural Advisory Service the silage that the calves received was of only medium quality. Had it been "good", the growth rate of the calves may well have been greater.
3. Even if a saving in costs of £2 per calf were achieved on all the calves reared, on a small farm rearing only five or six calves each year this system would not be worth the effort. Only on a larger farm where silage already forms an important part of the feeding programme would it be practical.

Although in discussing the results of this first trial the two groups have been compared with each other for liveweight gain and also compared with what might be expected as an "average" result, the actual differences between the two groups were very much less than the differences between either group and the "average". This suggests that perhaps the conditions of rearing were not really average. It may be questioned, though, how far the figures for liveweight quoted as "average" apply to a commercial farm—certainly the results on this farm did not appear to be particularly under average.

Also the figures shown for liveweight cannot be regarded entirely by themselves but need to be considered along with figures showing the costs that gave such results. A comparison of these costs with average costs of rearing dairy heifers will be found in Part IV. Even then, however, these "average" costs are those obtained on commercial farms and there is no certainty that they would be directly related to the costs of rearing heifers to achieve the recommended rates of growth.

Part III. 1956/57 Trial

Although it was not easy to determine the results of the 1955/56 trial, a second trial was run during the following winter.

Here again, there were two groups of four calves, born within two and a half weeks of each other and all to be reared as dairy herd replacements. They were all born on the same farm, Stepstones, and were kept together in the same house, separated only by fencing. Both groups were looked after by the same person and therefore had, as nearly as possible, the

same conditions of light, heat, space, etc. This year a milk replacer was being used on the farm to replace wholemilk and again the intention was that the two groups should receive equal quantities of the milk equivalent. During 1955/56 the calves on silage had been rather underfed so it was decided to continue the feeding of hay throughout the winter to this group instead of stopping it at weaning.

The measurements of the calves the previous year had been interesting, if rather difficult, but had not shown any unexpected or significant results, so that this year it was decided not to take these measurements but to rely on monthly weighings and observations only.

The two groups for 1956/57 were:

Group C. (Silage)

Connie	born 21.9.56
Dolly	born 1.10.56
Violet	born 20.9.56
Winnie	born 19.9.56

Group D. (Concentrates)

Betty	born 6.10.56
Clare	born 6.10.56
Pansy.	born 6.10.56
Tulip	born 27.9.56

Recording started on 26th October, 1956, when the youngest calf was twenty days old.

RATIONS

The rations fed were as follows:

Milk. All the calves received wholemilk for the first three weeks from birth and during the fourth week were changed over onto the milk replacer on which they continued for another six weeks. Before recording started, because of their different ages the groups had received different amounts of milk and gruel:

Group C—97 gallons wholemilk } between the group.
40 gallons gruel

Group D—87½ gallons wholemilk } between the group.
5½ gallons gruel

From the start of recording until being weaned they received:

Group C—50 gallons gruel per calf

Group D—2 gallons wholemilk per calf
55 gallons gruel per calf

Hay. Hay was introduced when the youngest calf was sixteen days old and was fed *ad lib.*, a record being kept of how much was given.

Silage was introduced to Group C on 2.11.56, the youngest calf then being thirty-two days old, when 12 lb. per day were given between the four calves. This was increased gradually up to 5.1.57, when the calves were being given 45 lb. per day between them. This was very much less than the silage-fed calves had received the previous year but Group C were also receiving hay, which, by 5.1.57, amounted to 5¼ lb. per calf per day. The silage in this second year was also classified as of "Medium Protein" quality; the Dry Matter of a sample taken from the middle of the silo was 33 per cent and the Crude Protein was approximately 4·5 per cent of the fresh silage.

Concentrates. These were first fed to Group D on 31.10.56, when the youngest calf was twenty-five days old. Initially they received ¾ lb. per calf per day but this was increased to 3 lb. per calf per day by 5.1.57. Details of the different concentrates mixtures fed are shown in the Appendix. The hay fed to this group was also *ad lib*, and by 5.1.57 they, too, were receiving 5¼ lb. per calf per day.

Water was available in troughs all the time.

These rations were continued fairly steadily until the calves went out to grass on 26th March, although during the last three weeks the amount of silage to Group C was increased a little.

Summaries of the amounts that the two groups received are shown in Table VII, and a summary of the Starch Equivalent and Protein Equivalent values of the two rations is shown in Table VIII. In calculating these values, figures for first quality silage have again been used, although the actual quality was less than this. It will be seen that right from the start, according to the Starch Equivalent and Protein Equivalent values given to the different foods, Group C was being fed at a very much lower level of nutrition than Group D. This was not, however, immediately apparent on the farm and only in the fourth month was there any big difference in the liveweights of the groups. It was thought that perhaps the calves were eating too much hay and not enough silage—they certainly appeared to prefer the hay—so the amount of hay supplied was slightly reduced. However, the amount of silage then eaten hardly increased at all, so in the fifth month the amount of hay was reduced again, from 4 to 2½ lb. per calf per day, when

the silage eaten increased by 2 lb. per calf per day. The total nutrients available to the silage-fed calves in this last month, however, were even less than in the previous month, even ignoring any falling-off in the quality of the silage at the end of the winter. There was indeed no silage to spare on the farm during March, so the ration could not be too generous.

Both groups of calves were turned out to grass in a paddock on 26.3.57 and whilst there received, with other calves, for the first twelve days, a ration of 2 lb. per head per day of concentrates and about $3\frac{3}{4}$ lb. per head per day of hay.

Throughout the spring and early summer flush of grass, the calves were grazed rotationally around the farm ahead of the cows.

RESULTS

The results of this second trial are discussed under the headings of health, liveweight gain and costs.

1. *Health*

Although by the end of the winter the silage-fed calves all looked very bedraggled—thin and with rough coats—they had not shown any signs of scour or of any dietary deficiencies and their general health appeared good. The health of the concentrates group, too, seemed good, despite a calcium:phosphorus imbalance that had been apparent in one calf, and all these animals were plumper and had smoother coats on them at the end of the winter.

To see whether the feeding of silage had contributed at all to a build-up of worms within the calves, a worm count was taken before they were turned out to grass. This showed that all the calves of both groups were virtually worm-free.

One feature in the rearing of these calves that was curious was that after two months at grass *all* the thirty-three calves running together in a bunch showed slight signs of copper deficiency. They did not improve naturally so at the beginning of June they were all given a copper drench. Two weeks later there was a very definite improvement in them—they had all lost ("moulted") their rusty coats and were almost normal again. Both the soil and the grass were analysed but neither a deficiency of copper nor an excess of molybdenum (as in the "Teart" pastures) was apparent. The cause was, therefore, rather inexplicable and may have been due to an unusual reduction in the availability of the copper. After drenching no further trouble was experienced.

TABLE VII

Summary of Foods Received by Silage and Concentrates Groups

27th October, 1956 – 6th April, 1957

SILAGE GROUP		*Per Calf*
Wholemilk		—
Milk Replacer: 27th October–9th December		50 galls.
Hay		
27th October–26th January.	Increased from 7 to 49 lb. per head per week	320 lb.
27th January–25th March	Average of 15 lb. per day between group	199½ lb.
At grass: 26th March–6th April		45 lb.
		564½ lb.
Silage		
2nd November–5th January.	Increased from 3 to 11¼ lb. per head per day	490 lb.
5th January–25th March	Increased from 11¼ to 15 lb. per head per day	961½ lb.
		1,451½ lb.
Concentrates whilst at grass		
Mixture IV } At 2 lb. per head per day		2 lb.
Mixture V } At 2 lb. per head per day		22 lb.
		24 lb.

CONCENTRATES GROUP		
Wholemilk (average) 27th October–3rd November		2¼ galls.
Milk Replacer: 27th October–16th December		54¾ galls.
		57 galls.
Hay		
27th October–26th January.	Increased from 7 to 49 lb. per head per week	335 lb.
27th January–25th March.	Average of 15 lb. per day between group	257 lb.
At grass: 26th March–6th April		45 lb.
		637 lb.
Concentrates		
31st October–29th December.	Mixture I	130¼ lb.
29th December–25th February.	Mixture II	174 lb.
26th February–23rd March.	Mixture III	77½ lb.
24th March–25th March	Mixture IV	6 lb.
		387¾ lb.
At grass:	Mixture IV	2 lb.
	Mixture V	22 lb.
		411¾ lb.

TABLE VIII

A Comparison of the Starch and Protein Equivalents of the Two Rations—Group II, 1956/57

Based on Analysis of Foods in *Rations for Livestock*, Bulletin 48, Ministry of Agriculture.

Food			28th Oct.–1st Dec. 35 days		2nd Dec.–29th Dec. 28 days		30th Dec.–2nd Feb. 35 days		3rd Feb.–2nd March 28 days		3rd Mar.–26th Mar. 24 days	
GROUP C												
Milk			—		—		—		—		—	
Gruel			42 galls.		8 galls.		—		—		—	
Hay			49 lb.		99¾ lb.		197¾ lb.		115½ lb.		57½ lb.	
Silage			137 lb.		274 lb.		394 lb.		319 lb.		327 lb.	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Milk per gallon	1·7442	0·3366	—	—	—	—	—	—	—	—	—	—
Gruel per gallon	0·8300	0·2150	34·8600	9·0300	6·6400	1·7200	—	—	—	—	—	—
Hay per lb.	0·3700	0·0460	18·1300	2·2540	36·9075	4·5885	73·1675	9·0965	42·7350	5·3130	21·2750	2·6450
Silage per lb.	0·1260	0·0165	17·2 20	2·2505	34·5240	4·5210	49·6440	6·5010	40·1940	5·2635	41·2020	5·3955
Average per day			2·0072	0·3870	2·7883	0·3868	3·5089	0·4456	2·9618	0·3777	2·6032	0·3350
GROUP D												
Milk			2¼ galls.		—		—		—		—	
Gruel			39¾ galls.		15 galls.		—		—		—	
Hay			62¼ lb.		89¼ lb.		210 lb.		115½ lb.		115 lb.	
Concentrates, Mixture I			56 lb.		74¼ lb.		—		—		—	
II			—		—		105 lb.		69 lb.		—	
III			—		—		—		15 lb.		63 lb.	
IV			—		—		—		—		6 lb.	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Milk per gallon	1·7442	0·3366	3·9244	0·7574	—	—	—	—	—	—	—	—
Gruel per gallon	0·8300	0·2150	32·9925	8·5463	12·4500	3·2250	—	—	—	—	—	—
Hay per lb.	0·3700	0·0460	23·0325	2·8635	33·0225	4·1055	77·7000	9·6600	42·7350	5·3130	42·5500	5·2900
Concentrates, Mixture I	0·6365	0·1649	35·6440	9·2344	47·2601	12·2438	—	—	—	—	—	—
II	0·5927	0·1566	—	—	—	—	62·2335	16·4430	40·8963	10·8054	—	—
III	0·6074	0·1572	—	—	—	—	—	—	9·1110	2·3580	38·2662	9·9036
IV	0·6052	0·1758	—	—	—	—	—	—	—	—	3·6312	1·0548
Average per day			2·7312	0·6115	3·3119	0·6991	3·9981	0·7458	3·3122	0·6599	3·5186	0·6770

2. *Liveweight*

The calves in the group that received silage were, because of their age advantage, slightly heavier to begin with, but after they were weaned their rate of gain very quickly declined. The concentrates group did not show this slowing-up and by the fourth month were, on average, heavier.

In late December, when the calves were two and a half to three months old, a lump appeared on the jaw of one of the concentrates calves, Clare. At first it was thought that perhaps this was just the result of her getting her head stuck between the bars of the pen at some time, but when it persisted a vet. was called in. He diagnosed this as a Calcium:Phosphorus imbalance, resulting from a deficiency of Vitamin D whilst the calves were receiving cow's milk. This appears very similar to the phosphate deficiency of Group B, on concentrates, the previous year. He said that all the calves of both groups showed this imbalance to some extent. They were accordingly all dosed with cod liver oil, for ten days at approximately 1½ oz. per day to each group, mixed with the silage or concentrates; the lump then quickly went down. During December and January the calf with the lump, Clare, grew less quickly than the others of her group, probably as a result of this imbalance, viz.:

Liveweight Gain

	Clare	*Others (range)*
November–December	22 lb.	28–31 lb.
December–January	22 lb.	30–35 lb.

However, by the end of January she could be considered as growing normally again.

The results of the monthly weighings are shown in Table IX, with the monthly gains for each calf and the averages for the groups. It will be seen that in each month the rate of gain of the silage group was 8–10 lb. less per calf than the concentrates group and that during March, towards the end of the silage all the calves on silage actually lost weight. The average loss of weight was 8 lb. per calf, which was, of course, very undesirable. Even when the calves were turned out to grass and an allowance of concentrates made available, two of these calves still continued to lose weight. One of them, Violet, which had previously been the heaviest, lost the considerable amount of 26 lb. Of the concentrates group, when turned out to grass, only one lost weight and that only 3 lb. On average they gained 6½ lb. per calf during their first month at grass, whereas the average weight of the silage group did not alter.

TABLE IX

Table of Liveweight Increases: Silage and Concentrates Groups

26th October, 1956, to 26th September, 1957

SILAGE GROUP

	Connie	Dolly	Violet	Winnie	Average	Monthly Gain				
						Connie	Dolly	Violet	Winnie	Average
Oct. 26	108	105	123	111	112					
Nov. 26	142	132	167	146	147	34	27	44	35	35
Dec. 20	168	147	189	164	167	26	15	22	18	20
Jan. 26	178	158	202	176	178	10	11	13	12	11
Feb. 25	196	170	220	188	193½	18	12	18	12	15
Mar. 26	179	168	219	177	186	—17	— 2	— 1	—11	— 8
Apr. 26	191	164	193	196	186	12	— 4	—26	19	0
Sept. 26	456	432	493	505	471½	265	268	300	309	285½

CONCENTRATES GROUP

	Betty	Clare	Pansy	Tulip	Average	Monthly Gain				
						Betty	Clare	Pansy	Tulip	Average
Oct. 26	114	100	98	104	104					
Nov. 26	161	133	129	156	145	47	33	31	52	41
Dec. 20	192	155	157	187	173	31	22	28	31	28
Jan. 26	222	177	192	219	202	30	22	35	32	30
Feb. 25	257	202	199	258	229	35	25	7	39	26½
Mar. 26	282	224	212	287	251	25	22	13	29	22
Apr. 26	279	237	222	292	257½	— 3	13	10	5	6½
Sept. 26	554	435	460	579	507	275	198	238	287	249½

At the end of February, before the silage group lost weight, the difference in the average weights of the two groups was 35½ lb., by the end of March this difference had become 65 lb. and after one month at grass it had increased still further to become 71½ lb. per calf. Also when the two groups were turned out to grass the difference in general condition between them was very marked. The concentrates group all looked well grown with good coats whereas the silage group were very scraggy with prominent hook bones and rough coats.

This big difference of 71½ lb. in the average weights of the two groups, means that the silage group was less than three-quarters of the liveweight of the concentrates group after one month at grass. On these results of liveweight, therefore, this method of rearing calves on silage could not be recommended.

After six months at grass the difference between the two groups had narrowed to become 35½ lb. per calf again, Group C having gained an average of 285½ lb. per calf and Group D an average of 256 lb. per calf. That is, after six months at grass Group C had just caught up the weight that they lost during March and during their first month at grass.

The average liveweight gains per day for both groups are again very much less than those normally recommended:

26.10.56–26.3.57. 151 days. *Group C* 0.490 lb. per day
Group D 0.973 lb. per day
26.10.56–26.9.57. 335 days. *Group C* 1·073 lb. per day
Group D 1·203 lb. per day

In fact, during the actual period of silage-feeding the growth made by Group C was only half that made by Group D—74 lb. compared with 147 lb. Where, therefore, the growth of calves during their first six months is of particular importance, e.g. for very early calving or, perhaps, for the sale of young heifers, the system of silage feeding is of little use.

That the calves failed to gain during their first month at grass is surprising, especially considering the fact that they were by then well used to dealing with grass products. Part of this apparent loss in weight, and of Group D's gains, may have resulted from difference in the weight of the rumen contents again. Just before the groups went out to grass they were eating (ignoring water drunk):

Group C—17·5 lb. per calf per day
Group D—8·0 lb. per calf per day.

Why there should be such a big loss in weight for the silage-fed calf, Violet, is again not very obvious. It had previously been the largest calf of the group and so had, perhaps, been eating more than its share of the food supplied. When turned out to grass the difference in the weight of rumen contents for this one calf would probably have been very much greater than for the other calves, thus giving the apparent loss. Alternatively, or perhaps as well, this calf might not have discovered the concentrates that were available. If this were so, though, it would follow that the gains of the other calves were dependent upon the concentrates that they were receiving and that, therefore, the silage they had received previously had not helped them to deal more efficiently with the fresh grass.

Looking at the range of liveweight gains for the two groups since the first weighings it would seem that the group averages that have been used for comparison have been influenced very much by individual calves.

Liveweight Gains

Silage group	*Best*		*Worst*		*Range*
Whilst indoors	Violet	96 lb.	Dolly	63 lb.	33 lb.
Whilst at grass	Winnie	328 lb.	Dolly	264 lb.	64 lb.
Over the eleven months	Winnie	394 lb.	Dolly	327 lb.	67 lb.

Concentrates group

Whilst indoors	Tulip	183 lb.	Pansy	114 lb.	69 lb.
Whilst at grass	Tulip	292 lb.	Clare	211 lb.	81 lb.
Over the eleven months	Tulip	575 lb.	Clare	335 lb.	240 lb.

For example, Dolly seemed to be a calf which is naturally smaller and slower-growing than most, while Tulip, on the other hand, seemed to be a big strong-growing calf.

Although whilst they were being hand-fed the silage calves grew at only about half the rate of the concentrates group, it seemed that they retained their ability for growth and when turned out were able to make greater gains. Over the six months at grass Group C gained an average of 29½ lb. per calf more than Group D and over the last five months at grass the gain for Group C was 36 lb. per calf more.

After six months at grass, namely, when the calves were about one year old, if the differences in liveweights are expressed as $\frac{Group\ C}{Group\ D} \times 100$, these differences between the groups become:

Averages of the groups	93 per cent
Heaviest animals of both groups . .	87 per cent
Lightest animals of both groups . .	99 per cent

It would seem, therefore, that the effect of a low level of feeding during the first six months of life is fairly easily overcome and does not result in any stunting of the animals. A more serious effect on growth seems to result from a deficiency of one item within the diet rather than from a general low plane diet. The calf, Clare, which showed the Vitamin D deficiency most markedly remained the lightest of her group although of course she might naturally be a light animal.

3. *Costs*

A comparison of the costs of rearing Groups C and D during the trial period is shown in Table X. The figures that have been used are:

MILK. The cost of £0·132 per gallon is the average cost of production of winter milk on 51 farms in the S.W. Province for the winter of 1956/57.

GRUEL. This cost £5·8 per cwt. supplied to the farm.

HAY. The cost of £0·4374 per cwt. is the average cost of production on 49 farms for the summer of 1956.

TABLE X

A Comparison of the Costs of Rearing Groups C and D—Out to Grass 26th March, 1957

27th October, 1956, to 6th April, 1957

GROUP C

Foods	Quantity Per Calf	Cost/Unit	Total Cost £	Total Cost £ s. d.
Wholemilk	—	—	—	—
Gruel	50 galls.	£5·800/cwt.	2·5983	2 11 10
Hay	519½ lb.	£0·4374/cwt.	2·0288	2 0 7
Silage	1451½ lb.	£0·1174/cwt.	1·5215	1 10 5
			6·1396	6 2 10
Cod Liver Oil	3¾ oz.	.	0·0775	1 6
Whilst at Grass:				
Concentrates, Mixture IV	2 lb.	0·2690s./lb.	0·0269	
Mixture V	22 lb.	0·2623s./lb.	0·2885	
Hay	45 lb.	£0·4374/cwt.	0·1757	
			£0·4911	9 10
				£6 14 2

Labour	Hours/Group hrs.	mins.	Cost/Hour £	Total Cost £
Gruel feeding	19	40	0·150	2·9500
Hay } feeding	17	25	0·150	2·6125
Silage }				
Whilst at grass	1	30	0·150	0·2250
				£5·7875
Per Calf				£1 8 11
Total Foods Plus Labour per Calf				£8 3 1

GROUP D

Foods	Quantity Per Calf	Cost/Unit	Total Cost £	Total Cost £ s. d.
Wholemilk	2 galls.	£0·132/gall	0·2640	5 3
Gruel	55 galls.	£5·800/cwt.	2·8482	2 17 0
Hay	592 lb.	£0·4374/cwt.	2·3120	2 6 3
Concentrates, Mixture I	130¼ lb.	0·3328s./lb.	2·1674	5 16 7
II	174 lb.	0·2858s./lb.	2·4864	
III	77½ lb.	0·2822s./lb.	1·0935	
IV	6 lb.	0·2690s./lb.	0·0807	
			11·2522	11 5 1
Cod Liver Oil	3¾ oz.		0·0775	1 6
Whilst at Grass:				
Concentrates, Mixture IV	2 lb.	0·2690s./lb.	0·0269	
Mixture V	22 lb.	0·2623s./lb.	0·2885	
Hay	45 lb.	£0·4374/cwt.	0·1757	
			£0·4911	9 10
				£11 16 5

Labour	Hours/Group hrs.	mins.	Cost/Hour £	Total Cost £
Milk } feeding	22	35	0·150	3·3875
Gruel }				
Hay } feeding	15	09	0·150	2·2725
Concentrates }				
Whilst at grass	1	30	0·150	0·2250
				£5·8850
Mixing Concentrates: 1 hour per month	5	0	0·150	0·7500
				£6·6350
Per Calf				£1 13 2
Total Food Plus Labour per Calf				£13 9 7

SILAGE. Similarly the cost of £0·1174 per cwt. is the cost of production of silage on twenty-four farms in 1956.

CONCENTRATES. These again have been charged at the price paid on the farm for the straight ingredients plus the cost of rolling where incurred.

LABOUR. Over the period of this second trial the agricultural rate for a man was 3*s*. per hour. Again, although the work was done by a boy, a full man's rate has been charged.

From Table X it can be seen that during the period of the trial the cost of food to the silage group was less than two-thirds that of the food to the concentrates group, i.e. £6 16*s*. 8*d*. per calf instead of £11 19*s*. 0*d*. A more surprising result, though, for this year, is that the labour for the concentrates group cost more than for the silage group. This must be regarded as very unusual although it is partly explained by the concentrates group being fed with gruel for a longer period during the trial. The differences in the daily and weekly times of feeding hay-and-silage or hay-and-concentrates were very small.

When the costs are considered with liveweight gains the conclusion to be drawn is that silage can provide a considerably cheaper food for rearing young stock, provided that not too much importance is attached to the rate of growth. Also it is presumably necessary that the calves are given an opportunity to make up for their previous low plane of nutrition by being turned out onto good grass before their 'growth potential' has become too restricted.

When the costs of the two groups are considered from birth until being turned out to grass, it will be seen that the saving in costs by feeding silage instead of concentrates amounts to £4 10*s*. 0*d*. per calf.

Group C.	Food	£9·9	*Group D.*	Food .	£14·3
	Labour	2·3		Labour .	2·4
	Misc. .	0·7		Misc. .	0·7
		£12·9			£17·4

This is indeed a very substantial saving. The most expensive period in the rearing of a dairy heifer is generally during its first few months of life, in which period foods usually amount to about 80 per cent of the total costs. They therefore offer the most likely field for any economies and if a saving can be effected during this period it will almost certainly reduce the total cost of rearing the heifer.

If the technique of making silage of good quality and in sufficient quantity could be practised more easily, it could therefore offer an opportunity of saving roughly 25 per cent of the costs during the most expensive part of a heifer's life.

A more detailed table of costs from birth until the time of going out to grass is found in Part IV (Table XI) where the costs for both groups of calves, silage-fed and "traditionally" fed for both years are compared with the "average" commercial costs.

This difference in cost between Groups C and D of £4 10*s*. 0*d*. per calf is remarkable. Even if it were one of £4 it would still be very much worth while trying to achieve. The 10*s*. 0*d*. not "saved" could be "spent" on an extra 4 cwt. of silage per calf, which would allow an extra 5 lb. per calf per day during the months of January, February and March. This extra silage would increase the allowance available from 15 lb. to 20 lb. per head per day and so should have a big effect on the live-weight gains of the calves during these months. If this were, in fact, possible, the result might be a saving of £4 on every calf reared with only a negligible difference in liveweight at the end of the first hand-feeding period when compared with calves reared more "traditionally".

Part IV. General Conclusions and Summary

Before drawing any conclusions from the results of these two trials, it may be interesting to compare the two separate years and see where they agreed and where they differed.

HEALTH

This is the least definite aspect to assess but it may not be without significance that in both years the calves that were receiving concentrates were the ones to show the first signs of dietary deficiencies (Group B, phosphate deficiency; Group D, vitamin D deficiency): this despite the generally higher level of nutrition of the concentrates group.

The apparently lower level of feeding in the silage groups might have been expected to lower their resistance to diseases and worm infestations, but there were no results to show that this had actually happened. Possibly the calves had not been exposed to any infections or perhaps, despite their very rough appearance at the end of the winter, the diet of the silage groups had been adequate to maintain normal resistance.

LIVEWEIGHT GAIN

Here both years showed very similar results in that the rate of gain of the concentrates-fed calves was very much greater than that of the silage-fed calves.

During the period of the trials and whilst the calves were at grass these gains averaged, in lb. per day:

TRIAL I

	Trial I	*at grass*
Group A (silage). . . .	0·621	1·157
Group B (concs.) . . .	0·975	1·254

TRIAL II

	Trial II	*at grass*
Group C (silage). . . .	0·490	1·544
Group D (concs.) . . .	0·973	1·391

The average daily liveweight gain of the concentrates groups during the trials was very similar for the two years, probably because the rations supplied to the groups had been very similar. On the other hand, the ration to the silage group was even lower in nutrient value in the second year than during the first year and consequently the rate of gain of these calves was even less in this second year. During the second year of the trial the gains from grass were, for both groups, greater than during the first year. This reflects the benefits of grazing young calves rotationally on good grass as compared with leaving them for longer periods on the same fields. In the second year, also, the greater gain from grass made by the silage-fed calves compared with the concentrates-fed calves shows the ability of calves to make up for previous low levels of feeding.

The nutrients available to an animal are related to and dependent upon the weight of dry matter contained in the food, which governs the amount that can be eaten. Comparing the two trial groups over similar periods, the average weights of dry matter ingested per day were:

11.1.56–10.2.56.	*Group A*.	8·6 lb. per day
	Group B.	7·9 lb. ,, ,,
13.1.57– 9.2.57	*Group C*.	9·2 lb. ,, ,,
	Group D.	7·5 lb. ,, ,,

In both years the silage-fed calves were eating a greater weight of dry matter per day than the concentrates calves but this did not seem to have had any restrictive effect upon the total amounts that could be eaten. As the ration was increased the calves showed no difficulty in eating the greater quantities.

The problem of the underfeeding of the silage calves therefore seems more one of the supply of silage and perhaps of efficiency of food use by the calves than one of physical limitations associated with bulk feeding.

In the past the development of a "barrel" capacity has often been stressed as necessary if animals are to be able to deal successfully with large amounts of roughages. The measurements of girth taken during the first winter did not give any support to the view that this barrel will develop as a result of the food fed. As the measurements were only continued up to an age of about five months, it may have been too early to tell, but the whole series of girth measurements seemed to fluctuate very considerably.

Before leaving the topic of liveweight gain it might be interesting to summarise the differences in average weights between the four groups at various stages of the trials.

	1955/56				1956/57			
	Group A		Group B		Group C		Group D	
	weight lb.	age days	weight lb.	age days	weight lb.	age days	weight lb.	age days
1st weighting .	110½	11	103	16	112	33	104	22
Out to grass .	190	151	221	156	186	184	251	173
After 6 months at grass .	404	336	453	341	471	368	507	357
Whilst at grass .	214	185	232	185	285	184	256	184

From this table, allowing for differences in the ages of the groups, it would seem that the concentrates system of feeding has had fairly consistent results. The results of the silage feeding appear very much more variable but this variability could result from the different rations that were fed in the two years. The system of hand-feeding seems to have had little effect upon the ability of the calves to grow when turned out to grass for a long period.

At almost one year old the differences in average weights between the concentrates and silage-fed groups were:

1955/56 . . . 50 lb. per calf
1956/57 . . . 36 lb. per calf.

On calves of approximately 4 cwt. liveweight with another fifteen months of growth before calving down, these differences are probably not very important.

COSTS

When the costs of rearing are compared for the two years of the trial, it is seen that in each year the silage-fed group cost less than the concentrates-fed group. In the first year the difference was only £1 0*s*. 0*d*. per calf but in the second year it was £5 6*s*. 0*d*. per calf. A better comparison, though, is of the costs from birth until going out to grass. These figures for the various groups are shown in Table XI where they are also compared with results obtained by Manchester University.* These Manchester results are for 418 heifers reared up to the time of first going out to grass. They may, therefore, be considered as representative costs of rearing dairy heifers on a commercial farm.

In building up these costs in all cases the initial values of the calves have not been considered and no charges have been made for the rental value of the buildings. The cost of straw litter has not been counted, as this would be credited as farmyard manure, and overheads are charged at the standard rate of 5*s*. per £1 of labour. If the 1952/53 costs obtained by Manchester University are brought to 1955/56 price levels, they might amount to £22·6 per calf, as shown in the last column of the table. The average age of the 418 Manchester calves when turned out to grass was 31 weeks, whereas the average ages of groups A and B were 22 weeks and 22½ weeks and of groups C and D were 26½ and 25 weeks respectively.

Hypothetical figures have been worked out for the cost of keeping the trial groups of calves indoors until the age of thirty-one weeks.

When the costs of the groups at thirty-one weeks old are compared, it seems that the Manchester "average" calves and those reared on what might be called "traditional" lines of milk, hay and concentrates, Groups B and D all have roughly similar costs of £20–£23 per calf. On the other hand. the two groups reared on silage have costs very much less than these—Group A £4 8*s*. 0*d*. and Group C £8 18*s*. 0*d*. per calf less than the average. This is a very remarkable saving, although it is not, of course, possible to say how much underweight these two groups might be at thirty-one weeks when compared with the average.

Although this method of comparing the hypothetical costs of the groups at thirty-one weeks serves to highlight the saving

* *Rearing Dairy Herd Replacements. Does it Pay?* J. E. Holt and T. W. Gardner. May 1956. Department of Agricultural Economics, University of Manchester.

TABLE XI

Cost of Rearing Calves from Birth Until First Turned Out to Grass

	Manchester† 1952/53		Group A 1955/56		Group B 1955/56		Group C 1956/57		Group D 1956/57		1952/53 Prices Brought to 1955/56 Level
	£	%	£	%	£	%	£	%	£	%	£
Milk	4·8	23·8	9·2	63·0	8·5	50·6	3·2	25·6	3·1	18·3	5·4
Purchased Foods*	9·0	44·5	—	—	4·7	28·0	3·1	24·8	8·8	52·1	10·8
Home-Grown Foods	3·4	16·8	3·7	25·3	1·9	11·3	3·6	28·8	2·3	13·6	3·4
Total Foods	17·2	85·1	12·9	88·4	15·1	89·9	9·9	79·2	14·2	84·0	19·6
Manurial Residues	0·6	2·9	0·6	4·1	0·4	2·4	0·4	3·2	0·4	2·3	0·9
Net Food Cost	16·6	82·2	12·3	84·3	14·7	87·5	9·5	76·0	13·8	81·7	18·7
Labour	2·8	13·9	1·8	12·3	1·5	8·9	2·3	18·4	2·4	14·2	3·1
Miscellaneous	0·8	3·9	0·5	3·4	0·6	3·6	0·7	5·6	0·7	4·1	0·8
Total Net Cost	20·2	100·0	14·6	100·0	16·8	100·0	12·5	100·0	16·9	100·0	22·6
Length of Period (weeks)	31		22		22·5		26·5		25		31
If fed to 31 weeks			18·2		23·4		13·7		20·3		

* Including milk substitute.

† *Rearing Dairy Herd Replacements. Does it Pay?* J. E. Holt and T. W. Gardner. May, 1956. Department of Agricultural Economics, University of Manchester.

that could, theoretically, be possible when feeding silage, in actual fact it is very unlikely that such a system could be continued for this length of time. For instance, in the 1956/57 trial, silage-feeding was started at the beginning of November and if it were to be fed until the calves were thirty-one weeks old, it would be continued until the end of April. Very few farms would have sufficient silage to last for almost six months. Where silage-making can give high yields per acre, however, and where the winters are relatively short, this system of silage-feeding might be practised quite successfully.

It has been shown that by changing over from "traditional" rearing to silage-feeding on the same farm a saving of more than £4 8*s*. 0*d*. per calf can be achieved, viz:

Group C cost £12 10*s*. 0*d*. reared to 26½ weeks old

Group D cost £16 18*s*. 0*d*. reared to 25 weeks old.

It is possible that this method of feeding silage to young calves could be adapted to fit into the general winter-feeding programme on many farms. If it could be introduced, even if only for part of the winter or supplemented by other foods, it would offer the possibility of quite substantial savings in cost per calf reared, so that the total cost of rearing replacements for the dairy herd could, therefore, also be quite substantially reduced.

The above results are for the rearing of young calves during their first year of life. Inasmuch as these calves are intended as dairy herd replacements, the results are only interim ones. They will need to be reconsidered later when rearing has been completed and the animals have calved down. It will then be seen whether any breeding difficulties or delays have resulted from this system of feeding. It would also be interesting, although very difficult, to determine whether there is any marked difference between the groups of animals in their milking ability when fed mainly on silage.

Summary

The main points that arose from these two trials are summarised below.

1. Calves can eat silage successfullly from the age of one month old and after the age of two months can live and grow on silage alone.
2. Silage can be fed in very much greater quantities than had previously been recommended, for instance, at three

months old the calves were eating 35 lb. per head per day. No restrictions in appetite became apparent as the result of the bulky nature of the food, although where silage is to be fed in quantity it seems advisable to restrict the amount of hay that is available.

3. Silage seems to provide a well-balanced diet for young calves: no symptoms of vitamin or mineral deficiencies or of scours or worms were apparent in the silage-fed calves.
4. The results, in terms of liveweight, obtained from the feeding of silage are likely to be rather variable due to the difficulty of assessing accurately the feeding quality of the silage. Results from the feeding of concentrates seem to be much more reliable. The greater liveweight gains that the concentrates-fed calves showed may have been due to a greater efficiency by these calves in the digestion of the nutrients supplied.
5. When turned out to grass the initial check is apparently more severe in the case of silage-fed calves. Even in the case of young cattle, 6–12 months old, good grass grazed rotationally, offers greater value than similar grass grazed by fixed stocking.
6. The differences in liveweight and condition between the concentrates-fed and silage-fed calves may be very marked after six months of winter feeding: if the calves are given good grass to graze, these differences are soon diminished.
7. This system of feeding silage to young calves requires a very good system of grassland management. Sufficient silage must be made to last the winter and it must be of reasonable quality: to continue growth during the summer the animals should be given good grazing.

By the substitution of silage for concentrates in the calf feeding programme of a farm, a saving of approximately £4 10*s*. 0*d*. per calf should be possible; where the costs of calf-rearing are about average, this saving might be as great as £8–£9 per calf over the first six months of life.

Appendix

Concentrates Mixtures 1955/56

	Mixture I	Mixture II	Mixture III	Mixture IV
Oats	5 cwt.	12 cwt.	2 cwt.	—
Barley . . .	¼	4	—	—
Ground nuts . .	1¼	12	—	—
Linseed cake . .	¾	1¼	1¼	1¼ cwt.
Locust beans . .	3	12	—	—
Maize Meal . .	—	3½	1½	—
Flaked Maize . .	—	—	—	3
Fish Meal . . .	¼	½	½	—
Minerals . . .	—	—	15 lbs.	10 lbs.
Cost per lb. . .	3·20*d.*	3·31*d.*	3·71*d.*	3·89*d.*

Concentrates Mixtures 1956/7.

	Mixture I	Mixture II	Mixture III	Mixture IV	Mixture V
Linseed cake . .	3 parts	9	9	—	—
Soya bean meal .	—	4	6	12	—
Ground nut . .	—	1	2	4	3
Locust beans . .	—	3	4	4	—
Barley . . .	—	3	3	3	} 6
Oats. . . .	3	2	2	2	
Wheat . . .	—	1	1	3	
Wheatings . .	—	1	—	—	—
Bran . . .	—	2	2	—	—
Rice bran . .	—	2	2	2	3
Maize meal . .	—	2	2	2	3
Flaked maize . .	3	1	4	4	4
Sugar beet pulp .	—	3	4	4	6
Fish meal . .	1	½	—	—	—
Cost per lb. . .	3·99*d.*	3·43*d.*	3·39*d.*	3·23*d.*	3·15*d.*

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