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Systems of Beef Production

by

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The returns from farms in cattle production in Ireland are not very impressive either in terms of economic return or number of cattle produced per farm. A stocking rate of three acres/beast is a long way from the potential of Irish grassland. This paper highlights some of the key factors which are limiting the returns on farms in beef production.

It is possible to make money from cattle production in Ireland without having either much technical input or without having high output of liveweight gains per acre. In Table 1 two systems are shown which were run on two 60 acre units.

Table 1

Returns from two systems of cattle production on two 60 acre units

	System	
	Weanling to Finished Beef	Stores Bought in Winter—Sold in April and June
No. of cattle	75	140
Time on farm (months)	16	4.5
Meal fed/animal (lb)	744	0
Liveweight gain/acre (lb)	905	360
Gross margin/acre	£55	£52
Net margin/acre	£32.60	£32.50

In the first system, weaners were bought in and finished as beef and in the second, stores were bought in winter and sold before the following June. Although liveweight gain in the latter was only 40 percent of that of the first system, gross margin per acre is practically similar and net margin per acre is exactly similar. In other years, there were higher returns from No. 2 system. Thus under Irish conditions technical efficiency and economic efficiency do not go hand in hand. It must, however, be admitted that No. 2 system carries a fair amount of risk which many farmers may not be prepared to take. But we must accept that if we want to produce beef all stages of that production cycle must be carried out on farms in Ireland and there must be an economic return at all stages of that production cycle.

Let us now consider production systems. It is necessary to clarify two points:

i) Most of the calves in this country are born in spring;

ii) From the calf stage to the final finish stage, an animal will change hands a number of times. It is unusual for the bought-in calf to be reared and fattened on the same farm. There is a tendency for the smaller producer to buy and rear calves for sale as stores and for the bigger producer to buy stores for fattening and sale as finished beef.

A typical spring born calf, from birth to slaughter, will probably have the following liveweight pattern at different ages as shown in Table 2 for systems A and B. From birth to eight months calves are generally well fed, but on some farms they may be affected by parasites and performance may be reduced so that at eight months there is a difference of say, 70 lb liveweight, between systems A and B. In system A weanlings initially weighed 350 lb, and 420 lb in B. System A cattle eventually finish at 32 months of age and system B cattle at 29 months of age.

Table 2

Liveweights of cattle at different ages on different systems of production (lb)

Date	Mar 1	Nov 1	Apr 15	Nov 1	Apr 15	Aug 1	Nov 1
Age (months)	0	8	13	20	25	29	32
Farm System A	80	350	400	750	700	950	1150
Farm System B	80	420	500	890	900	1200	
Grange System	80	420	570	940	1200		

On the other hand, if system B is compared with the Grange system, it is found that at eight months of age the weanling cattle are the same weight as those in system B but over the first winter the performance of the Grange cattle is 70 lb better. At the end of the grazing season, this difference is reduced to 50 lb, but over the second winter, system B cattle are fed to maintain liveweight, whereas the Grange system cattle are fed to gain liveweight and consequently reach slaughter weight at 25 months of age.

The costs of calf rearing are shown in Table 3. It will be seen that the average cost of rearing a calf from birth to eight months is £30.

Table 3

Calf rearing costs (£)

55 lb milk replacer	£9.00
$1\frac{1}{2}$ cwt calf nuts	6.00
2 cwt barley	6.00
Grass	3.00
Veterinary and medicines	3.00
Equipment and running costs	1.00
Feed and treatment costs lost through mortality	2.00
Total	30.00

The costs of grazed grass are shown in Table 4. This amounts to £24 per acre.

Table 4

Cost of grazed grass—£ per acre

Fertilizer	
3 cwt of N	9.00
2 cwt of 8% Super P	4.50
1 cwt of Potash	3.00
Rent and rates	4.50
Miscellaneous (water and fencing, etc.)	3.00
Total	24.00

Silage production costs are shown in Table 5. These amount to £4.50 per ton of silage or 1p per lb of silage dry matter.

Table 5

Cost of production of silage—£ per acre

Fertilizer	19.50
Harvesting	12.00
Additive and covering	3.50
TOTAL	35.00
Yield of edible silage (19% D.M.)	8 tons
Cost per ton of silage	£4.50
Yield of edible dry matter (lb)	3,500
Costs per lb dry matter	1p

The silage and barley required for the three systems of cattle production are shown in Table 6.

Table 6

Silage requirements (tons)

System	1st Winter	2nd Winter	Total	Acres (cut twice)
A	3.5	4.5	8.0	0.50
B	3.5	4.5	8.0	0.50
Grange	4.0	7.0	11.0	0.68
Grange system barley (cwt.)	2	6	8	

It will be noted that total silage used in systems A and B is similar (8 tons) whereas in the Grange system, the total silage amounts to 11 tons. The extra silage in the latter system is accounted by 0.5 tons in the first winter and 2.5 tons in the second winter. In order to obtain this extra silage 0.18 acres per beast or 36 percent more land must be cut twice in the Grange system as compared with systems A and B. It will also be noted that in systems A and B no barley is fed, whereas in the Grange system a total of eight cwt. is fed (2 cwt. the first winter and 6 cwt. the second winter) during winter. The land requirement during different stages of the animal's life is shown in Table 7.

Table 7

Total land requirements to produce one animal/year

System	Silage	Calf Stage	13-20 mths	24 mths to finish	Total acres
A	0.50	0.13	0.33 + silage aftermath	0.75	1.71
B	0.50	0.13	0.33	0.66	1.62
Grange	0.68	0.13	0.33		1.14

Except for silage, there is no difference between the three systems up to the 24 months old stage when the Grange cattle are sold out fat. Systems A and B cattle must go to grass for another season in order to finish as beef (A by November and B by August). This means that the total land requirement per finished beast is 1.71 acres for system A, 1.62 acres for system B and 1.14 for the Grange system. If these land requirements are divided into 100 acres, we get the total number of cattle which could be produced from such a size farm (Table 8).

Table 8

Number of cattle produced from 100 acre farm

System	Acres/beast	Cattle/100 acres
A	1.71	58
B	1.62	62
Grange	1.14	88

It will be seen that system A would produce 58 cattle, system B—62 cattle, the Grange system—88 cattle. Thus, for feeding an extra 3 tons of silage and feeding a total of 8 cwt. of barley, the throughput of cattle would increase from 58 or 62 to 88 head on a 100 acre farm.

The feed costs for each period are set out in Table 9.

Table 9

Feed costs for each period in production cycle (£)

System	Mar 1		Nov 1		Apr 15		Nov 1		Apr 15		Aug 1		Nov 1
A		30		16		8		20			18		
B		30		16		8		20			16		
Grange		30		22		8		50					

It will be noted that the main difference in costs up to 24 months between the Grange system and the other two systems occurs during the winter period. This amounts to £6 the first winter and £30 the second winter but this extra expenditure (£36) resulted in a land saving per finished beast of 0.57 acres when compared with system A, and 0.48 acres when compared with system B. The total feed costs per finished beast would be £92 for A and £90 for B and £110 for the Grange system (Table 10).

Table 10

Cumulative feed costs for successive periods (£)

System	Mar 1		Nov 1		Apr 15		Nov 1		Apr 15		Aug 1		Nov 1
A		30		46		54		74					92
B		30		46		54		74			90		
Grange		30		52		60		110					

The income and expenditure for the three systems if operated on 100 acre farms are shown in Table 11.

Table 11

Income and expenditure per 100 acres (£)

	A	B	Grange
Feed cost	4,968	5,580	9,680
Gross income : Assume			
(a) Carcase @ 40p			22,880
(b) Carcase @ 36p	12,946	14,508	
Assume calf cost @			
£25/head (incl. mortality)	1,450	1,550	2,200
Gross output	11,496	12,958	20,680
Margin	6,016	7,378	11,000
Labour	3,C00	3,000	3,000
Return on investment in stock, feed, buildings and machinery	3,015	4,378	8,000

Since systems A and B cattle are sold late in the season, they are valued 4p per lb less than the Grange system cattle. The gross output from the three systems amounts to £11,496 for A, £12,958 for B and £20,680 for the Grange system. After allowing for feed costs and labour (£3,000), this leaves a corresponding return on investment of £3,015, £4,378 and £8,000 for systems A, B and Grange respectively. This is a difference of £3,600 between system B and the Grange system. This difference in favour of the Grange system is due to two factors, namely, a greater margin per beast but much more important, it is due to a greater throughput of cattle per 100 acres—88 v 62 or 58. The stocking rate factor is the most important one, and it cannot be overstressed. In the systems described, the higher stocking rate was carried by reducing the slaughtering age from 32 months to 25 months and the latter was achieved by providing an extra three tons of silage per finished beast per year and supplementing with eight cwt of barley.

The key factor therefore in cattle production at farm level is winter feed supply (silage and concentrates). It cannot be denied that if this part of the system of production (calf to finish) is adequately taken care of, then the returns will be much greater than from those systems where a haphazard approach is adopted to winter feed supply.

Winter Beef Production — Recorded Results on Commercial Farms

by

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The levels of performance of silage fed cattle on commercial farms in Ireland has been described[1]. It was shown that the average daily gain (ADG) at 0.6 lb per head was substantially below what was expected from the quality of the silages fed. Analyses of the data failed to explain adequately the reason for poor animal performance. A major variable, namely silage intake, which could have a significant effect on performance, was not measured. Accordingly, a study was undertaken to measure silage intake during the winter of 1974-75. This paper presents a brief account of the study.

Silage intake was estimated as follows: all animals were individually weighed on two occasions, i.e. about two weeks after the start of winter feeding and towards the end of winter feeding. Only groups which were expected to have in excess of 70 days between the two weighings were selected for the study. The volume of silage displaced between first and second weighings was measured. The volume of silage waste was also measured. It was then possible to establish the nett volume of silage consumed (a). The silage was sampled with a corer of known internal volume and the silage in the corer was weighed at time of sampling. This allowed the weight of silage per unit of volume to be calculated (b). The dry matter percentage of the silage was obtained from the chemical analyses (c). The total number of feed days was calculated by multiplying the number of cattle in the group (d). The weight used in calculating the percentage of dry matter intake was the average of the animals mid-way between first and second weighings. This was derived by adding half the total gain between these two weighings to the average weight of the animals at first weighing (e). The formula used for calculating the dry matter per 100 lb of body weight was therefore as follows:

$$\frac{a.b.c.}{d.e.} \times 100$$

Table I gives details of the study. Table 2 gives the average chemical analysis of the silages. The recorded and expected intakes are given in Table 3.

It is clear that intake is substantially below that expected from a truly *ad libitum* system. Against this background of only 75% to 80% of the

Table 1

Average performance of animals on recorded farms

	Group type	
	No meal	+ meal
No. of animals/group	6	12
Average meal feeding level lb/hd/day	0	4.4
Mean no. of animals/group	67	58
Mean initial liveweight lb	980	1070
Mean no. of days on trial	96	81
Average daily gain lb	0.60	1.16

Table 2

Silage quality, average results

	Group type	
Silage analysis	No meal	+ meal
pH	4.2	4.2
Dry matter %	18.9	20.1
Dry matter digestibility %	66.1	66.7

Table 3

Average silage intake, lb D.M./100 lb body wt.

	Group type	
	No meal	+ meal
Recorded (A)	1.46	1.22
Expected (B)	1.80*	1.62**
A/B	81%	75%

* expected intake assumes ad libitum feeding
** 10% reduction in intake is assumed because of meal feeding

voluntary intake of silage being achieved on farms, it is clearly not possible to exploit fully the feeding value of silage.

Table 4 shows that for both levels of feeding there is close agreement between the recorded gains and that expected from the metabolizable energy intake of the rations.

Table 4

Recorded and expected performance of animals on farms

	Group type	
	No meal	+ meal
Average daily gain lb—Recorded	0.60	1.16
—Expected	0.60	1.20

It appears that low intake was the major cause of the poor animal performance recorded in this study. It may be reasonable to assume that low silage intake was the major cause of the poor performance recorded in previous years.

It should be borne in mind that since the results relate to only 18 groups of animals they must be regarded as tentative. Further work along similar lines is planned for the coming winter.

(1) Barlow, M. and Moore, E. (1975). Ir. Grassl. Anim. Prod. J. **10,** 91-96.

Future Prospects for Single Suckling under Lowland Conditions

by

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High calf prices are attractive to the dairy farmer in the short-term but in the long-term are problematical for Irish farming, resulting in cycles similar to the early seventies (excessively high calf prices in 1972 and 1973 followed by low prices in 1974 and 1975). The development of an organised beef industry with efficient grassland systems, namely, taking calves from birth to slaughter, would be very difficult in such circumstances. This would perpetuate emphasis on buying and selling at the right time rather than emphasis on efficient production.

An important question for beef farmers is whether or not single suckling can provide reasonable economic returns. Before discussing this question, I will summarise briefly the results from spring calving herds at Grange.

Cows calve in February/March as it is important to have the cow dry for most of the winter to keep feed costs low, and adequate high quality pasture in spring ensures high fertility. In relation to the cow, stocking rate during the grazing season and winter feed requirements are the most important considerations. In addition to these two topics, other factors influencing calf performance will also be discussed.

Stocking rates

The overall objective is to obtain high animal performance during the grazing season and restrict animals if necessary when the cost of providing feed is greater. However, stocking rate is a major factor influencing returns per acre. Therefore, it is necessary to obtain high production per acre (which means using high stocking rates) in addition to high performance per animal during the grazing season.

With a total input of about 160 units of fertilizer nitrogen per acre, Grange results have shown that one cow (calving in February/March) and her calf to 14-15 months of age on 1.2 acres of pasture can be carried. The approach has been to stock heavily when grass growth is highest (May/June) and close as much silage area as possible for winter feed. Rotational grazing is practised, commencing about mid April when the calves are on average about six weeks old. The effect of stocking rate during the period from April to August on calf performance is shown in Table 1.

Table 1

Average calf liveweight gains (lb/day) before August

	Stocking rate (ac. per cow and calf)		
	Low (1.0)	Medium ($\frac{2}{3}$)	High ($\frac{1}{2}$)
1966 (June 2 to August 4)	2.1	2.1	2.1
1967 (April 3 to August 2)	2.4	2.3	1.9
1968 (April 11 to August 1)	2.2	2.3	2.2

Grazing commenced late in 1966 but the pasture was controlled from the start by a combination of grazing and cutting. Increasing the stocking rate to 0.5 acre (high) resulted in a decrease in daily gain of the calves in 1967 only and this can be explained by the fact that grazing commenced early in that year (April 3). The grazing schedule for four years is shown in Table 2 and satisfactory calf performance was obtained in all instances. During the period from April to August, approximately 0.55 acres per cow and calf were required for grazing. The remainder was cut twice for silage, about May 20 and again in late July. From a total of 1.2 acres per cow and calf, an average of 0.65 acres can be cut twice for silage providing a total of 9¾ tons of silage for the cow and weaned calf in winter.

Table 2

Stocking rates used for the suckler herd

		Stocking rate (ac. per cow and calf)			
	Initial grazing	To end of May	May to August	August to Nov	Date grazing ended
1969	April 17	0.53	0.62	1.0	Nov 13
1970	,, 20	0.40	0.62	1.0	Nov 9
1971	,, 21	0.42	0.48	1.2	Nov 19 to Dec 3
1972	,, 20	0.42	0.70	1.2	Nov 16

When trying to achieve these high stocking rates, grass supply can sometimes be scarce and can be overcome by grazing a small proportion of the silage area and by allowing the second cut (cow silage) to grow for a longer period to achieve higher yields. Application of nitrogenous fertilizer to the grazed area can also increase feed supply in a period of scarcity.

From August to the end of the grazing season, the stocking rate must be reduced in order to maintain a high level of calf performance. The effect of stocking rate during the latter part of the grazing season on calf performance is shown in Table 3.

Table 3

Calf liveweight gains (lb per day) from early August to end of season

	Stocking rate (ac. per cow plus calf)		
	Low (1.0)	Medium (⅔)	High (½)
1966 (August 4 to Oct. 18)	2.0	1.6	1.4
1967 (August 2 to Oct. 4)	2.1	1.6	1.0
1968 (August 1 to Sept. 24)	2.1	1.6	1.2

The grazing season ended early each season because of the poor performance of animals at the high stocking rate. Each increase in stocking rate resulted in a decline in calf gain during all three years. In this period, only those calves at the low stocking rate (1 acre per cow and calf) continued to have satisfactory liveweight gains Thus, to ensure good calf performance during the latter period of the grazing season the stocking rate must be reduced substantially. In practice, the entire area (1.2 acres) would be grazed during this period.

The performance of calves from birth to weaning is shown in Table 4. Average weight at weaning was almost 600 lb. The only extra feed was rolled barley (about ½ to ¾ cwt per head) introduced gradually during the last 4-6 weeks of the grazing season.

Table 4

Performance of spring born calves to weaning

	1970	1971	1972
Date of birth	Feb 26	Feb 20	Feb 29
Wt (lb) going to pasture	142	149	143
Weaning wt (lb)			
Bulls	600	662	—
Bullocks	590	—	594
Heifers	—	582	543
Weaning date	Nov 9	Nov 19	Nov. 7

Winter feeding of the cows

In the system outlined, mature suckler cows are generally in good body condition at the start of winter. As the provision of winter feed is more costly than grazing and as the feed requirements of dry cows are low relative to that of lactating animals, studies were carried out to determine the extent to which feed could be restricted during late pregnancy. One group of mature cows were individually fed 60 lb silage per head daily during the last 80-100 days of pregnancy. A second group were fed silage to appetite during the same period. All received silage to appetite from calving until grazing commenced and they were grazed together.

Medium quality silage (DM digestibility=67%. DM=19%) was fed in 1970/71 but the silage used in 1971/72 was poor (DMD=61%. DM=17%). The results show (Table 5) that although restricted cows lost substantially more weight than their counterparts during late pregnancy, they gained faster subsequently resulting in only slight weight differences after 180 days of lactation.

Table 5

Effect of restricted feeding during late pregnancy on weight changes of cows (1110 lb)

	1970/71			1971/72		
	Plane of Nutrition			Plane of Nutrition		
	High	Moderate	Diff	High	Moderate	Diff
Experimental period (days)	103	98		79	77	
Wt change (lb) To post-calving	4	—126	130	—106	—184	78
To 180 days post-calving	66	48	18	— 4	— 27	23

Although the period of restricted feeding was shorter in 1971/72, the liveweight losses were much greater than in the previous year, due to the difference in quality and dry matter of the silage fed. There was no effect of plane of nutrition on calf birth-weights or subsequent calf performance (Table 6). This does not mean that calf birth-weights cannot be influenced by the pre-calving plane of nutrition. It shows however that there is a wide range within which nutrition of the cow only slightly influences the weight of the calf. Greater weight losses in similar type

Table 6

Level of feeding during late pregnancy on birth-weights and performance of calves

	1970/71		1971/72	
	Plane of Nutrition		Plane or Nutrition	
	High	Moderate	Moderate	Low
Birth-weights (lb)	78	75	82	82
Gain (lb) — birth to 180 days	339	359	364	361

cows or the same losses with cows in poorer condition initially have been shown to cause large reductions in calf birth-weights.

Reductions in pre-calving nutrition are likely to reduce calving difficulties and, particularly with heifers, animals fed on high levels of nutrition prior to calving have greater calving problems. With the greater usage of the larger breeds, calving difficulties will be higher and thus, it will be more important to avoid having the animals fat at calving. As a general rule, maintenance of liveweight during the last three months of pregnancy is quite adequate for mature cows. As a result of the weight losses at calving, the cow will be about 120 lb lighter after calving than three months earlier which is far less severe than the lower feeding levels in the above studies.

In these experiments, cows were let to pasture 6-7 weeks after calving and level of feeding during pregnancy had no ill-effects on subsequent fertility despite a total winter weight loss of as high as 250 lb (1971/72 low). However, the period from calving to fertile heat for both groups was delayed somewhat (83 days) in the latter study but was adequate to maintain a calving interval of about one year. The delay was due to the poor quality of the silage available after calving and because this silage was fed for 50 days before grazing started. The results demonstrate the ability of the cows to recover satisfactorily when subsequently provided with adequate high quality pasture The animals most sensitive to restricted feeding particularly from the point of view of fertility are first calvers and these should not be restricted in the manner outlined for mature cows.

Breeds

There is a high positive correlation between growth rate of the calf and milk production of the dam and therefore, a cow with relatively high milk production capacity is required. I consider the progeny of Hereford or Angus bulls with Friesian cows to be the most suitable suckler cows.

Where a crossbred cow is used, the bull should preferably be from a third breed. The two most important factors in relation to the bull are high growth potential in the calves and a low incidence of calving problems. In addition to breed difference for these factors, there is tremendous variation within any one breed. Thus, in selecting the bull, the most important point is to choose one known to have a low incidence of calving problems. In addition to breed differences for these factors, there is tremendous variation within any one breed. Thus, in selecting the bull, a most important point is to choose one known to have a low incidence of calving difficulties. Considering the potential for faster calf growth by using breeds such as the Charolais and the better market in Europe for the leaner carcasses produced from these breeds, I consider that it is essential in suckling to use the continental type bull breeds. Relative to Hereford bulls, an increase in final liveweight of up to 8 percent or 90 lb can be expected by using the better, late maturing bull breeds. Where a bull is not available, these breeds can be availed of by using A.I. Results at Grange during the last few seasons with spring calving cows at pasture have been good but we have not been as successful when breeding in winter. A vasectomized bull with a chin-ball mating device was used to detect heat and cows were inseminated on the basis of paint marks. For those without previous experience, it would be advisable to use A.I. for only the first six weeks of the breeding season and then to turn out a bull. A.I. can also be availed of by using heat synchronization treatments. Due to calving difficulties, it is not advisable to use a fast growing Continental type bull on heifers.

Creep feeding calves at pasture

The results suggest that a response to creep feeding or meal supplementation can only be expected under conditions of pasture scarcity. Because of cost the only circumstances under which meal feeding should be practised is where the objective is to finish the animals in winter. For this, it is necessary to feed up to one cwt of barley during the last 4-6 weeks of the grazing season in order to achieve high meal intakes early in the winter feeding period.

Finishing the calves

In the system outlined, adequate silage is available to feed both the cow and the calf in winter. Because of market fluctuations, the producer of weaned calves for sale in autumn is in a very vulnerable position and under lowland conditions the calves should be fattened on the farm. This may not be possible under hill or marginal land conditions where the provision of winter feed causes problems. At Grange, fattening of weaned calvees during the first winter has been examined. Taking the first cut for silage about May 20 ensures high quality material for the calves provided preservation is good. The performance of spring born sucklers fed high quality silage and approximately 6 lb meals daily is shown in Table 7.

Table 7

Finishing spring born suckled calves at 14-15 months of age

	1970		1971	
	Bulls	Bullocks	Bulls	Heifers
Slaughter wt (lb)	917	900	993	852
Hot carcass wt (lb)	536	514	561	475
Age at slaughter (days)	413	415	437	438
Total meals (lb/head)	935	935	984	984

Although performance was good, final carcase weights at approximately 14 months of age are low. The possibility of increasing carcase weight by grazing for a couple of months in spring before slaughter was studied for three years and the average results are shown in Table 8.

Table 8

Effect of plane of nutrition in winter (149 days) on pasture performance (average for 3 years)

	Plane of nutrition in winter	
	High	Low
Daily livewt gain—winter (lb)	1.8	0.8
Daily livewt gain—pasture[1] (lb)	0.9	1.8
Daily carcass gain—winter (lb)	1.1	0.5
Daily carcass gain—pasture[1] (lb)	0.7	1.2

[1] = average duration of the grazing period was 91 days

The performance at pasture of animals fed on a high plane of nutrition from birth to 14 months was poor. Therefore, the alternatives are either to provide a high plane of nutrition in winter and slaughter at the end of winter or to feed silage and only a small quantity of meals in winter and finish at a later date.

Problems

(*a*) *Scour in calves*

This is undoubtedly the greatest problem with herds calving indoors. The only satisfactory solution found at Grange is to calve each cow in a thoroughly clean calving box The cow and calf remain in the box for 3-4 days after which the cows are fed in a wood and the calves have access to pasture. The following management factors help to reduce the incidence of scours:

1. Ensure the calf suckles within the first six hours of life.
2. Avoid mixing calves of different ages.
3. Avoid mixing cows from different herds at calving.
4. Isolate all purchased calves and do not mix with the remainder of the herd until at pasture.
5. The incidence of scours is far less when calving occurs at pasture and if possible, aim to keep the calf outdoors for about the first three weeks of life.

(*b*) *Hypomagnesaemia in cows*

Grass tetany problems in our spring calving herd arise mainly during the first 4-6 weeks at pasture in spring. Dusting the pasture at this period with about 28 lb calcined magnesite per acre before grazing each paddock deals effectively with the problem.

Economic assessment of suckling systems

To evaluate suckling economically, four spring calving systems are taken in which the calves are disposed of at different ages as follows : (1) in autumn at 8-9 months; (2) in spring as stores at 14 months; (3)

as fat animals in spring at 14-15 months; (4) heifers fat at 19 months of age and bullocks at 25 months. To form a basis of comparison, a fifth system which involves taking a spring born Friesian bull calf from the dairy herd from birth to slaughter is included.

A summary of the five systems is shown in Table 9 which includes weight at sale and selling price. As the selling prices represent relative cattle prices taken over a number of years, the relative returns from the systems do not necessarily apply to any particular year but represent the average expected over a number of years assuming similar fluctuations take place in the future as occurred in the past. In these

Table 9

Production details for five systems

	System 1	System 2	System 3	System 4	System 5
System	Suckling	Suckling	Suckling	Suckling	Calves from dairy herd
Date of birth	February	February	February	February	March
Av. age at sale (months)	8-9	14	14	22	25
Mart weight or **cold carcass wt**					
Males	5¼ cwt	6¾ cwt	540 lb	728 lb	619 lb
Females	4½ cwt	6 cwt	460 lb	507 lb	
Price[1]					
Males	£24/cwt	£29/cwt	44p/lb	44p/lb	44p/lb
Females	£21/cwt	£26.50/cwt	42p/lb	36p/lb	
Total meals per animal (cwt)	0	2.0	10.0	5¼	13½
Acres per animal sold	1.0	1.25	1.25	1.80	1.05
Animals sold per 50 acres	50	40	40	28	48

[1] = Selling price was decided on the basis of data compiled by Mr. B. Hickey, Rural Economy Section, which shows the relative selling prices for animals of different weights and sex throughout the year. The only exception was System 3 where light animals are sold fat and therefore, fat cattle prices are used rather than the price of animals of this weight in April which is higher.

calculations, the growth of bullocks from the suckling systems are assumed to be the same as the Friesians in System 5 when feeding levels were similar, as are selling prices. It is also assumed that the animals can reach these target weights without becoming excessively fat and any other advantages (extra growth and higher selling prices) from using continental type bulls are discussed later.

The costs and returns per acre from the five systems are shown in Table 10. Calves from the dairy herd (Friesian bulls) are charged at £55 per head, based on the average price of all calves over the last eight years being about twice the value per cwt of a fat animal in spring. The gross margin per acre is only £53 where weanlings are sold in autumn, £77 where stores are sold as yearlings and over £80 for systems where the animals are taken to slaughter. When overhead costs are deducted, the figures obtained (net margins) follow a similar trend. Net margins represent the actual return per acre which the farmer obtains, assuming no capital is borrowed. Assuming that all capital has to be borrowed for livestock, buildings, etc., and that interest is charged at 12%, then the figures for net margin less interest on working capital apply. Because of the large differences in the number of stock carried and the duration they are on the farm, this figure provides the most valid comparison of the five systems. In practice, a varying proportion of the buildings and livestock would be already available but some borrowing would be necessary, the amount being greater for some systems than others.

Table 10

Costs and returns per acre (£) from the different systems

	System 1	2	3	4	5
Total receipts	116	148	178	147	261
Total variable costs	63	71	92	64	165
Gross Margin (Receipts less variable costs)	53	77	86	83	96
Total overhead costs	20	21	21	20	22
Net Margin (Gross margin less overhead costs)	33	56	65	63	74
Interest charges on capital at 12%	23	33	33	34	39
Net Margin less interest charges	10	23	32	29	35

Miscellaneous costs include transport and marketing, calcined magnesite, slurry spreading etc. Labour is not included in costs.

Interest on working capital amounts to about £33 per acre (varies with the system). A large proportion is interest charges on the cows (about £18 per acre) which are valued at £150. This figure is large as it is assumed that the interest is charged from the time the cow is purchased before calving until the calves are sold. Therefore, this figure is far too high for most situations and the actual relevant figure will depend on the circumstances.

Another major cost factor is repayments plus depreciation of buildings which together amount to about £14 per acre. On many farms, at least a proportion of these buildings are available thereby reducing this cost factor. The major building charge is for the cows. Some farms may have rocky outcrops, woods or scrub land for outdoor wintering of cows, and the build-up of disease which occurs indoors is avoided with a resultant decline of calf scours.

The stocking rates used for all systems were high, but adequate to ensure sufficient feed if properly managed. Grass grazed *in situ* is a cheap feed and in beef production it is essential not to stock so heavily that the performance of animals is restricted to less than 95% of potential growth during the grazing season.

Other factors affecting returns

Calf mortality is taken at 6% in the systems outlined and if this is increased to 12% returns would be reduced by about £3 per acre. This varies somewhat between systems and assumes that the calf dies in early life and can be replaced.

Relative to Hereford bulls, carcase weight increase of 8% or 50 lb can be expected by using the better late maturing breeds. At 44p per lb carcase this increases sale value per animal by £22.

Increasing carcase price by 2p per lb increases returns by £12 per animal (600 lb carcase). If a higher price were paid for the leaner carcases, this would be a tremendous incentive for producers to breed these animals.

Bulls can be expected to gain about 10% faster than bullocks, are more efficient converters of feed and produce leaner carcases. Therefore, the general advantages discussed in relation to the faster growing breeds (carcase weight and carcase value) also apply to bulls with the exception that, in a suckler herd, half the progeny will be heifers.

In System 5, calves were charged at twice the price per cwt of beef in spring or £55 per head. If calves were purchased at £42 or 1½ times the price per cwt beef, then net margin per acre less interest on working capital would increase from £35 to £51 per acre. This demonstrates the tremendous effect of calf prices on returns from this system.

In conclusion, in the absence of reasonable alternatives single suckling can give satisfactory returns. However, use of Continental type bull breeds on mature cows and taking the progeny to slaughter are strongly advised. It is essential that cattle numbers be maintained or increased (otherwise calf prices will become excessive) and it may be necessary to increase the payments per cow in the Beef Incentive Scheme to keep pace with inflation.

The Economic Implications of Breed Differences in Commercial Beef Production Systems

by

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The overall objective of efficient commercial beef production is to produce carcases of the weight, shape and saleable beef yield demanded by the market, by the most profitable production systems. To the extent that there is a range of profitable systems, flexibility in the operation of a single system and continuous development of systems of production, there is scope for selecting breeds and crosses which best meet the overall objective. The complication in the designation of the 'best' breeds is equating the various, often antagonistic, requirements of different sectors of the industry. For the calf producer ease of calving and calf mortality have considerable importance. In countries such as Britain where considerable reliance is placed on beef from the dairy herd these considerations are particularly highlighted and often represent a clear conflict between the calf supplier and the beef producer. The rearer and finisher are concerned with growth, slaughter weight, and in beef systems using expensive diets, feed efficiency. In Britain there is a close relationship between the beef and dairy sectors, as well as providing calves for beef production the dairy herd is also a major source of supply of replacement beef cross cows for the beef herd. Here there is a potential conflict between the requirement for high growth rate progeny and replacement cow size. The meat trade seeks carcases with a high yield of saleable beef, much of it distributed in the high price cuts. These examples give an indication of the conflicting difficulties involved in creating a production and marketing chain which recognises these separate requirements.

There is a wide range of sire breeds available to the individual beef producer in Britain. Breeds of sire differ in lateness of maturity (i.e. the weight at which they achieve a given level of fatness or finish) and mature size. In commercial practice the former is of high economic importance along with an indirect character associated with mature size —growth rate. Mature size is only of consequence per se in relation to cow size in the beef herd. Both lateness of maturity and growth rate affect the third economically important character — feed conversion efficiency.

In combination with this range of breed types there is a spectrum of economically viable beef production systems with markedly different slaughter weights and ages. At one extreme cattle fed all-concentrate diets are slaughtered at less than a year of age to produce lightweight carcases. At the other extreme cattle are fed low levels of concentrates and are grass finished at over 2 years of age producing heavyweight carcases. To optimise resource use it is important to select the breed or cross for the beef system in which its characteristics are best utilised i.e. 'horses for courses'.

Performance results—growth rate and slaughter weights

Most of the available information on the comparative growth and slaughter weights of breeds and crosses has been derived from commercial beef units recorded by the Meat & Livestock Commission. Daily gains and slaughter weights given as percentage deviations from contemporary Friesian steers are shown in Table 1 for two systems of production—cereal beef and 18-month beef. The large late maturing breeds led by the Charolais and closely followed by the Simmental and South Devon produced the highest gains and slaughter weights. The performance of the Hereford x Friesian is an exception to the general rule in that its growth rate is higher than would be predicted from a consideration of the performance of its pure-bred parents. Despite a higher average growth rate compared to the Friesian it has a lower commercial slaughter weight i.e., it is earlier maturing. Breeds of sire rank the same on both the cereal beef and 18 month beef systems.

Table 1

Comparative growth rates and slaughter weights of breeds and crosses in cereal beef and 18-month beef units

	Cereal beef		18-month beef	
Breed or cross (steers)	Daily gain*	Slaughter weight	Daily gain*	Slaughter weight
	% above (+) or below (−) contemporary Friesian steers			
Charolais x Friesian	+ 8.4	+ 9.1	+10.4	+ 7.2
Simmental x Friesian	+ 7.7	+ 1.8	+10.3	+ 5.4
South Devon x Friesian	+ 7.2	+ 7.8	+ 8.9	+ 4.4
South Devon	+ 6.7	+ 6.1	+ 7.7	+ 2.6
Devon x Friesian	+ 6.7	+ 5.5	+ 6.7	+ 2.4
Lincoln Red x Friesian	+ 6.4	+ 4.8	+ 7.2	+ 2.8
Sussex x Friesian	+ 3.6	− 2.1	+ 3.4	− 0.9
Hereford x Friesian	+ 3.3	− 5.1	+ 3.1	−10.4
Limousin x Friesian	+ 1.9	+ 1.1	+ 2.8	+ 2.9
Friesian (Mean 2.6 lb)	0 (862 lb)	0 (1.8 lb)	0 (1091 lb)	0
Charolais x Ayrshire	− 9.1	− 6.8	− 8.9	− 5.4
Aberdeen-Angus x Friesian	−12.1	−14.2	−11.4	−15.7
Ayrshire	−16.3	− 8.9	−18.9	−13.9

* from three months of age to slaughter

Table 2 shows similar information on the weaning weight of suckled calves in beef herds. The ranking of sire breeds is the same as in Table 1 and although the absolute weights decline from the lowland to the hill environment, reflecting nutritional differences, the ranking within each environment is consistent.

Table 2

Effect of sire breed on calf 200-day weights

	Lowland	Upland	Hill	Weight above (+) or below (−) Hereford x calves in same herd (lb)
	Weight at 200 days (lb)			
Charolais	530	501	452	+ 34
Simmental	512	490	436	+ 28
South Devon	510	487	440	+ 26
Devon	497	474	421	+ 20
Lincoln Red	490	472	416	+ 18
Limousin	474	449	411	+ 17
Sussex	474	456	411	+ 12
Hereford	459	428	406	0
Aberdeen-Angus	428	402	388	− 31
Overall	487	464	421	

Table 3 shows the performance of weaned suckled calves in the finishing period. Higher weaning weights are reflected in high finishing gains and higher slaughter weights. Again the consistency of ranking of sire breeds in performance is striking.

Table 3

Breed comparisons in winter finishing of suckled calves

Sire breed	Average daily liveweight gain (lb)	Gains above (+) or below (−) Hereford x calves*	Average slaughter weights (lb)	Weights above (+) or below (−) Hereford x calves*
Charolais	1.9	+ 0.3	1001	+ 73
Simmental	1.8	+ 0.2	994	+ 67
South Devon	1.8	+ 0.2	990	+ 66
Devon	1.7	+ 0.1	985	+ 40
Lincoln Red	1.7	+ 0.1	974	+ 33
Limousin	1.6	0	987	+ 38
Sussex	1.6	+ 0.1	955	+ 35
Hereford	1.5	0	925	0
Aberdeen-Angus	1.4	− 0.2	877	− 40

* Contemporary comparison with Hereford crosses

The sire breed rankings of crossbred calf performance closely follow a ranking based on purebred weight for age (Table 4). Also shown in this table is an indication of the variation in individual performance whch exists within all breeds. Obviously sampling techniques are an important factor in obtaining reliable breed comparison figures and the individual farmer must be aware of individual performance when purchasing a bull after having made his choice of breed.

Table 4

Breed average 400-day weights and weight ranges

	400 day weight (lb)	
	Average	Range (lb)
Aberdeen-Angus	875	720 - 1255
Charolais	1276	998 - 1648
Devon	1052	825 - 1480
Hereford	973	735 - 1420
Limousin	972	742 - 1334
Lincoln Red	1097	820 - 1460
Simmental	1171	920 - 1713
South Devon	1168	854 - 1700
Sussex	969	737 - 1346
Welsh Back	1048	863 - 1316

Performance results—calf birthweights and calving difficulties

The major problem with the use of heavier breeds to increase growth rate and slaughter weight is that they inevitably sire calves with higher birthweights, which is a major factor involved in difficulties of calving and perinatal calf mortality. Table 5 summarises the effect of sire breeds on calf birthweights in suckler herds, it is interesting to note that calves born in lowland herds weighed nearly 10 lb more on average than calves born in hill herds.

The effects of using larger breeds of sire on dystokia and calf mortality are well documented on dairy cows in Britain (Table 6).

These figures clearly show that the larger breeds of sire are associated with higher levels of difficult calvings and calf deaths than the smaller breeds, and that the differences are most dramatic with heifer matings. Results from the US Meat Animal Research Centre (Laster, Glimp, Cundiff and Gregory 1973) clearly indicate the larger breeds should not be used for heifer matings (Table 7).

There are only limited data available on calving difficulties and calf mortality levels in beef herds in Britain. Table 8 summarises information on calving performance in recorded suckler herds by breed of sire. The data on sire breeds are confounded with herd differences so that they cannot be used for precise breed comparisons. However, the breeds follow a similar pattern to the results in Tables 6 and 7 although

Table 5

Sire breed effects on calf birthweights (lb)

Type of herd	Lowland	Upland Calf birthweights*	Hill	Weight above (+) or below (−) Hereford x calves
Sire breed				
Charolais	96	90	82	+ 13
Simmental	95	89	81	+ 11
South Devon	94	89	80	+ 11
Lincoln Red	88	85	81	+ 5
Limousin	87	86	80	+ 4
Devon	86	84	79	+ 9
Sussex	83	81	77	+ 2
Welsh Black	81	78	71	− 2
Hereford	80	76	70	0
Aberdeen-Angus	73	68	64	− 5
Beef Shorthorn	74	71	65	− 6

* Average of bull and heifer calves

Table 6

Effect of breed on difficult calving and calf mortality

	Friesian heifers		Friesian cows	
	% difficult calvings	% calf mortality	% difficult calvings	% calf mortality
Simmental	8.8	11.6	3.5	4.4
Limousin	7.7	11.8	2.4	3.2
Charolais	—	—	5.4	5.5
Hereford	2.5	5.0	0.9	2.7

Source: Simmental & Limousin Steering Committee

the differences between breeds in calf mortality tend to be lower. To obtain more precise information the MLC started a calving survey in beef herds in the autumn of 1974. The preliminary results from this survey confirm the relationship between birthweight, calf mortality and difficuly of calving. Calves born dead were on average 9.1 lb heavier than live born calves. Calves born at assisted calvings weighed 7.8 lb more than calves born at unassisted calvings.

There are considerable differences in calving characteristics between bulls within a breed, and so monitoring individual bulls in AI studs is essential. It is also important that calf mortality and difficult calvings are put into context; it is inevitable that the use of larger breeds will result in more difficult calving and dead calves even if the worst indivi-

Table 7

Sire breed effects on calving difficulty and birthweight

Age of dam (years):	2		3		4 - 5	
	Calving difficulty (%)	Birth-weight (lb)	Calving difficulty (%)	Birth-weight (lb)	Calving difficulty (%)	Birth-weight (lb)
Hereford	38.3	67	7.1	71	2.0	75
Aberdeen-Angus	27.0	64	2.6	69	0.2	73
South Devon	62.5	72	28.6	79	5.9	78
Limousin	73.8	73	9.8	80	8.7	84
Simmental	65.6	77	22.2	83	10.2	85
Charolais	67.5	75	19.0	80	6.2	86
(Laster 1973)						

Table 8

Calving performance in suckler herds by breed of sire

	Per 100 cows to bull		
	Live calves born	Calf mortality	Calves weaned
Charolais	93.4	5.9	87.5
South Devon	93.7	6.0	87.7
Lincoln Red	94.0	4.1	89.9
Devon	94.4	4.7	89.3
Sussex	95.6	3.8	91.8
Hereford	94.8	4.4	90.4
Aberdeen-Angus	95.8	4.0	91.8
(Herd averages 1970-1974)			

dual bulls within a breed are selected against. Table 9 shows the number of calves per 100 cows required to produce the same total weaning weight as 100 Hereford cross calves. For example 93 Charolais cross calves will produce the same total weaning weight as 100 Hereford cross calves or 107 Angus calves. These differences do not represent the full story, for example they do not take into account the additional costs of supervision at calving, the extra stress on the cow, etc., nevertheless, the differences are appreciably higher than the differences in calf mortality levels in both Table 6 (cow figures) and Table 8. Thus it could be more profitable to use a larger breed of sire resulting in a lower number of calves reared than a smaller breed with a greater number of calves produced.

Table 9

Number of calves per 100 cows required to equate with 100 Hereford cross calves

Aberdeen-Angus	107
Charolais	93
Devon	96
Lincoln Red	96
Simmental	94
South Devon	94

'Horses for courses'

The results presented earlier show no evidence of an interaction between breed and system sufficient to change the order of ranking of breeds and crosses on the basis of growth rates and slaughter weights. The ranking was consistent whether considering the pure-bred performance, cross-bred performance in different beef production systems, in different environments and Table 10 extends this to look at the performance out of contrasting dairy cows.

Table 10

Performance of crossbred calves out of different dairy cows

	Daily gain (% above or below Friesian steers)		
Sire breeds	Friesian cows	Ayrshire cows	Channel Island cows
Aberdeen-Angus	—11.4	—25.3	—
Charolais	+ 10.4	— 7.6	—22.2
Hereford	+ 3.1	—14.8	—30.8
Red Breeds	+ 5.7	—10.0	—
Simmental	+ 10.3	—	—
South Devon	+ 8.9	— 9.0	—24.6

Despite this consistency there is still room for a 'horses for courses' argument in terms of the overall suitability of a cross for a system of beef production on the grounds of complementarity. The aspect of cattle performance with the greatest impact on the way in which breeds and crosses fit into beef production systems is earliness of maturity. Size is often, but not always, related to earliness of maturity—small breeds such as Angus are earlier maturing; large breeds such as the Charolais are late maturing. These breeds represent the extremes in size and degree of maturity in commercially available cattle but between these there is a whole spectrum of combinations of size and maturity.

Early maturity can be exploited in two ways. Either the cattle can be finished earlier but lighter on the same diets as late maturing types or they can be finished on lower concentrate—higher forage diets than later maturing types and still produce carcases of acceptable market finish. By contrast late maturing cattle are lean and can be fed high energy cereal diets, they grow fast to a rellatively high slaughter weight; they are inclined to produce slaughter weights too high for many market outlets in high forage systems. These characteristics are summarised overleaf.

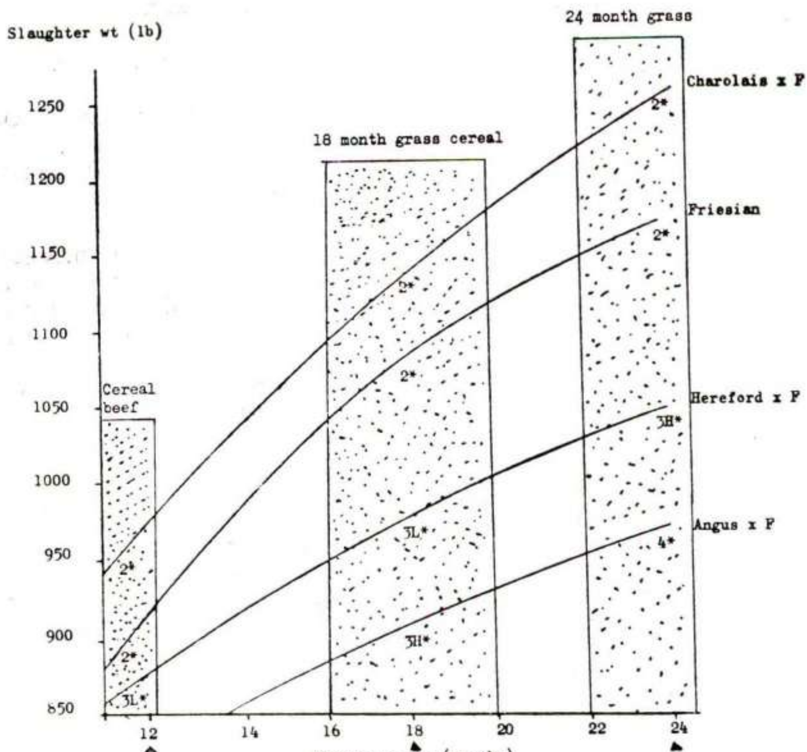
Attributes of early and late maturing stock

Early maturing	*Late maturing*
★ Early slaughter—quick turnover.	★ Late slaughter—high return.
★ Finished carcase from high forage diets.	★ Lean carcase from good quality feeds.
★ Low feed requirement — high stocking rate.	★ High total feed-minimum stock numbers.
★ Not at best for intensive beef.	★ Restricted market for heavy grass beef.

On farms the tendency is to reduce the potential differences between breeds by slaughtering early maturing Angus and Hereford crosses at a higher level of carcase fat cover than later maturing Friesian and Charolais crosses. The carcases are then used by different sectors of the meat trade. These differences are illustrated graphically in Figure 1 which shows a curve relating slaughter weight and slaughter age for the Friesian and main beef breed Friesian crosses. The figures below the curve are the typical carcase classifications (on the MLC scheme) achieved by cattle for the three major identified systems of production. It can be clearly seen that within the broad description of a single system that there is a wide range of slaughter ages and weights depending upon the type of cattle and precise way in which they are managed on the individual farm. In fact there is a continuous range of slaughter age/weight combinations within which adjacent systems of production overlap. The information on carcase classification shows a tendency for both the fatness and conformation scores to increase as cattle are slaughtered at older ages and heavier weights. At each point slaughter at a lower level of fat cover would reduce the slaughter weight.

For a full evaluation of the total fitness of a breed or cross for a system of production additional information on feed efficiency and carcase characteristics is required. Such information is now being collected in two MLC beef units established specifically for this purpose. At one unit the finishing performance of suckled calves is being evaluated in two common systems—the winter finishing of autumn-born calves at about 18 months of age and the overwintering of spring-born calves followed by summer finishing. At the other unit the performance of dairy-bred calves is being evaluated again under two systems of management — a semi-intensive system with the final finishing period in the second winter of life and two-year system with summer finishing. At both units the cattle are fed diets based on dried grass to reproduce commercial growth rates and for the period of six months before slaughter, individual feed intakes are recorded using electronically controlled feeding gates. The cattle are slaughtered at constant finish determined by ultrasonic scanning. The carcase cutting test involves jointing the side by a standard method, deboning and trimming excess fat. This then measures the yield of saleable meat.

Fig. 1: Slaughter weight, slaughter age and carcase fat class in dairy-beef systems



* Fat class on scale 1 leanest, 2, 3L, 3H, 4, 5 fattest

It will be some time before full results are available but results for cattle finished in the summer of 1974 at the suckled beef unit (Ingliston) illustrates some of the considerations involved in an evaluation of overall fitness (Table 11). Since each sire breed is represented by only 12 steers per intake, results for a single finishing group cannot be sufficiently precise for an accurate evaluation, so care must be exercised in drawing firm conclusions from the present set of results However, the programme will be repeated year by year so that accurate results can be used for more precise evaluation later. Table 11 shows that there are important differences between sire breed groups in slaughter age, slaughter weights and daily gains. As in the data from commercial beef units, early maturing types such as Aberdeen Angus crosses were slaughtered at a much lower slaughter weight than late maturing Charolais crosses. There were especially large differences in total feed intake, late maturing groups such as Charolais, Simmental and South Devon crosses consuming nearly twice as much feed during the finishing period as early maturing Angus crosses. At the same time these late maturing groups were amongst those with the lowest feed conversion efficiency. The variation in saleable beef percentage, the most important carcase measure, is relatively small, but even a one percent change has commercial significance.

Choice of breed affects working capital needs, total feed requirements and efficiency of feed use. This illustrates the complexity of designating the best breeds. With only a small number of cattle of each cross slaughtered for each of the beef systems so far, it is too soon to attempt a complete economic evaluation of the results. However, in conjunction with the large amount of performance data from farms, they provide the input/output values for the performance balance sheet. The information is vital to the beef producer seeking to fit a breed or cross into his beef system with reference to the feed resources and buildings available and cash flow requirements.

For the information to be useful it must be presented in a simple and effective way. It is intended to combine the date with economic values to calculate relative calf values for different situations to give the same level of profitability.

Some attempts have already been made at this type of evaluation using farm data; the information collected at the breed evaluation units will considerably improve the precision to such calculations. Table 12 shows how farmers treat different breeds and crosses differently in commercial practice. The figures in the table are average performance levels and concentrate inputs for three breed types in three systems of production from recorded farms. For the 18-month and 24-month beef systems the effect on stocking rates have been estimated from farm records.

In cereal beef units Charolais Friesians are slaughtered 60 lb heavier than Friesians at about the same age and with a similar overall input of concentrates they have better feed conversion. Hereford x Friesians were slaughtered at weights 40 lb less than Friesians, and take 23 days less to slaughter, conversion of concentrates is poorer than the Friesian. In grass/cereal 18-month beef units the Hereford x Friesian is slaughtered at appreciably lower weights than the Friesian (110 lb liveweight difference). Its overall growth rate is similar to the Friesian and hence the production cycle is 48 days shorter on average. Because they are early maturing, farmers feed them less concentrates in the finishing winter and the overall conversion of concentrates per lb of gain is lower than for the Friesian and Charolais x Friesian.

In grass 24-month beef the overall concentrate usage is more similar between the three breed types, a reflection of the finishing stage being

Table 11

Finishing performance of calves in the Ingliston beef unit 1974

Sire breed :	Angus	Charo-lais	Devon	Here-ford	L.Red	Sim-mental	S. Devon	Sussex
Summer finishing								
Slaughter age (days)	538	578	557	560	542	578	571	559
Slaughter wt (lb)	890	1151	1044	1019	1062	1147	1086	1060
Daily gain (lb)*	2.1	3.0	2.6	2.4	2.6	2.9	3.1	2.4
Total feed (lb)*	1355	2560	1908	1965	1616	2506	2459	1940
lb feed/lb gain*	11.0	8.5	9.3	10.1	10.1	8.6	8.6	10.0
Saleable beef (% of carcase)	72.0	71.9	71.1	70.9	71.0	72.5	70.8	71.6
Fat trim (%)	10.0	9.8	11.3	11.0	10.9	9.0	10.8	10.8
Winter finishing								
Slaughter age (days)	458	521	484	493	495	511	515	509
Slaughter wt (lb)	869	1111	940	907	967	1108	1035	980
Daily gain* (lb)	1.5	1.7	1.5	1.5	1.8	1.8	1.7	1.8
Total feed* (lb)	1632	3331	2066	2250	2389	3147	2945	2611
lb feed/lb gain*	14.6	14.3	13.6	13.6	11.6	13.7	12.9	11.6
Saleable beef (% of carcase)	72.9	72.5	70.8	71.8	71.7	71.6	71.3	72.1
Fat trim (%)	9.6	9.4	11.4	10.5	10.0	10.8	10.6	10.1

* Finishing period only

at grass rather than in yards. However, in this situation the Hereford x Friesian is finishing on average 80 days quicker than the Friesians.

It must be stressed that these data are based on farm results and are therefore strongly influenced by the management that farmers apply to the different breeds, they are in no way breed comparisons under a standard management system. Nevertheless they reflect how producers can and do adopt management to allow for differences in the characteristics of the crosses they are using. The main adaptation is in concentrate usage and this reduces the impact of additional silage requirements and stocking rates and the length of the production cycle. If concentrate levels were not adjusted breed differences would reflect themselves in greater differences in overall stocking rates and the differences in the number of days to reach a given level of finish would be increased. The figures clearly reflect that beef producers who run mixed breed batches of cattle cannot apply optimum management and feeding to take account of the appreciable differences between crosses.

Killing-out percentage

The percentage that the carcase forms of the live weight is an important and very variable economic factor. Cattle which produce

Table 12

Average farm performance levels and concentrate usage by breed type and system (all steers)

System	Friesian	Charolais x Friesian	Hereford x Friesian
Cereal Beef			
Slaughter weight (lb)	880	940	840
Slaughter age (days)	331	329	308
Daily gain (lb)	2.4	2.6	2.5
Total concentrates (cwt)	37.1	37.5	36.2
lb concentrates per lb LWG	5.2	5.0	5.4
Grass/Cereal—18-month			
Slaughter weight (lb)	1070	1150	960
Slaughter age (days)	570	560	522
Daily gain (lb)	1.7	1.9	1.7
Concentrates in finishing winter			
—cwt	15.2	16.4	9.6
—lb per head per day	8.3	9.4	6.8
Total concentrates (cwt)	23.9	22.0	18.1
lb concentrates per lb LWG	2.7	2.8	2.3
Estimated silage usage in finishing winter (tons)	4.5	4.7	3.6
Estimated overall stocking rate (beasts/acre)	1.30	1.25	1.40
Grass—24-month			
Slaughter weight (lb)	1140	1240	1020
Slaughter age (days)	754	770	674
Daily gain (lb)	1.4	1.5	1.4
Total concentrates (cwt)	21.1	22.0	16.7
lb concentrates per lb LWG	2.2	2.2	2.0
Estimated overall stocking rate (beasts/acre)	1.00	0.95	1.10

carcases of better shape, but not necessarily higher fatness, kill out better. Thus the 'Continental' beef breeds generally kill out better than the British breeds at the same level of fatness. This is illustrated in Table 13 which summarises data on killing out percentages in trials co-ordinated by the Limousin and Simmental Steering Committee. The Limousin crosses are particularly striking in this respect.

Economically important carcase characteristics

Carcase characteristics are only important to the producer if they are are reflected in economic terms. With the present marketing system in Britain differences in the value of carcases due to quality variations are difficult to detect against the general background of variations in price due to supply and demand. The beef producer knows that he must generally avoid excessive fatness and 'under-finished' cattle but beyond

Table 13

Killing out percentage of some breeds and crosses (Limousin & Simmental Steering Committee)

Breed Type	Intensive beef		Semi-Intensive beef
Friesian	56.4	52.8*	54.9
Hereford x Friesian	—	51.2*	—
Simmental x Friesian	56.8	52.7*	55.2
Limousin x Friesian	58.2	55.0*	—

(* Standardised to 20% of fat in the carcases)

this he receives no clear direction from the market on the type that will be most beneficial for him to produce. Producers require positive feed-back from the market about what to produce and the relative value of different types. A carcase classification scheme is central to changing the position so that the industry can attach higher values to better than average carcases and can discount more clearly those poorer than average. The method of carcase classification developed in Britain (MLC 1975 a) is now applied to 45 percent of all cattle slaughtered and involves a visual judgment of fat class and of conformation classes in addition to weight and sex. Yield of saleable beef is the most important overall assessment of a carcase. It is very variable but particularly determined by the extent of carcase fatness and the ratio of lean to bone. The amount of fat trim is the primary determinant of value; weight coupled with fat classes explains over half of the variation in the yield of saleable meat.

Conformation, in addition to fatness, is important in a carcase classification system however, because there are important shape related differences in meat yield between breeds (differences within breed types are small and not important) especially between dairy breeds and the more muscular Continental beef breeds (Table 14). Breed is a vital factor in the conformation/lean meat yield relationship. For example Table 14 shows that among carcases classified 2.3 the average lean content varied from 62% for Friesian x Ayrshire steers to 67% for Limousin x Friesian steers.

If the market expresses a preference for better conformation at low levels of fatness (a classification scheme is essential if such preferences are to be expressed), this should have the effect of encouraging the adaptation of breeds in commercial production with a high yield of saleable meat and therefore an economic advantage.

There has been a reluctance in Britain to accept carcases at low levels of finish, despite the production desirability of this, because generally these are associated with poor conformation in British breeds under British conditions. Carcases of low levels of fatness are much more acceptable to the meat trade when they are of good conformation even though there may not be a much higher yield of saleable meat. Addi-

Table 14

Average percentage of lean meat among carcases of various class conformation with different breed types

	Fat class 2					Fat class 3				
Conformation	1	2	3	4	5	1	2	3	4	5
Breed type										
Friesian x Ayrshire	—	61	62	—	—	—	58	58½	—	—
Friesian	64	64	63½	63	—	60	59	59	59½	59½
Hereford x Friesian	63½	64½	64½	—	—	—	61	60	60½	60½
Simmental x Friesian	—	65½	64	64½	—	—	59½	60½	—	—
Charolais x Friesian	—	—	63½	64½	65½	—	—	—	61½	61½
S. Devon x Friesian	—	64	—	—	—					
Limousin x Friesian	—	—	67	66½	—					

tionally there is a relationship between conformation and thickness of the lean meat (as apposed to its yield) amongst crosses of similar weight and fatness.

Although the demands of the retail trade are variable and to some extent, flexible, there is a doubt that the average beef carcase can be improved with substantial benefits to the efficiency of beef production. On a long term basis a realistic efficiency target is to move the average British beef carcase from 3 3 towards 2 4 (i.e. leaner, but with improved conformation) with some increase in carcase weight and with improved feed conversion. The scale of the advantage in carcase terms that might be achieved by such a change is shown in Table 15. The MLC Marketing Department have introduced the concept of 'Target Beef' (MLC 1975 b) in an attempt to improve the efficiency of the meat trade by getting it to modify its buying practices and to link price positively with clear grades defined in classification terms. The simple concept of target beef clarifies the improvement objectives to the producers and encourages the emergence of clear incentives for them to move towards the improved type.

Target beef classes are shown in Figure 2. As far as breed comparisons are concerned what is important is the proportion of carcases falling into these target groups. Nationally about a third (the top third) of carcases are wihin this group but there are emerging large breed differences, for example in recent trials, 83 and 90 percent have been achieved by different groups of Limousin crosses. The best way of improving conformation quickly is by giving preference to Continental breeds which will also bring about the desired improvements in the yield of saleable beef.

The appearance and eating characteristics of beef are affected as much by the treatment of the animal before slaughter as by the handling of the carcase after slaughter. Providing beef is young (as the bulk of it will be under modern production systems) then any differences between

Table 15

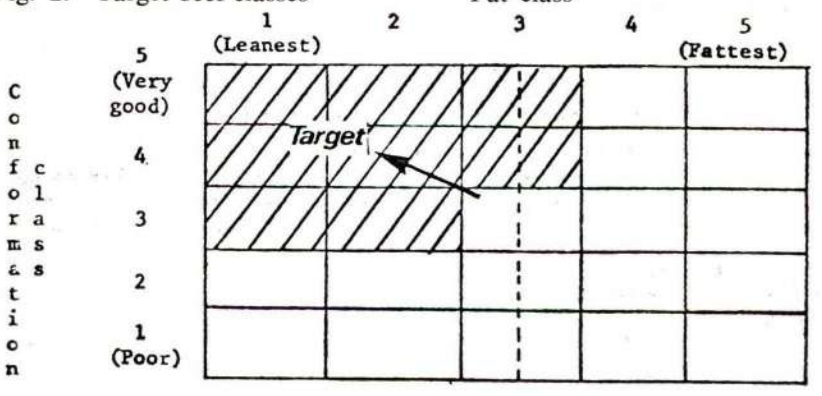
Comparison of current average beef carcase with an improved beef carcase

MLC Classification	The current average beef carcase 3.3	An 'improved' beef carcase	Direciton of change 2.4
Carcase weight (lb)	550	↑	600+
Fat cover : thickness over the eye muscle (10th rib)	11 mm	↓	8 mm
Extent of fat (% carcase weight)	9	↓	6
Lean to bone ratio	4.0	↑	4.5
Lean meat thickness : depth of eye muscle (10th rib)	65 mm	↑	85 mm
Percentage of lean meat in high priced cuts	49.0	↑	49.5
Saleable meat yield (%)	68.5	↑	72.5

breed types which have been determined have been small and cannot be considered important in relation to the wide range acceptable to the consumer and the wide range of variation found in commercial beef due mainly to age and handling techiques.

Currently beef cattle in Britain are either Friesians, British breed crosses or Continental breed crosses. It is inevitable, in view of the structure of the beef industry that the purebred Friesian steer will continue to make an important contribution. The Friesian currently produces typically a 2 2 carcase with only a small proportion of carcases attaining 2 3 and therefore falling into the target group. Few could

Fig. 2. Target beef classes



be expected to achieve a 2 4 classification. A recent disturbing feature of the Friesian breed is the increasing proportion of Canadian Holstein blood being incorporated into the breed which will inevitably make it more difficult to achieve improved conformation and saleable meat yield at the target fatness level. The most commonly used beef breed of bull in Britain is the Hereford. With the Hereford x Friesian conformation class 4 is usually achieved at fat class 3 but it is more difficult to achieve 2 4 although there is extensive variation within the breed. In commercial production the Hereford cross at fat class 2 is frequently too light for market demand. The situation is even worse with the most early maturing breeds such as the Angus. Angus crosses are not often suitable for the mass market but meet the demands of the quality beef market where higher levels of finish are desired in young light weight animals. Such crosses are of course more expensive to produce.

In cereal and grass/cereal systems quick growing, late maturing breeds of good muscular conformation imported from Continental Europe can produce crosses with the Friesian or smaller cows which are muscular and lightly covered with external fat. Charolais and Limousin crosses readily attain a 2 4 classification although on limited evidence the Simmental seems to be a rather more variable breed providing a higher

Table 16

The number of carcases falling into different classifications and percentages in the 'Target Group'

	Fat class 1	Fat class 2				Fat class 3				Fat class 4 or 5	Percentage in target group
		22	23	24	25	32	33	34	35		
Friesian	1	13	1	—	—	2	7	1	—	1	8
Hereford x Friesian	1	—	4	—	—	2	5	5	3	11	39
Simmental x Friesian	1	3	15	8	—	1	10	8	1	1	67
Limousin x Friesian	3	—	6	9	2	—	1	3	—	—	83

Table 17

Results of trials with Limousin and Simmental crosses

	Carcase weight (lb)	Average fat class	Average conformation class	Percentage in target group
Limousin x Friesian	513	2.0	3.9	90
Simmental x Friesian	497	2.2	3.8	86
Friesian	495	2.3	3.2	47

Source : Limousin & Simmental Steering Committee proportion of 2 3's, 3 3's and 3 4's (Table 16 & 17). Further comparative data on the carcase quality of the various breeds and crosses in use in Britain is required.

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THE ALL-PURPOSE FERTILISER

MULTIGRO-THE GREAT ALL·ROUNDER

Breed Comparisons in Single Suckling Herds

by

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Of the national herd of two million cows, approximately one-third are beef cows, mostly in single suckling herds. Little detailed information is available concerning animal performance in these herds. Surveys were conducted in 1973 and in 1975 in order to obtain data on the effects of sire and dam in suckling herds.

Methods

Mainly spring calving single suckling herds were selected with the aid of County Advisory personnel, A.I. stations, Beef Incentive Bonus Scheme offices and co-operating farmers. While the majority of herds encountered were predominately single suckling, some herds with double and multiple suckled calves were recorded. In 1973 the survey covered the following counties: Meath, Westmeath, Offaly, Galway, Mayo and Roscommon. In 1975 the survey was concentrated in the Western area and covered Donegal, Sligo, Mayo, Roscommon, Galway and Offaly and only herds using at least two breeds of sire were selected. Calves were weighed on two occasions in 1973, July and September-October, and once in 1975, September-October.

The results were analysed by the method of least squares on a within herd basis. This means that information on the relative merits of breeds was obtained only in herds with at least two different breeds. The model included effects for sire breed, dam breed, lactation number, month of calving, sex, method of suckling, days of age and a sire breed by dam breed interaction. Close examination of the 1975 data led to some changes in the model, mainly the inclusion of a sire breed by dam breed interaction.

Results

Table 1 summarises the scope of the survey.

The proportion of Charolais and Simmental increased from 12% in 1973 to 36% in 1975. A probable reason for this may be that the 1975 survey was conducted mainly in the western region, serviced by Sligo A.I. station and which has a high usage of continental type bulls. Hereford usage dropped from 55% to 30% while the remaining breeds remained more or less static.

Table 1

Numbers, average age and weight of calves

	1973	1975
Number of herds	172	53
Number of calves	3,100	689
Average age (days)	179	176
Average weight (lb)	425	446

The distribution of sire breed is shown in Table 2.

Table 2

Percentage distribution by breed of sire

Breed type	1973	1975
Charolais	10	23
Simmental	2	13
Hereford	55	30
Friesian	16	13
Aberdeen Angus	12	15
Shorthorn	5	6

Breed of bull

The effect of breed of sire is shown in Tables 3 and 4.

Table 3

Sire effect, 1973

Breed type	No. of calves	Adjusted mean wt. (lb)	% of Hereford
Charolais	290	459	110
Simmental	48	448	107
Hereford	1,611	419	100
Friesian	487	421	100
Aberdeen Angus	343	414	99
Shorthorn	164	409	98
Not recorded	155	405	97

Sire breed had a significant effect on the weight of calves in both years. In 1973 Charolais and Simmental crosses were 10% and 7% better than Hereford crosses. Friesian and Hereford crosses were similar, while Aberdeen Angus and Shorthorn were somewhat lighter. In 1975 Char-

Table 4

Sire effect, 1975

Breed type	No. of calves	Adjusted mean wt. (lb)	% of Hereford
Charolais	157	475	107
Simmental	92	474	107
Hereford	210	441	100
Aberdeen Angus	100	440	99
Friesian	88	421	95
Shorthorn	42	422	95

olais and Simmental crosses were 7% heavier than Herefords. Hereford and Aberdeen Angus crosses were about equal while Friesian and Shorthorn types were 5% lighter than Herefords.

Breed of dam

Tables 5 and 6 set out the effect of breed of dam.

Table 5

Dam effect, 1973

Breed type	No. of calves	Adjusted mean wt. (lb)	% of Hereford
Friesian	464	430	102
Hereford x Friesian	170	428	102
Charolais	59	428	102
Hereford	1,216	420	100
Aberdeen Angus	486	415	99
Shorthorn	518	411	98
Not recorded	187	443	105

Table 6

Dam effect, 1975

Breed type	No. of calves	Adjusted mean wt. (lb)	% of Hereford
Friesian	140	453	103
Hereford x Friesian	37	453	103
Charolais	37	450	103
Hereford	200	439	100
Aberdeen Angus	163	441	100
Shorthorn	112	439	100

Breed of dam was a significant source of variation in 1973 but not in 1975. However, if the unrecorded group in 1973 is ignored then breed differences are small. In both years, Friesian type, Hereford x Friesian and Charolais type dams had slightly heavier calves, 2-3%, than progeny of Hereford cross, Aberdeen Angus or Shorthorn cross dams.

Lactation number of dam

Table 7 shows the effect of lactation number on the weight of calves.

Table 7

Lactation effect

Lactation no.	1973	1975
	Adjusted wt. (lb)	Adjusted wt. (lb)
1st	404	421
2nd	428	452
3rd	434	444
4th and later	440	468

Lactation number had a significant effect on calf weights in both years. As the lactation number increased, weight of calves also increased except in 1975 when 2nd lactation cows had slightly heavier progeny at six months than 3rd lactation cows. There was no evident reason for this effect. Progeny of 1st lactation cows were 36 lb. and 47 lb. lighter than those of 4th and later lactation cows. It is likely that lighter calf birth weights and lower milk yields of 1st lactation cows was the reason for this effect.

While the model included effects for month of calving and age, both of these were confounded in the data and it was not possible to separate either effect clearly.

Sex of calf

The effect of sex of calf is shown in Table 8.

Table 8

Sex effect

	1973		1975	
	No. of calves	Adjusted mean wt. (lb)	No. of calves	Adjusted mean wt. (lb)
Male	1644	437	397	462
Female	1456	413	292	430

Type of sex was a significant source of variation in both years. Males were heavier than females by 24 lb. and 32 lb. in 1973 and 1975 respectively.

Method of suckling

As stated previously the survey dealt mainly with single suckling herds. However, other methods of suckling were practised and these effects were included in the model (Table 9).

Table 9

Effect of suckling method

	1973		1975	
Suckling method	Adjusted mean wt. (lb)	% of single suckling	Adjusted mean wt. (lb)	% of single suckling
Single	458	100	482	100
Double	433	95	455	94
Multiple	406	89	401	83

The effect of suckling method was a significant source of variation in in 1973 and 1975. Double suckled and multiple suckled calves were lighter by 25 lb. and 52 lb. in 1973 and by 27 lb. and 81 lb. in 1975 respectively.

Sire breed x dam interaction

Sire breed x dam breed interaction was not a significant source of variation in 1975. This effect was not included in the 1973 analysis because of missing or small subclasses.

Discussion

The mean calving dates in the two years 1973 and 1975 were similar, April 5th and April 7th respectively. Hence, calves were almost six months of age at weighing and weighed 425 lb. and 446 lb.— Table 1. If a mean birthweight of 80 lb. is assumed, the average daily gain is 1.93 lb./day and 2.08 lb./day for 1973 and 1975 respectively. Whilst this rate of gain appears satisfactory, average weaning weight is much too low. Research by the Agricultural Institute at Grange has shown that average weaning weights can be as high as 550 lb. This can be achieved by earlier calving and by use of fast growing bulls. The mean calving date in this survey is at least one month too late and should be brought forward to early March. This could be achieved at very little extra cost and improve weaning weights by up to 60 lb.

The survey showed that the use of faster growing bulls can improve calf performance on average by 30-55 lb. Charolais and Simmental crosses were from 7-10% heavier than those of Hereford crosses at weighing in autumn. This result is similar to that obtained by the Meat and Livestock Commission in Great Britain, where Charolais and Simmental crosses have consistenly outranked all other breed crosses in terms of performance.

Crosses which impart higher growth rates also tend to have greater incidence of calving difficulties largely because of greater calf birthweights. No attempt was made to assess calving difficulties in this survey. However, it is agreed that continental type bulls should not be used on heifers and any bull with a history of difficult calvings should not be used on either cows or heifers. Such a bull can be identified on the basis of records and withdrawn from service. Data on ease of calving would allow further exploitation of the growth potential of continental type bulls.

Calf performance was somewhat higher in 1975 than in 1973, probably because of the higher proportion of Charolais and Simmental crosses in 1975. There were smaller differences among dam breeds than among sire breeds. Nevertheless, the progeny of Friesian cross, Hereford Friesian cross and Charolais cross cows tended to give heavier calves due to extra milk or more growthiness.

Progeny of heifers were lighter than those of second and subsequent lactation cows at weighing time and this is in agreement with MLC results in Great Britain. Similarly male calves were heavier than female calves.

Single suckled calves were heavier than double and multiple suckled calves in both years. The weight difference ranged from $\frac{1}{4}$ to $\frac{3}{4}$ cwt. over and above double and multiple suckled calves respectively. This difference must be borne in mind when considering which type of suckling is more profitable. For intensified beef production, light weanlings present a problem. Where the aim is the production of beef at two years of age extra meals must be fed to the lighter weanlings in order to achieve an acceptable weight at turnout.

Spring Milk Production in Britain

by

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There is a high demand for liquid milk in Britain, and in 1974/'75 59 per cent of all milk produced was sold to the liquid market. This varied from 47 per cent of total production in May to 70 per cent in November.

Unlike the Republic of Ireland there is no distinction between producers supplying the liquid or the manufacturing market. All producers sell milk to the Milk Marketing Board and receive a similar average or pool price for their milk regardless of farm location.

Because the demand for liquid milk is fairly constant and because the variable costs of producing summer milk are less than winter milk, the Board needs to operate a variable seasonal price schedule to encourage winter milk production. This price schedule for the year ending March 1976 in pence per gallon is shown in Table 1.

Table 1

Producers season price schedule 1975/76

Milk Marketing Board of England & Wales—North West Region
(Based on milk of total solids percent 12.40 - 12.50)

Month	Price p.p.g.
April 1975	33.28
May	29.26
June	29.30
July	31.00
August	32.96
September	36.72
October	39.00
November	39.41
December	39.62
January 1976	39.93
February	39.73
March	39.70 (i)

(i) Estimated

In practice one result of this seasonal schedule is that 75 per cent of all herds calve "all the year round" and maintain a level output. Physical and financial results for average herds (selected on a gross margin per acre basis) calving all the year round are shown in the first column of Table 2. These are from a survey of over 1,500 L.C.P. members for the year ending March, 1975.

Table 2

Analysis by Seasonality of Production [1]

Average producers selected by gross margin per acre, year ended March '75

	"All Year"	"Winter"	"Summer"
Herds	1147	189	171
Size	76	87	63
Yield—gallons/cow	955	994	856
Concs—cwt/cow	28.5	30.7	22.4
Nitrogen—units/acre	141	146	125
Stocking rate—acres/cow	1.24	1.26	1.33
Milk price p.p.g.	27.1	28.0	25.1
Margin/cow (£)	139	147	128
Margin/acre (£)	112	116	96

Source : LCP Services
[1] Summer 60% of milk produced Apr-Sept.
Winter 55% of milk produced Oct-Mar.

At this level of performance there is very little in favour of the winter producer compared with all the year round calving but the summer producer lags £20 behind on a gross marging per acre basis.

Any analysis of herds on a time of calving basis is bound to include some herds seasonal calving by accident rather than design. This is particularly true when looking at average results. Many producers may appear in a survey as summer producers simply because they are bad managers and the herd calving index has slipped round to produce a spring calving pattern. In order to examine herds intentionally calving on a seasonal basis, Table 3 compares the top 10 per cent in each calving group.

The data show that the winter producing herd is superior, on a gross margin per acre basis, to the summer herd by £31. The surprising feature to many specialist spring calf producers, aiming to maximise production from grass, is the high level of concentrates used by the spring calving group.

These LCP results show (at the gross margin level of analysis) that a combination of technical efficiency and milk pricing make autumn calving currently a more attractive proposition in Britain than spring calving.

So far we have only considered technical efficiency and gross margin. Are higher margins reflected in higher profits and a higher cash surplus? In discussing dairy farming, the crucial word must be profit.

Table 4 compares the average summer milk producer with the top 10 per cent of summer milk producers on a total gross margin and profit

Table 3

Analysis by Seasonality of Production

Top 10% producers selected by Gross Margin per acre, year end March '75

	"Winter"	"Summer"
Yield—gallons/cow	1099	907
Concs—cwts/cow	30.6	22.2
Nitrogen—units/acre	241	173
Stocking rate—acres/cow	0.85	0.88
Milk price p.p.g.	28.8	26.2
Margin/cow (£)	179	158
Margin/acre (£)	211	180
Acres	100	100
Cows	118	114
Total margin (£)	21,100	18,000
Source : LCP Services		

basis. For ease of comparison a 100 acre all-grass farm carrying cows only is considered. The overhead costs are obviously theoretical but are based on a full farm survey of LCP farms in this size bracket and are therefore representative of this type and size of farm. At the gross margin stage the top 10 per cent man is achieving an additional £7,700 over the average man. When overhead costs are deducted (excluding financial charges) the net profit shown by the top 10 per cent man is £5,420 above the average.

Table 4

Summer Milk Producers "Profit"

	Average	Year end March 1975 Top 10%
Acres	100	100
Cows	75	111
Total margin	£10,300	£18,000
Overheads :		
Labour	1500	3000
Machinery	1800	2000
Property	1300	1600
Sundries	770	1050
Total overheads	£5,370	£7,650
"Net Profit"	£4,930	£10,350

Table 5 examines the fate of profit when other essential commitments (finance, repayment, private) are deducted from the profit. The average summer producer has insufficient cash left for any sensible replacement or expansion policy and any move in this direction must lead to an increase in borrowing. The top producers on the other hand have cash left for both replacement of machinery and expansion.

Table 5

Summer Milk Producers "Cash"

	Average	Top 10%
Net profit	+4930	+10350
— Finance charges	950	1200
Capital Repayments	720	890
Private (including tax)	2730	3280
Total 'spending'	−4400	− 5370
Cash available for:		
Replacement of machinery		
Expansion	+ 530	+ 4980
Investment		
Replace tractor, say:	1500	1500
Cash 'left'	− 970	+ 3480

This brief analysis shows therefore that improving technical performance and moving from the average bracket into the top 10 per cent is highly justified. However, at all levels of efficiency overhead costs and commitments need to be kept in perspective.

Table 6 shows the fate of a top producer when his business is subjected to an impossible—but unfortunately not too uncommon—level of overheads and commitments.

Table 6

Effect of over commitment

Top 10 per cent Total margin	18,000
Overheads	6,550
Net profit	11,450
But, 100 acres purchases via long term loan of £30,000	
Cows financed by short term loan of £10,000	
Capital repayment	1,700
Bank interest	1,400
A.M.C. interest	4,200
Insurance cover	800
Private (including tax)	3,000
Total spending	£11,100
Cash available for replacement	+ £350

Table 7

Summer Milk Producers

Top 10% compared with average

	Average	Top 10%
Size	63	70
Yield —gallons/cow	856	907
Concs—cwt/cow	22.4	22.2
lbs/gallon	2.9	2.7
Nitrogen—units/acre	125	173
Stocking rate	1.33	0.88
Milk price p.p.g.	25.0	26.2
Concentrate cost (£/ton)	64.5	64.7
Sales: Milk	218	238
Calves	23	24
	£241	£262
Costs: Concentrates	71	71
Bulks	4	4
Herd replacement cost	13	7
Forage	12	9
Sundries	13	13
	£113	£104
Margin over concentrates	£147	£166
Margin per cow	£128	£158
Margin per acre	£96	£180

The difference in gross margin per acre between average and top 10 percent is £84.

Provided outgoings are kept under control it is obviously desirable to move from the average bracket to the top 10%. Table 7 examines the difference in physical and financial performance between the two groups.

The two factors really influencing this difference are yield per cow and stocking rate. The value of a high stocking rate has been stressed previously and these results confirm this view. Unfortunately, both groups—average and top 10 per cent—will find stocking rate harder to increase in the future.

Increased stocking rate on the all grass farm can only be achieved by increasing cow numbers. Cow prices are now in excess of £300 and the cost of additional buildings is almost prohibitive. Table 5 shows that the average producer is not generating a sufficient cash surplus to allow for expansion. Increased borrowings to buy the marginal cow always look attractive on paper but need careful planning to avoid the kind of situation shown in Table 6.

The top 10 per cent producer is already up to a stocking rate of 0.9 acres per cow and recent experience in Britain has persuaded many farmers that this is quite high enough (too high for the drought of 1975!). Higher stocking rate will only increase the need for more bought-in feed etc.

Both groups of producers need to focus attention much more on individual cow performance.

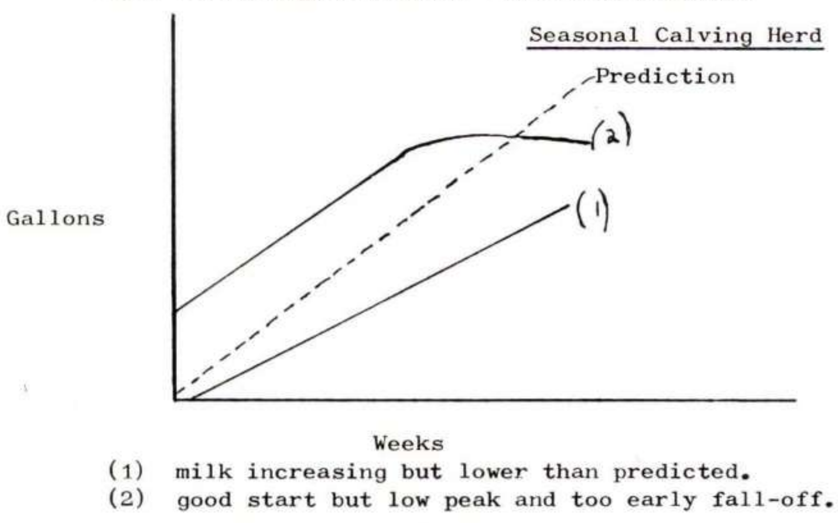
Within LCP we are conscious of how easy it has been to increase total farm margin simply by increasing stocking rate. We are now looking more closely at increasing individual cow performance. The remainder of this paper describes briefly three of the new developments we are using at field level.

1. Herd management control

This scheme was initially called milk yield predictions. Knowing the past and current performance of an animal, calving date and lactation number, it is possible to accurately predict her future yield. If this is done for all animals in the herd, a graph showing expected level of herd production can be drawn. If actual production is then graphed against the prediction any deviation from expected yield can be spotted immediately and hopefully corrective management action taken.

The prediction is especially useful in seasonal calving herds, where it is easy to be lulled into a false sense of security by increasing output in the early season. The question that must always be asked is: "Is the milk yield going up fast enough?" Similarly in mid and late lactation when the milk yield starts to decline: "Is the milk yield falling too soon and too quickly?" Figure 1 shows how Herd Management Control allows one to spot these deviations immediately.

Fig. 1. Herd Management Control — Milk Yield Predictions



(1) milk increasing but lower than predicted.
(2) good start but low peak and too early fall-off.

Herd management Control is linked via Milk Recording Services to the the Milk Marketing Board computer and farmers using the prediction service are provided with an up-dated printout every two months.

2. Grassland assessment

In winter we make every effort to analyse quality of winter feed and measure the quantity available. Subsequent rationing starts from this logical basis. At grazing we work on a very arbitrary basis and traditionally, grass is allocated and valued according to months of growing and almost totally regardless of the quantity available.

There is little use in imposing stocking rate simply on an area basis. We must know the quantity of grass available within that area. If we know the quantity of grass on offer and the requirements of the stock (for both production and growth) then we can adjust the stocking rate to match the requirements. This might, for example, mean offering more grass by moving the fence further or speeding up the paddock rotation or, in a very dry period, might even mean feeding supplement. When grass growth starts to slow down in August and September, it is very easy to over-estimate the quantity of grass on offer and underfeed.

Assessing grass quantity has been practised for years in New Zealand under the name of paddock scoring. Whereas it is obvious that over time a high degree of skill in paddock scoring can be developed solely by walking the field and visually assessing "how much there is", we in LCP felt we needed to start from a more logical point. Basically grass quantity is a product of the height and density of grass on offer and currently we are developing techniques aimed at measuring these two factors. The grassmeter described in a recent edition of *Farmers Weekly* is one such development.

3. Condition scoring

Correct rationing of cows involves an inter-relationship between milk yield, feed available and body reserves. Various opinions have been expressed on cow condition or "fitness". But what is meant by condition, and more important what condition is required at various stages of the lactation cycle? It is agreed that cows should be fit at calving, but what do we mean by fit, and if cows were fitter, would they produce more milk?

In LCP we are using a technique—pioneered by the Meat & Livestock Commission on suckler cows—called simply "Condition Scoring" to quantify and rank cow condition. The technique involves handling cows at three specific areas—the spinus processes, the hip bone and the area around the tail head. The condition score is based on the degree of fat cover on a scale 0 - 5.

Once a cow has calved her appetite is unable to match her milk output and she is bound to lose weight (and condition). In order to lose condition it must be there to begin with. Many specialist summer producers are guilty of running the herd down in late lactation and then leaving the cows on a low plane of nutrition for the early part of the dry period. There is then insufficient time available to replace body weight to get the cow in optimum condition for calving.

The technique of condition scoring can be used to identify when a herd is losing condition and at what stage management action is needed to influence body condition. Within the herd individual animals will show very different condition scores at any one point in time, and may need to be picked out and grouped together for specialist treatment.

Summary

In Britain there is a high steady demand for liquid milk. In 1974/'75 59 per cent of all milk produced went into the liquid market. There is no distinction between liquid and manufacturing producers. Seasonality of milk production is influenced by a variable monthly pricing schedule.

Better technical performance is generally reflected in higher profits and cash available for replacement of machinery and expansion.

There is a big difference in margin and profit between the average and top 10 per cent of summer milk producers. Stocking rate and yield per cow account for the major differences between average and top 10 per cent.

In the future, less reliance can be placed on improvement of stocking rate and much more emphasis must be placed on increasing margin per cow.

Herd Management Control (milk yield prediction), grass assessment techniques and condition scoring are recent LCP developments aimed at improving cow performance.

Dairying in Holland

by

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Because of climatic and farm structural circumstances in Holland and Ireland I believe that dairying will be the most obvious choice if not the only possibility for the majority of farmers. Therefore it is interesting to study the large differences in dairy farming in our two countries. Table 1 gives several data concerning the structure of animal husbandry in Ireland and Holland.

Table 1

The structure of dairy farms (1974)

	Irish Republic	The Netherlands
Average size of agricultural holding (ha)	17.1	14.2
Number of holdings ('000)	279.4	146.9
Number of holdings with dairy cows ('000)	143.6	99.0
Production of cows milk ('000 ton)	3,950	9,915
% of EEC milk production	4.1	10.2
Number of dairy cows (million)	1.344	2.215
Average number of cows per farm	9.7	22.8
Average milk production per cow (kg)	2,587	4,490

It is at once obvious that although the size of the holdings is greater in Ireland than in Holland both the number of cows per farm and the production per cow are, on average, notably greater in Holland than in Ireland. Of the total E.E.C. milk production, 4% is produced in Ireland and 10% in Holland. Table 2 gives a more detailed account by reproducing the percentage of the dairy herd in the various sized groups.

The situation in Ireland in 1973 is very comparable with the Dutch situation in 1960. Since 1960 there has been in Holland a rapidly growing tendency towards larger units for dairy farming. This is shown in Table 3. The number of farms comprising dairy herds has decreased strongly during the last 10 years and the total number of dairy cows has greatly increased.

Due to the use of cubicle houses with milk chute parlours it is technically possible to increase the number of cows that can be managed by

Table 2

Percentage of herds in each size group

Size of herd (cows)	Irish Republic	The Netherlands	
	1973	1960	1975
1 - 9	66.6	69.2	23.0
10 - 19	18.4	21.8	25.1
20 - 29	8.0	6.3	21.0
30 - 49	5.1	2.6	21.2
50 and over	1.9	0.1	9.7

Table 3

Developments in the structure of dairying in The Netherlands

	1964	1970	1974	1975
Number of holdings with dairy cows	161,946	116,332	96,987	91,560
Number of dairy cows ('000)	1,685	1,896	2,199	2,218
Average number of cows per farm	10.4	16.4	22.7	24.2

one man. There is therefore a great interest in constructing these stalls on all farms planning to continue with dairy herds in the future. Table 4 gives the number of cubicle houses built in Holland during the last few years. At this moment 10,740 of these cubicle houses are in use.

The changeover to larger units did not, however, occur simultaneously with the enlargement of farm size. Because it is almost impossible to buy or rent additional land, the feed position of the larger units of dairy cattle is protected by high nitrogen fertilisation and a greater purchase

Table 4

Number and size structure of cubicle houses in The Netherlands

	1970	1976
No. of units	834	10,740
Size of unit—under 40 cows	25.5%	6.9%
40 - 60 cows	54.9%	41.8%
60 - 100 cows	16.5%	40.7%
100 - 150 cows	2.2%	9.2%
over 150 cows	0.9%	1.4%

of concentrates and roughage from outside the farm. This is illustrated in Figures 1 and 2 in which are shown the trends in usage of nitrogen fertilizers and concentrates for cattle over the last 15 years. In Table 5 these figures are expressed in kg N per ha and kg concentrates per cow.

Table 5

Changes in nitrogen use, consumption of concentrates and acreage of forage maize

	1960	1970	1975
Nitrogen use on grassland (kg N/ha)	100	200	230
Consumption of concentrates by cattle (kg/cow + followers)	800	1,050	1,500
Acreage of forage maize (ha)	4,000	6,400	77,500

Forage maize is mostly cultivated by landowners who will not sell or rent their land but will contract to grow maize for dairy farmers. Maize cultivation is a very attractive enterprise because all the work can be given out to a contractor. Also, landowners with intensive livestock units can get rid of large quantities of organic manure under the maize.

The economic background to the strong increase in usage of nitrogen fertilizers and concentrates is that the price relationship between milk and nitrogen fertilizers plus concentrates has developed favourably. In 1960 the price ratio between 1 kg of nitrogen and 1 kg of milk was 3.4. This decreased to 2.4 in 1975. The price ratio between 1 kg of concentrates and 1 kg of milk decreased in the same period from 1.2 to 0.8. Thus there has been a strong incentive to use more nitrogen and concentrates. When we compare the costs of 1 kg of starch equivalent in the different products, 1 kg of SE in grass costs 4p, in maize silage on contract 8p, and in concentrates 12p.

It is clear therefore that with increase in stocking rate all the possibilities of the farm producing its own feed must be considered. This means firstly a level of nitrogen fertilisation that guarantees a maximum grass output, combined with a good utilisation of the grass, either fresh grass or as conserved product.

Intensive dairy farming in Holland is illustrated by reference to the technical and financial results of four nitrogen experimental farms. These are privately owned and farm results are being studied by the Dutch Nitrogen Fertilizer Industry Agricultural Bureau, the National Agricultural Advisory Service, the Animal Health Service and the Research and Advisory Institute for Cattle Husbandry.

The four farms are: a family farm, a two man farm, a three man farm and a four man farm. In Table 6 the acerage and stocking rates of these farms are given. Smaller farms are buying forage maize on contract to increase the amount of roughage for the winter period. It is expected that this policy will develop further in the near future and that the forage

Fig. 1. Usage of nitrogen fertilizers in the Netherlands (1000 tons of N)

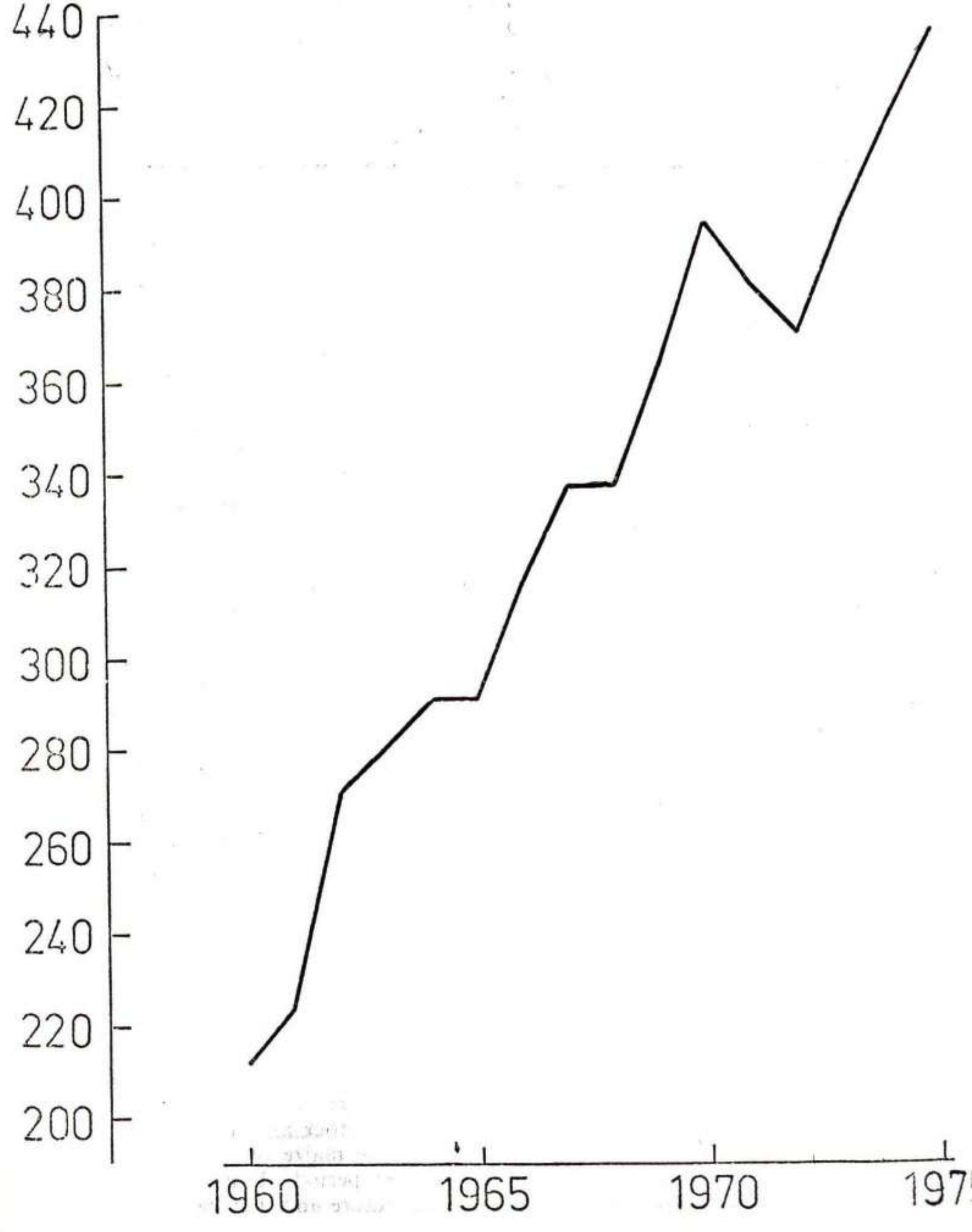
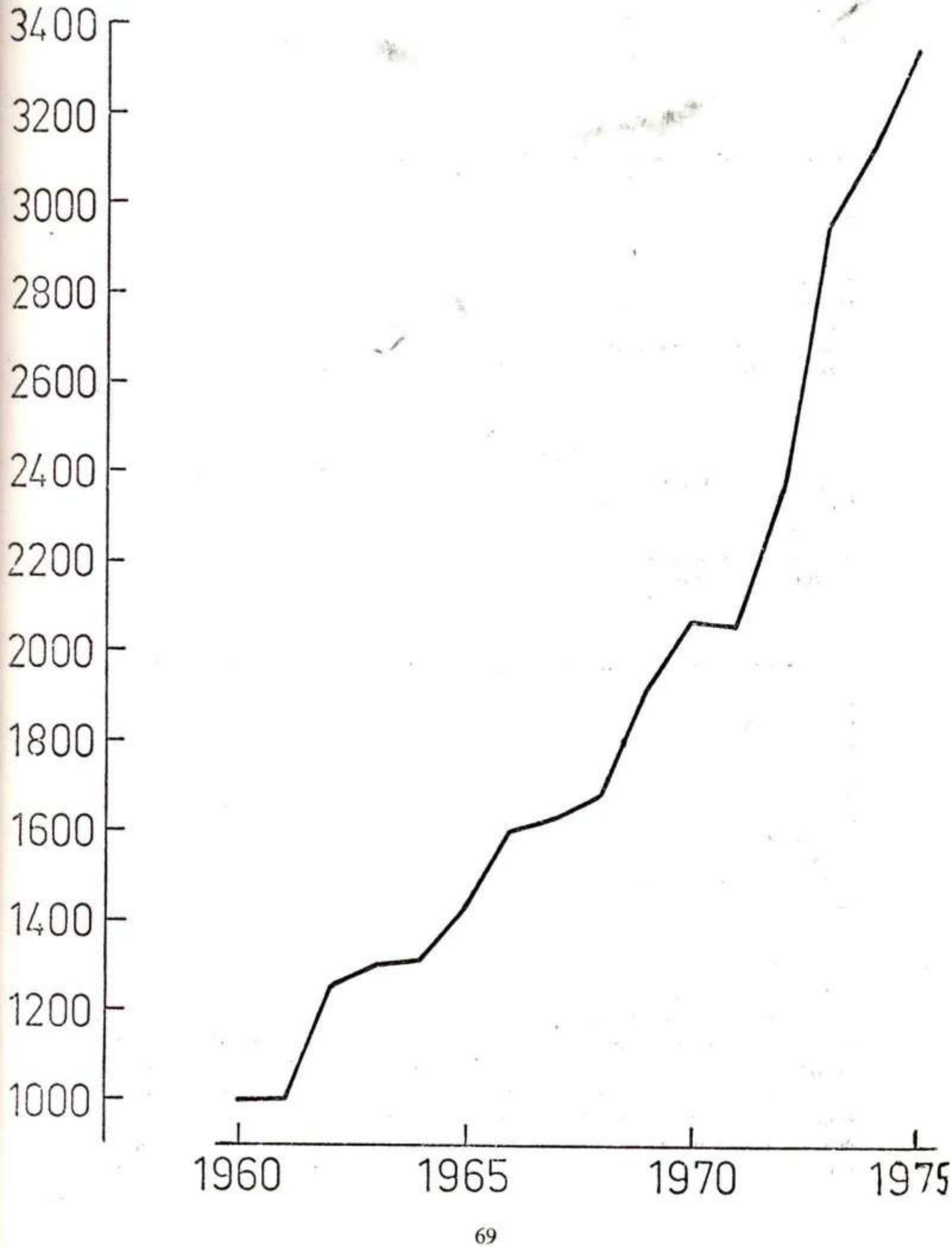


Fig. 2. Usage of concentrates for cattle in the Netherlands (1000 tons)



maize acreage will increase to about 100,000 ha in the next 10 years. The forage maize is concentrated on the sandy soils in the south and the east of Holland and plays only a minor role in the typical grassland districts in the north and west of the country.

Table 6

Employed labour, acreage and stocking rate on intensive grassland farms in The Netherlands (1974)

Fully employed labour	1.6	2.1	3.0	3.6
Acreage grassland (acres)	45	83	100	—
Acreage forage maize (acres)	4	—	—	200
Maize on contract (acres)	12	10	—	—
Dairy cows	50	90	113	162
Stocking rate (cattle units/ acre grassland)	1.5	1.4	1.4	1.0

In Table 7 the milk production of the four farms is given. Per employed labourer, 40 to 50 thousand gallons of milk are delivered to the factory. The aim on these farms is to produce 1,300 gallons with 4% fat per cow with 50 to 60 cows per man. The four farms are progressing towards these targets. About 45% of milk is produced in the period from November to May.

Table 7

Milk production on intensive grassland farms in The Netherlands

Fully employed labour	1.6	2.1	3.0	3.6
Milk production (gallon)	61960	108990	133560	199500
Milk per cow (gallon)	1239	1211	1182	1232
Milk per employed labourer (gallon)	38718	51900	44250	55416
Fat content	3.86	3.98	3.78	4.01
% winter milk	45	44	45	52
Return per gallon (pence)	40.2	43.0	43.4	42.9

Table 8 presents fertilizer usage on the four farms shown.

Nitrogen fertilization between 300 and 400 lbs. of N per acre per year is the maximum to be applied according to Dutch standards. Only on soils which naturally provide a certain amount of nitrogen through mineralization, such as peat soil, is the maximum level of nitrogen reached at about 225 lbs. of N per acre per year. Nitrogen fertilizer is predominantly applied in the form of 26% calcium ammonium nitrate and 22% magnesium ammonium nitrate. There is a growing trend for the storage of nitrogen fertilizers in polyester silos to improve labour efficiency. Farm

Table 8

Fertilizer use on intensive grassland farms in The Netherlands (lbs/acre)

Fully employed labour	1.6	2.1	3.0	3.6
N (fertilizer)	359	395	298	366
N (organic manure)	26	26	23	59
P_2O_5 (fertilizer)	—	41	13	33
P_2O_5 (organic manure)	26	28	46	74
K_2O (fertilizer)	—	—	—	—
K_2O (organic manure)	94	129	114	180

layout must be such that all the paddocks are within convenient reach of the silo.

From Figure 1 it is clear that in the near future more nitrogen fertilizers will be used. It is very important to note that according to Dutch research and practical experience there is no evidence for adverse effects on the health and productivity of the animals with high levels of nitrogen fertilization. There is however a condition regarding fertilization using nitrogen, phosphate and potassium, namely that the limits for maximum grass production are not exceeded to any great degree. Sufficient account must be taken of the plant nutrients which are returned to the soil with farmyard and liquid manure. On intensive grassland farms a large amount of minerals are bought in via the concentrates. This means that with an increase in stocking rate less rather than more P and K needs to be supplied in the form of fertilizers. Table 8 shows that no K-fertilizers and only a small quantity of P-fertilizers are bought in.

A high level of nitrogen fertilization must be combined with good utilisation of the extra herbage. Hence there is a growing interest in the Netherlands in limiting grazing losses by reducing the duration of grazing. This is achieved in practice by allowing cows to graze during the daytime and housing them at night. Small quantities of grass or conserved feed are sometimes fed indoors as a supplement depending on the quantity and quality of the available herbage. Especially in spring and in autumn, this is an effective way to maintain good milk production levels. Also, it offers the possibility in cases of poor lay-out of the paddocks to feed fresh grass from paddocks that have no direct access to the milking parlour. Only where land is badly parcelled out and where there is so little land near the farm buildings that access to pasture is not possible, even in the daytime, is zero grazing considered as a prospect of farming in a modern manner. Although grazing losses are reduced, farm results have shown that machinery costs and expenditure on concentrates are much higher in this system than in traditional grazing and no direct financial advantage results from zero grazing.

Another remarkable feature is the amount of concentrates fed during the summer period. Per cow per day, 5.5 to 8.8 lbs. of concentrates are fed. This practice is very much discussed and criticised in the Netherlands because in grazing experiments it was seldom proved economical to feed concentrates to a cow with a production of 60 lbs. per day and less. However, this discrepancy between research and practice can perhaps be explained by the following factors which are affecting modern dairy farms with an increased number of cows per acre. The erection of a milking parlour with automatic feeders on a farm is often the starting point of increased concentrate usage because:

a. it is easy to feed concentrates;
b. cows remain in the milking parlour;
c. it ensures a good production level in periods of grass shortage or periods with poor quality grass;
d. it reduces grass intake by 0.6 lb. of dry matter of grass per lb. of concentrates given. With high stocking rates extra feed has to be bought in in any case and concentrates are easy to handle and to store with minimum losses;
e. the price ratio between milk and concentrates has developed favourably in the last few years.

Nevertheless, high use of concentrates during the summer period should be examined critically. The difference between the four farms in this matter proves that there is certainly a possibility to save on costs by a good grazing policy and a system of feeding whereby the cows that respond to concentrates really consume them and the cows with lower production are refused them.

Conservation is another important aspect of the utilization of produced herbage. A conservation system with low losses and a finished product with a high feed value and a high voluntary intake is of the greatest importance. The two largest farms referred to above conserve silage only and the two smaller farms are gradually changing over to silage making. This demonstrates the huge development in the field of roughage conservation which have taken place in the last few years. Table 9 illustrates this development. While in 1970 only 30% of the roughage was conserved

Table 9

Changes in conservation method. Use of mown area for different methods (%)

	1964	1970	1973	1974
Hay	72	65	50	42
Silage, total	23	30	47	54
Silage, high dry matter	7	20	33	45
Other products, mainly dried grass	5	5	3	4

in the form of silage, in 1974 it had risen to 54%. This trend is expected to continue in the future. The arrival of the high dry matter method, in which the grass is wilted in the field to a minimum of 40% dry matter has given an important boost to this trend, despite the fact that, compared with direct cut silage, the field period is lengthened, more field treatments must be carried out and heating occurs more easily than with a wet silage. To explain this trend, the following factors can be considered:

a. Mechanisation can be simple. On the average grassland farm this consists of a rotary drum mower, a tedder and a pick-up trailer. A chain of machines needed for direct cut silage consisting of a forage harvester and several trailers and tractors would be too large an investment.
b. Labour input in conservation can be spread over a long period.
c. Aftermath comes regularly available all through the grazing season.
d. Conservation and intake are positively influenced by the wilting of the grass.
e. With the use of tractor mounted silage cutters the heating of the silage during the feeding period is no longer a problem when the silage is taken out of the clamp once a week. Also, labour involved in feeding the silage is much reduced.

The important feature is that the method enables farmers, under Dutch conditions, to make a high quality silage from grass at an early stage of growth with high nitrogen fertilization. Farmers can take full advantage of a maximum of home produced feedstuffs also during the winter.

Finally, let us consider the financial results of the four farms. They are based on Dutch prices of milk and concentrates and are in this regard not directly comparable with Irish circumstances of today. However, the figures give an insight to the Dutch situation which can be, in the same Common Market, Ireland's situation tomorrow.

Tables 10 and 11 show that a margin per cow over bought in feeds of £400 to £500 was achieved. The gross margin per acre varied from £300

Table 10

Financial results of intensive grassland farms in The Netherlands

Farm (employed labour)		1.6	2.1	3.0	3.6
Gross output:	milk	510	530	523	537
£/cow	cattle	143	105	77	64
	sundries	—	1	11	—
	Total	653	636	611	601
Feed costs:	concentrates	107	132	136	88
£/cow	milk products	12	11	6	9
	roughage	60	34	65	6
	straw	—	—	3	1
	Total	179	177	210	104
Gross output-feed costs (£/cow)		474	459	401	497
Gross margin (£/acre)		393	360	400	301
Labour income (£/f.e. labourer)		5,853	7,410	8,394	6,819

to £400. This resulted in a labour income that varied from £5,800 to £8,400 per fully employed labourer. Net profit per 100 kg. milk varied from £0.52 to £1.06 per 100 kg. of milk. This results in a net profit of £4,000 to £7,000. In the costs, the importance of grassland management and feeding policy is expressed in the variation of costs of feedstuffs from £1.78 to £3.73 from 100 kg milk. Here the average Dutch farmer can make further progress.

Table 11

Costs, output and net profit per 100 kg of milk (£)

Farm (employed labour)	2.1	3.0	3.6
Labour	2.22	2.90	2.05
Casual labour	0.19	0.06	0.15
Machinery	1.06	0.94	1.05
Feedstuffs	3.06	3.73	1.78
Fertilizers	0.65	0.41	0.68
Land + buildings	1.36	0.59	1.67
Miscellanous	1.67	1.29	2.37
Total costs	10.21	9.29	9.75
Milk price	9.20	9.28	9.16
Cattle	1.82	1.37	1.09
Sundry output	0.03	0.33	0.02
Gross output	11.05	10.98	10.27
Net profit	0.84	1.06	0.52
Milk production (x 100 kg)	5190	6360	9500

Feeding the Spring Calving Cow Under Northern Ireland Conditions

by

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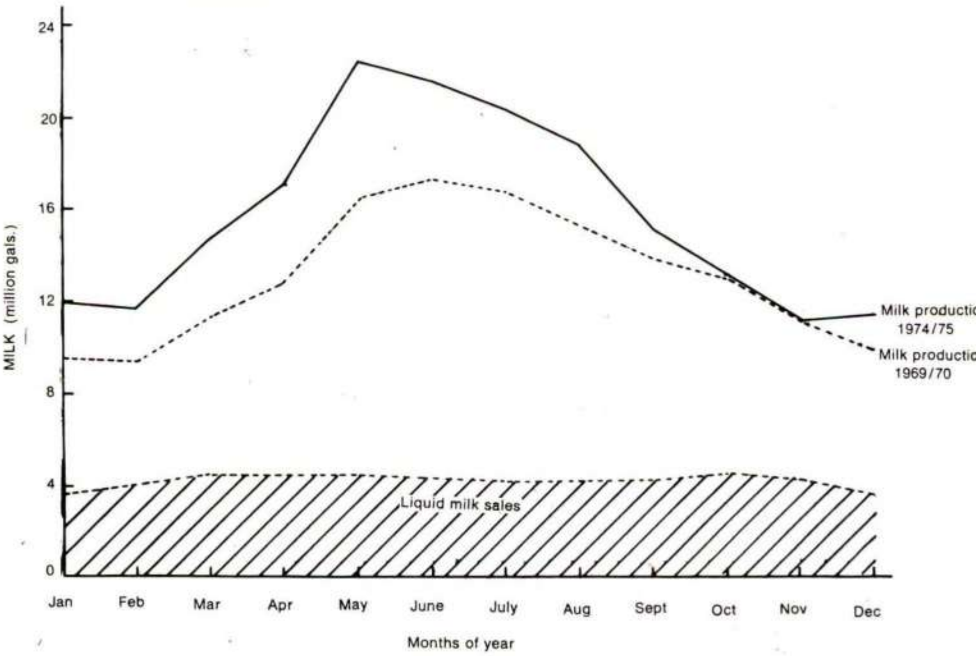
In Northern Ireland the pattern of milk production over the season has traditionally been more evenly distributed than in Southern Ireland. This has been due to the pricing policy of the Northern Ireland Milk Marketing Board with a considerable differential in price in favour of milk produced during the winter being maintained. This policy is similar to that used throughout the remainder of Great Britain where, because a large proportion of the total milk produced was required for the liquid trade, there was a need to stimulate winter milk production. During the late 1960's the Milk Marketing Board carried out a reappraisal of this policy and concluded that, as only 25% of the milk produced in Northern Ireland was required for the liquid Market, there was less need for such a high proportion of winter milk. It was therefore decided that it would be to the overall benefit of the dairying industry if a greater proportion of the milk was produced during the summer period at grass. On the question of timing of calving in the spring to produce this milk at grass it was felt that, while late spring calving would minimise production costs per gallon, milk output per cow would be reduced. A policy of January/February calving was therefore adopted as it was likely to reduce production costs considerably yet also maintain relatively good yields per cow. The monthly pattern of the prices for milk paid by the Milk Marketing Board was therefore weighted in favour of the January/February calving cow by increasing the price paid for milk during the early spring months and reducing that paid for early winter milk. During the past four years this change has resulted in a significant trend towards early spring calving as is demonstrated by the production trends shown in Figure 1. Over this period there has been no increase in the quantity of milk produced during the autumn but a considerable increase in that produced during the spring and early summer. It would seem likely that this trend will continue for some period in the future. It is for this reason that a January/February calving herd was established at the Institute to provide information on the optimum management of these animals.

Feeding during the dry period

Under Northern Ireland conditions these animals will normally be housed by mid November. They are given *ad libitum* access to medium quality, direct cut, grass silage. Silage intakes have been monitored dur-

Fig. 1. Seasonal Pattern of Milk Production and Utilisation in N. Ireland



ing the period from housing until calving and on average, one cwt. of silage has been consumed per day. The need to provide concentrates prior to calving depends upon the level of nutrition supplied by the basal diet and the body condition of the cow. In general terms, provided live-weight gains of $1\frac{1}{4}$ - $1\frac{1}{2}$ lb. per day are being achieved, additional concentrate feed is unlikely to provide an economic response. Over the past few years *ad lib* silage alone has produced average gains of $1\frac{1}{2}$ lb./day during the last six weeks of pregnancy. For this reason, in the system used at the Institute no concentrates are given during the dry period.

Feeding during lactation

Traditionally, January and February calving cows have been fed on a similar basis to those calving in the autumn. This implies feeding to meet the animals nutritional requirements for maintenance and milk production coupled with a degree of 'overfeeding' in early lactation in order to stimulate a high peak milk yield. At the outset it was therefore important to establish if, in view of the shorter time that the January/February calving cow spends indoors post calving, the level of feed could be reduced below that used for the autumn calver. The date of going to pasture in Northern Ireland is generally around mid-April, except in a few of the areas with drier land.

An experiment was carried out over a two year period using two groups of cows to examine the effect of reducing meal levels. One group was fed according to their nutritional requirements with an averege meal intake of 21 lb. per day from calving until going to grass. The second group received on average only 16 lb. meal per day and was therefore nutritionally being underfed. Both groups had *ad lib* access to the same direct cut medium quality grass silage during the 10½ week post calving indoor feeding period. The effects on milk yield both during the indoor period and at pasture are given in Table 1 below. All cows were stocked at the same rate at pasture (mean of 2.3 cows per acre over the grazing season).

Table 1

Effect of reducing concentrate feeding to January/February calvers Results fom 1972 and 1973

	A	B
Average meal/day (lb)	21	16
Milk produced indoors (gal)	441	421
Milk produced at grass (gal)	625	644
Total lactation yield (gal)	1066	1065
Total lactation concentrate (cwt)	16½	12

These results show that the cows given the lower level of meal feeding produced 20 gallons less milk indoors but went on to produce more milk at pasture. The overall result was that there was no effect on total lactation yield. This represents a considerable economic saving in feed costs to the farmer.

During 1975 and 1976 the effect of further reduction in meal feeding levels have been examined. Average meal intakes of 16, 12 and 8 lb. per day from calving until going to grass have been used. The results for the first year of this trial are given in Table 2 below. All cows were stocked at the same rate at pasture (mean of 2.3 cows/acre over grazing season.)

These results showed that when more severe underfeeding was practised the response in milk yield at grass was not sufficiently high to attain

Table 2

Effect of further reductions in concentrate intake Results for 1975

	A	B	C
Average meal/day (lb)	16	12	8
Milk produced indoors (gal)	380	355	347
Milk produced at grass (gal)	708	665	673
Total lactation yield (gal)	1088	1020	1020
Total lactation concentrates (cwt)	11	8½	5½

a similar lactation yield to the cows with the highest concentrate intake. Nevertheless it is important to appreciate that even at the extremely low level of feeding used with Group C the carry over effect on yield was only similar in magnitude to that of the direct effect. Even at this extreme level the carry over effect had not reached the large proportions of 2-3 times the direct effect so often quoted for the autumn calver.

Although at present prices in Northern Ireland there is little difference between the three groups in terms of milk returns less the cost of concentrates, our present advice to the industry would be to feed 16 lb. meal/ day. This is particularly important if milk quality as assessed by solids non fat or protein content is to be maintained. There is also the fact that the animals given the lower concentrate level will have a greater requiremet for silage. However it is worth bearing in mind that even at low meal levels yields of over 1,000 gallons per cow can be achieved under good management.

The effects on overall animal liveweight and milk quality are given in Table 3.

Table 3

Effect of reduced feeding on milk composition and liveweight

Group	A	B	C
Average meal (lb/day)	16	12	8
Liveweight			
Wt before calving (cwt)	11.9	11.9	11.9
Wt at going to grass (cwt)	10.4	10.0	9.8
Wt at next calving (cwt)	12.3	12.3	12.1
Milk composition			
Winter period—Butterfat (%)	3.71	3.62	3.70
Solids non fat (%)	8.64	8.61	8.56
Total lactation—Butterfat (%)	3.86	3.80	3.83
Solids non fat (%)	8.74	8.71	8.70

Pattern of feeding

As the mean period from calving until going to grass is of 10 - 11 weeks duration it was considered important to establish if there was any difference between feeding at a uniform rate per day from calving until turnout and giving the greatest proportion of the meal during the period immediately after calving followed by a period of reduced meal intake. This latter approach would be in line with the information produced for the autumn calver by Dr. Broster at the National Institute for Research in Dairying in which the ability to obtain a high peak yield has been shown to be important. Two systems of meal allocation were therefore tested. The first was a uniform feeding level from calving until going to grass and the second a high level for 4 weeks after calving followed by a lower level. The results obtained are given in Table 4 below.

Table 4

Effect of pattern of feeding concentrates to cows
(Results from 1975)

Feeding system	Total meal (cwt)	Milk produced indoors (gal)	Milk at grass (gal)	Total lactation
Uniform	8½	360	682	1042
High for 4 wks then low Total meal	8½	361	681	1042

Although these are only the results from the first year of the two year trial it would seem that there is unlikely to be any difference between the two systems of meal allocation.

Effect of stocking rate

In any system which is based on achieving a high output of milk from grass it is important that the cows are properly stocked at pasture. Two stocking rates of 2.6 and 2.0 cows per acre over the total grazing season have been compared over a 2-year period. The effects on production are shown in Table 5.

Table 5

Effect of stocking rate during grazing season
(Results for 1972 and 1973)

Stocking rate (cows/acre)	2.0	2.6
Milk per acre (gal)	1280	1489
Liveweight change/cow (cwt)	+1.0	+0.5
Milk per cow (gal)	1104	1026

There was therefore a considerable decline in milk yield per cow at the higher stocking rate. Nevertheless in terms of output per acre the higher stocking rate resulted in an extra 209 gallons of milk per acre. This high output of milk at 1,489 gallons per acre demonstrates firstly the milk producing potential of grass and secondly the ability of the January and February calving cow to exploit this potential. There remains the conflict for each farmer of deciding how far he is prepared to increase stocking rate at the expense of performance per cow.

General conclusions

The results obtained at Hillsborough have clearly shown that considerably lower daily meal inputs may be used with the January/February calver during the winter than those normally associated with the autumn calver. This reflects the ability of the spring calver to either completely or partially eliminate the normal detrimental effects of obtaining a low peak yield when put to pasture. The results demonstrate the ability to achieve good yields per cow even at low meal inputs and high stocking rates provided the proper animals and management level are used. However, in Northern Ireland maximum profitability to the individual farmer is obtained by a mild rather than severe degree of underfeeding. With medium quality silage this would be obtained by feeding 16 lb. meal. Nevertheless the overall efficiency of the lowest meal input system is remarkably high and worth consideration. For example the results for 1975 showed an average milk yield of 1,020 gallons per cow with the use of $5\frac{1}{2}$ cwt. of meal.

An assessment of the total silage consumed along with the area grazed indicated that this was produced at an overall stocking rate of 0.85 acres per cow. That is:

1 cow + 0.85 acres + $5\frac{1}{2}$ cwt. concentrates produced 1,020 gal. milk.
Assuming $5\frac{1}{2}$ cwt. concentrates is equivalent to $4\frac{1}{2}$ cwt. barley + 1 cwt. of groundnut and minerals, $4\frac{1}{2}$ cwt. barley can be produced from 0.13 acres (based on 35 cwt. barley/acre).
Total acreage in overall system = 0.85 acres grass + 0.13 acres barley (0.98 acres).

Milk output per total acre of land used in the system is 1,041 gal. This is a very high figure and represents very efficient use of our land resources. If such a system is compared with what would be considered a very good high input system, a considerable contrast is obtained. For example, consider a high yielding herd producing 1,300 gallons per cow and being given 30 cwt. of meal (2.6 lb./gal.) this would be stocked at a slightly lower level of around 1 acre per cow in order to allow the cow to achieve her potential. Then:

1 cow + 1 acre grass + 30 cwt. meal = 1,300 gals.

Again, assuming 30 cwt. meal is equivalent to 25 cwt. barley + 5 cwt. of groundnut or other protein supplements, 25 cwt. barley can be produced from 0.7 acres (based on 35 cwt./acre).

Total acreage in system = 1 acre grass + 0.7 acres barley (1.6 acres). Milk output per total acre of land used is 765 gals. (ignoring protein supplements).

In terms of efficiency of total land used in the system this latter system only produces 73 per cent of that of the first system. In fact the system feeding 30 cwt. meal would require to produce an average yield per cow of 1,770 gals. before it would become as efficient as the low input system.

These calculations are based on achieving efficient use of our land, but it is appreciated that for the individual farmer it may be more profitable to buy acres by feeding purchased concentrates. In this there lies the clear conflict between maximum profitability to the individual farmer and the overall efficiency of use of land resources. This leads to the question of where does the future of milk production lie? Is it to be in a high yield system based on imported feedingstuffs or is it to be based on achieving maximum efficiency in using our own land with minimum inputs from outside?

SIXTH RICHARDS-ORPEN MEMORIAL LECTURE

Recent Developments in Reproductive Physiology in Cows

by

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Introduction

I would like to thank sincerely the trustees of the Edward Richards-Orpen Memorial Trust for inviting me to present the Sixth Memorial Lecture. I interpret this invitation as recognition of the progress made by the Agricultural Institute in reproductive physiology. I was not privileged to know Mr. Edward Richards-Orpen but from the tributes paid to him by previous speakers, the loss was indeed mine.

In 1974 cattle represented 46% (£238 million) of total agricultural output and milk 33% (£180 million). Of 1.8 million calves born, one-third were beef calves and the remainder came from the dairy herd. Usually, about 75% of dairy calves are used for beef production. Since beef and dairy production account for 79% of total agricultural output, it follows that the national cow herd is the foundation stone of agricultural output. Therefore, any increase in reproductive efficiency of our cows will have a major effect on agricultural output, farm income and the national economy. Hence, it is appropriate to review the reproductive efficiency of the national cow herd.

Reproductive efficiency of national herd

A 12 month calving interval increases annual output in dairy or beef suckler herds. Hence, the target must be to get each cow in calf within 82 days of previous calving. Hartigan, Langley, Nunn and Griffin (1974) found that the interval between calving and first heat was 49 days in 86 spring calving dairy cows in Munster. Cunningham, Shannon, Fallen and O'Byrne (1976) found that the calving interval of 44 spring calving dairy herds was 363 days, and the average culling rate was 12.2%. This indicates a high level of reproductive efficiency. However, in a survey of the Leinster area, which includes winter milk producers, Crowley, Hartigan and Lacy (1967) found that the average interval between calving and first insemination was 82 days and the calving interval was 380 days for the 89.9% of cows that calved. Thus, the calving interval may be slightly longer in the Leinster area than in other parts of the country where winter milk production predominates. Similar data on the calving interval in suckler beef herds are not available.

Over the past four years between 50% and 60% of cows were bred by artificial insemination (A.I.). In a survey carried out jointly by The Agricultural Institute and Galtee Cattle Breeding Station on the reproductive efficiency of cows following A.I., 95% of the 3,096 dairy cows in the survey calved to A.I., which is a very satisfactory performance. There were significant effects of sire and of operator on conception rate. The day of the week and using the same or a different sire for a repeat insemination did not affect the conception rate. Calving difficulties were reported for 4.4% of births, and 3.7% of all calves were born dead or died within 24 hours. If the results of this survey are indicative of the calving rate to A.I. in the country, they indicate that conception rate to A.I. is very satisfactory and as good in Ireland as overseas. Furthermore, in a comparision of fertility following A.I. or a single service from a bull, no difference was obtained (O'Farrell, 1973).

Calving pattern

Over 85% of cows calve between January and June each year. Both beef and dairy production systems are based on maximum utilization of grass and conserved grass products because these are the cheapest feeds available. The large majority of cows must calve before mid-March in order to achieve maximum production from peak grass growth from April to June. Cunningham *et al.* (1976) reported that the mean calving date of dairy cows was March 27 and Cunningham (1972) also reported that 40.2% of 16,196 cows calved between April and June. In Tipperary (County Tipperary N.R. Comm. of Agr. Report, 1970-'71) 34% of cows calved after April 1 and it was considered that the major reason for low milk yields was late calving. Type of mating, natural or artificial, did not affect the calving pattern, indicating that management was the key factor responsible. Late calving resulted in lower financial returns from the sale of milk and poorer prices for late born calves, as well as preventing maximum production from the use of early spring grass.

In Tipperary, it was also shown that the calving date of heifers was even later than that of cows since 62% of the heifers calved after April 1. Cunningham *et al.* (1976) found that heifers calved on average 18 days later than cows (April 15). The late calving of heifers is a consequence of the majority of calves being born in March and April and heifers being bred at 15 months of age. Heifers must calve down as early as possible in the calving season if an early calving herd is the objective. In the case of heifer replacement calves, the earlier they are born in the calving season, the earlier they can be bred the following breeding season. In the case of a cow, the date of calving is the main factor determining when she can be re-bred and therefore it is difficult to get them to calve much earlier the following year.

In beef suckler herds Barlow *et al.* (1974) reported that the mean calving date was April 5. This late calving date was a major factor in the production of light weanlings in the autumn.

Financial cost of late calving

In 1974 about 1.2 million dairy cows calved in the spring, which means that about 480,000 calved after April 1. If the calving date of these cows could be brought back by 30 days, they would on average produce an extra 42 gallons of milk per lactation (Cunningham, 1972) at little extra cost since most of the production would come from early grass. National production would increase by 20.16 million gallons of milk, worth an extra £6.45 million income to dairy farmers.

Likewise in suckler cows, if the calving date could be brought back by 30 days, an extra 27 kilos of liveweight at weaning would result, valued from £8 to £12. The half million suckler calves could be worth an extra £4 to £6 million to the beef industry of Ireland. Therefore, the national aim should be to bring forward the calving date of all cows calving after April 1, which would increase significantly milk and beef output.

Having illustrated the importance of reproductive efficiency in the national herd both to the country and the farmer, and shown the economic loss that results from the present calving pattern, the remainder of this lecture will be concerned with factors affecting reproductive efficiency in cows. The development of new techniques for controlling reproduction will also be discussed and the role they can play as an aid to the reproductive management of cows in present day Irish farming will be put in perspective.

Resumption of reproductive activity after calving

There is a wide variation in the interval from calving to first heat. This interval varies from 18 to 76.3 days for dairy cows and from 40 to over 100 days for beef cows (Morrow, Roberts and McEntee, 1969). Clapp (1937) showed that the frequency of milking affects this interval since cows milked four times daily had a 23-day longer interval than those milked twice daily while continuous suckling by the calf or four times daily milking resulted in the same interval to first heat. In experiments at Grange, first lactation cows suckling calves had a mean interval of 51.6 ± 9.5 days from calving to first observed heat while animals milked twice daily had a mean interval of 26.5 ± 3.0 days. The level of milk production also affects the interval. It has been shown that each increase of 1,000 lb. of 4% milk delays the post-partum interval by 1.5 days (Morrow, Roberts and McEntee, 1969).

In autumn calving beef sucklers at Grange (Roche and Drennan, unpublished data), both the plane of nutrition and bodyweight affected the post-partum interval in first lactation cows as is shown in Table 1. This illustrates the fact that heifers should calve down in reasonable body condition and not lose weight following calving until they are in calf again.

Heat detection

This is the key factor to efficient reproduction where artificial insemination is being used. The single most important indicator of heat in the cow is *standing to be mounted* by other animals. However, not all cows will stand to be mounted and it is important to watch for other signs such as restlessness, presence of clear mucus on the vulva or tail and a red or swollen vulva. The proportion of cows identified as being in heat is

Table 1

Effect of weight gain on interval from calving to first heat in autumn calving first lactation cows

Plane of nutrition	No. of cows	Range of calving dates	Body wt. after calving (kg)	Body wt. mid Nov. (kg)	Interval from 1st heat (days)	No. not observed in heat
Silage + barley after calving	15	23/8 to 2/10	385	395	45±3.6	None
Silage only	23	8/9 to 15/10	388	363	61±3.0	4/23
Silage + barley from mid Nov.	24	21/8 to 26/10	360	344	67±2.8	2/24

determined by the number of times each day the cows are checked for heat. Research in large dairy herds (Williamson, Morris, Blood and Cannon, 1972) has shown that 9% of cows actually in heat were missed when checks were carried out at 7.00 a.m., 12 noon and 4.00 p.m. This increased to 16% if cows were checked at 8.00 a.m. and 4.00 p.m. A single check resulted in 25% of the cows in heat being missed. Between 20 and 30% of dairy cows have standing heat periods of less than 7 hr. duration (Esselmont, 1974). To pick out the maximum number of cows in heat, it is necessary to check them four times daily at 7.00 a.m., 12 noon, 4.00 p.m. and 10.00 p.m.

Efficient heat detection requires an observant stockman, an easy system of identification such as plastic ear tags or freeze branding, a pencil and note book. Heat detection cannot adequately be carried out while animals are being brought in from the paddock or during milking. It should be done while the animals are at pasture.

Beef cows

Heat detection in beef cows is more difficult than in dairy cows. The behavioural signs of heat are less intense. They are also more prone to show silent heats and have a longer interval from calving to first heat. Thus, many beef farmers use their own bull and therefore cannot avail of the higher genetic merit of bulls standing at A.I. stations. In addition, choice of breed when using natural mating is limited by the cost of a bull.

Silent heats

A silent heat occurs when the cow releases the egg from the ovary (ovulation) without showing any visible behavioural signs of heat. The cow is ready for breeding but is not observed. The frequency of silent heats is related to the length of the post-partum interval. In a large survey in the U.S., 68% of cows had a silent ovulation before first heat (Morrow, Roberts and McEntee, 1969). Forty-four percent of ovulations during the first 60 days after calving were not accompanied by behavioural signs of heat while 11% of ovulations 60 or more days after calving occurred without oestrous symptoms. Hartigan, Langley, Nunn and Griffin (1974) found that 25% of dairy cows had silent heats up to day 60 after calving. High yielding dairy and suckling cows are more prone to have silent heats. The occurrence of silent heats makes it more difficult to achieve a 365-day calving interval.

Synchronization of oestrus

Because time of standing heat cannot be predicted in cows and due to the problems of heat detection and occurrence of silent heats, work was begun at Grange in 1971 on methods to control the oestrous cycle of the cow so that time of A.I. could be predicted days or weeks in advance. The aim was to treat cows with hormones for a short period and inseminate at a pre-determined time eliminating the need for heat detection. Scientists in many countries have been working on this problem and while heat can be synchronized, the fertility to matings at the controlled heat has been low (Jochle, 1972; Dziuk, 1974). At Grange the objectives were:

i) develop a practical method of administering hormones to cows.
ii) Overcome the low fertility at the synchronized heat.

Control of the oestrous cycle

Before discussing synchronization of heat, it is important to describe the normal pattern of reproduction in the cow. Following calving, dairy cows on average will show first heat at about six weeks while in beef cows, the return to first heat is delayed by a further three to six weeks. A non-pregnant cow or heifer will show heat about every 21 days with a range from 18 to 24 days. The length of standing heat in individual cows can vary from one to 30 hr. depending on age, season, stress and nutritional status of the cow, but generally lasts 12 to 18 hr. in most cows. The egg is released from the ovary (ovulation) about 10 to 14 hr. after the end of standing heat.

Following ovulation the egg passes down the female reproductive tract and will meet sperm from the male if breeding has taken place. The follicle on the ovary from which the egg has been released forms a new structure called a corpus luteum, which takes 4 - 5 days to reach maximum size. This corpus luteum secretes the hormone progesterone and at high concentrations in the blood, this hormone prevents the animal from showing any further heats. While progesterone levels are high, levels of other hormones in the blood are low. About 16 or 17 days after heat in the non-pregnant animal, the corpus luteum degenerates very rapidly, consequently progesterone levels in the blood fall and the levels of luteinizing and follicle stimulating hormones and oestrogen rise and normally within 2 - 4 days, the animal is back in standing heat, ovulates again and a new cycle is initiated.

Methods of synchronization

To synchronize oestrus in a group of animals it is necessary to be able to control the corpus luteum and thereby the level of progesterone in the blood. This allows one to predict the time of next heat. There are two basic approaches to the problem :

i) to administer progesterone for the length of an oestrous cycle of 18 to 21 days. The progesterone has little or no effect on the normal life span of the corpus luteum but it prevents the animals coming into heat until the corpora lutea in all treated animals have regressed. When the progesterone treatment is terminated after 18 to 21 days, about 95% of the animals will come into heat 2 to 6 days later. However, fertility both to natural mating and A.I. is low at this synchronized heat and this treatment is of little commercial value;

ii) to shorten the life span of the corpus luteum by using either an oestrogen in conjunction with a short-term progesterone treatment (9 to 12 days) or by administering prostaglandin F_2. Following either of these treatments, fertility has been reported to be normal to A.I. at the synchronized heat (Roche, 1974a; Sreenan, 1975; Wiltbank and Gonzalez-Padilla, 1975; Chupin, Pelot and Thimonier, 1975; Roche, 1976a).

Administration of progesterone

The commercial application of oestrous synchronization in cattle with progesterone requires a simple, practical method of administration of the hormone. Intravaginal sponge pessaries have been tried but results have been variable, particularly in cows, where the loss rate of the sponges from the vagina is higher than in heifers (Carrick and Shelton, 1967; Sreenan, 1974). Recently, Sreenan, (1975) has reported good retention rates of sponge pessaries containing progesterone in heifers.

At Grange, work has concentrated on the development of a silastic coil containing progesterone for the administration of progesterone (Roche, 1976b). Stainless steel strips 30 cm long, 3.2 cm. wide and 0.0203 mm. thick were coated with silastic rubber which contained the progesterone. Following hardening of the rubber, the strips were coiled to a diameter of 5.5 cm. and inserted into the vagina of cows or heifers with the aid of a plastic speculum 3.6 cm in diameter. A nylon string which had been attached previously to the posterior end of the coil was left protruding from the vulva and this was used to remove the coil subsequently. The smaller the diameter of the coil, the lower the number of coils lost during treatment (Table 2). The silastic coil, therefore, is a practical method of administering progesterone to cows.

Development of a 12-day progesterone treatment

The development of a 12-day progesterone treatment has been described previously (Roche, 1974a, b) and therefore will only be summarized here. Initial work confirmed that treatment of heifers with progesterone for 18 to 21 days resulted in a high synchronized oesrous response but low fertility to natural or artificial mating at the synchronized heat. Normal fertility was achieved by reducing the period of progesterone treatment to between 9 and 12 days. This necessitated using a second

Table 2

Retention rate of progesterone impregnated silastic coils following a 12-day period in cows or heifers

Year of trial	Diameter of coil, cm	Environment	Type of animal	No. of coils inserted	No. of coils removed	% retention rate
1974	5.5	Pasture	Cow	784	724	92
,,	5.5	,,	Heifer	499	480	96
,,	>5.0	Housed	Cow	309	271	88
,,	>5.0		Heifer	128	117	91
1975	5.0	Pasture	Cow	1257	1155	92
,,	7.0	,,	Cow	1142	984	86
,,	5.0	,,	Heifer	680	649	95
,,	5.2	Housed	Cow	403	395	98
,,	5.2	,,	Heifer	301	295	98

hormone at the start of treatment to shorten the oestrous cycle by causing the corpus luteum to regress prematurely. Wiltbank and Kasson (1968) originally used oestrogen for this purpose, but when we used oestrogen with a 9-day progesterone treatment, it was ineffective in causing premature regression of the corpus luteum in animals shortly after heat. However, injecting extra progesterone with the oestrogen in animals between day 0 and 3 of the cycle at the start of treatment resulted in a high synchronized oestrous response when a 12-day progesterone treatment with implants was used (Roche, 1974a). The demonstration that extra progesterone was required with the oestrogen at the start of a 9 to 12-day progesterone treatment using implants has now been confirmed by others (Mauleon, 1974; Sreenan, 1975; Wiltbank and Gonzalez-Padilla, 1975). Having developed a practical method for administering progesterone and an effective 12-day progesterone treatment, which gave normal fertility to A.I. after treatment, farm trials were conducted in 1974 to substantiate the value of the new treatment under the different management situations prevailing at farm level.

Results of farm trials

In 1974, 412 Friesian dairy cows received the 12-day progesterone treatment as described. Following removal of the coils, the cows were inseminated once as they came in heat 2 to 6 days after treatment. The calving rate in these cows was compared to the calving rate in 384 similar non-treated cows on the same farms bred by A.I. These trials showed that the majority of cows were detected in heat the second and third day after removal of the coils and that calving rate to a single insemination was similar in synchronized and control cows (Table 3).

Having established the fact that the 12-day progesterone treatment did not reduce fertility, experiments were conducted at Grange and Clonroche to determine if the time of insemination could be fixed following treat-

Table 3

Onset of oestrus and calving rate in the 12-day progesterone treated animals and controls

	12-day progesterone treatment		Control
	Heifers	Dairy cows	Dairy cows
No. of coils inserted	156	412	384
No. of coils removed	153	378	—
No. of animals inseminated	143	342	365
No. present at calving	139	311	337
Onset of oestrus Day 2	104	242	
3	20	62	
4	16	16	
5	1	18	
6	2	4	
% non-return rate	63	53	55
No. calved to 1st insemination	83	170	169
No. calved to repeat	40	71	71
% of treated cows that calved	53	41	44
% of animals inseminated that calved	58	45	46
% of animals present at calving that calved	60	55	50

ment. Mature Hereford cross heifers were inseminated as they were detected in heat to serve as controls. Similar heifers received the 12-day progesterone treatment and were inseminated at various intervals after treatment (Table 4). Normal fertility was obtained after the 12-day progesterone treatment when heifers were inseminated after treatment (a) at heat, (b) once at 56 hr. or (c) twice at 56 and 74 hr. A single insemination at 74 hr. after treatment resulted in significantly lower fertility. These results indicate that a single or two fixed time inseminations would give normal fertility.

In 1975, further farm trials were carried out to confirm if fixed time A.I. after a 12-day progesterone treatment was practical (Roche, O'Farrell, Prendiville, Davis and Condon, 1976c). Two types of control cows were used in order to establish the normal level of reproductive efficiency in the herds under study (Table 5). In the first group of controls, the number of cows that had already been inseminated was taken to establish the normal level of fertility. In the second type of controls, cows selected at random were checked for heat over a 24-day period beginning the day the coils were inserted. They were inseminated in normal farm practice as they were detected in heat. The number of cows inseminated during the 24-day period was taken to indicate the normal level of reproductive activity and the number of these that held to A.I. would indicate the fertility level in the herds. Thus, it was possible to compare the number of synchronized and control cows which went in calf over a given period of time.

Table 4

Pregnancy rate in heifers following a 12-day progesterone treatment and insemination on a fixed time basis.

	Control	12-day progesterone treatment		
	AI at oestrus	AI at 56 hr	AI at 74 hr	AI at 56 hr + 74 hr
No. of heifers	24	26	25	25
No. inseminated	24	26	24	25
No. with repeats	10	4	6	4
No. pregnant	14	17	11	17
% pregnant to AI	58	65	46	68

Table 5

Conception rate in control and 12-day progesterone treated cows following AI at different times in farm trials in 1975

	No. of coils inserted	No. removed	Cows inseminated No.	Cows inseminated %	120-day non-return rate
Treated Cows					
AI at heat	692	637	522	75	63
AI at 56+74 hr	709	653	653	92	69
AI at 56 hr	349	321	321	92	71
			1496		67
Control Cows					
Already bred			533	100	66
Nominated for AI for 24 days		769	512	67	66
			1045		66

The 120-day non-return rates for these Friesian dairy cows are shown in Table 5. In the control cows already inseminated, the non-return rate was 66%. In the other controls, 66% were detected in heat by the farmers and inseminated, and the non-return rate of these inseminated cows was the same as the first control group. It is important to point out that 34% of the cows in the latter group which were not observed in heat may have had a silent heat or may have been in heat but were not detected. This may indicate that detection of heat in dairy cows is a bigger problem than is at present realized. The retention rate of the progesterone coils (Abbott Labs., U.S.A.) was 92% and the non-return rate in these cows following insemination once or twice on a fixed time basis after treatment was similar to controls. Where synchronized cows were to be inseminated following an observed heat, only 82% of the cows were detected in heat

2-5 days after removal of the coils and again the non-return rate in these cows was similar to controls. The fact that a single insemination at 56 hr. after treatment gave the same non-return rate as two inseminations at 56 and 74 hr. after treatment indicates that the onset of oestrus was sufficiently precise to allow one insemination to be used.

Significantly more synchronized cows were inseminated on the 14th and 15th day after treatment started than in the control cows over the 24-day period when the farmer was checking for heat. A high submission rate to A.I. was achieved by using synchronization. This should result in a large batch of cows calving early in the spring with consequent higher milk yield. It would also allow farmers to dry off all cows at the same time in the winter with little effect on total milk production.

The effect of progesterone on the post-partum interval

Experiments were carried out at Moorpark, in conjunction with my colleague Mr. Kevin O'Farrell, in Friesian dairy cows to determine how long cows needed to be calved before they will give a high synchronized oestrous response after the 12-day progesterone treatment. The data in Table 6 show that a high synchronized oestrous response was obtained in animals which were treated 30 or more days after calving irrespective of whether or not they had been previously detected in oestrus.

Table 6

The effect of the post-partum interval in dairy cows on the synchronized oestrus response following the 12-day progesterone treatment (O'Farrell & Roche, unpublished)

Treatment	Post-partum interval (days)	No. of cows	Observed in oestrus	
			No.	%
Controls	10-30	35	6	17
	31-45	29	15	52
	45+	14	14	100
12-day progesterone	10-20	24	13	54
	21-30	37	20	54
	30+	85	73	86

Since 40% of the control cows were detected in heat more than 45 days after calving, this suggests that the progesterone-oestrogen injection followed by the 12-day progesterone treatment advances the time of first heat after calving in some cows. This would have a beneficial effect on the calving pattern in a dairy herd. In another experiment, 23 late calving cows, in good body condition and with an average post-partum interval of 24 days, were rectally examined and found to have inactive ovaries. They were given the 12-day progesterone treatment (O'Farrell and Roche, unpublished data). Within 3 days of removal of the coils, 19 cows were detected in heat and were inseminated. Thirteen animals were subsequently diagnosed pregnant to this insemination and 11 calved down. This again suggests that this 12-day progesterone treatment advances the time of first fertile oestrus in late calving dairy cows.

Simplification of 12-day treatment

The present treatment consists of the insertion of a progesterone coil into the vagina for 12 days and an injection of oestrogen + progesterone at the start of treatment. More recently, we have found that, by using the progesterone coil, the release rate of progesterone from the coil is sufficiently large and rapid (Maurer, Webel and Brown, 1975) that only oestrogen need be injected at the start of treatment. In order to eliminate the need to inject the oestrogen, gelatin capsules containing the hormone were attached to the inside of the coil. These capsules dissolve within 1 hr. in the vagina and release the hormone. Farm trials were conducted to determine the efficacy of the capsule technique. The onset of heat and the non-return rate were similar indicating that capsules were as effective as the injection (Table 7). With the elimination of injection, the 12-day progesterone treatment is simple and the idea of farmers treating their cows should be considered, having made prior arrangement for a single insemination at a fixed time. As in sheep, a similar treatment does not require professional supervision.

Table 7

Effect of administering oestrogen by intra-muscular injection or by gelatin capsule attached to the coil on heat response and 60-day non-return rate to AI at heat or on a fixed time basis

	Injection	Capsule
No. of coils inserted	128	141
No. of coils removed	125	137
Allocated for AI at heat	60	65
No. detected in heat	56 (93)[1]	51 (84)[1]
No. of repeats	23	21
Non-return rate	59	59
No. allocated for fixed time AI	65	72
No. of repeats	19	28
Non-return rate	71	61

[1] = percentage

The 12-day progesterone treatment developed at Grange is simple to administer, results in normal fertility to a single insemination on a fixed time basis and can induce heat to occur earlier in late calving cows.

Use of prostaglandins to synchronize oestrus

Effective synchronization of oestrus necessitates control of the corpus luteum and it has been demonstrated that an injection of prostaglandin will cause premature regression of the corpus luteum in cattle. However, prostaglandins are not effective in non-cyclic animals or in cyclic animals for four or five days after heat. Therefore, if a group of animals at different stages of the cycle are treated with prostaglandin, about 66% will respond to the first injection and show heat 2-3 days later. These animals are not bred but all animals receive a second injection 11 or 12 days later. Following this second injection, 90 to 95% of animals will be in heat within three days (Cooper, 1974; Hafs, Manns and Drew, 1975). The use of the two injections of prostaglandin 11 or 12 days apart is a simple method of overcoming the fact that animals have to be at a certain stage of the cycle in order to respond to the prostaglandin. To confirm the efficacy of the synthetic analogue of prostaglandin $F_2\alpha$ (Estrumate, $F_2\alpha$ ICI Ltd.) to control oestrus, 72 heifers were given two injections each of 500 ug, 11 days apart. The occurrence of oestrus was determined by observing standing heat. Thirty heifers were found to be in oestrus at 48 hr., 21 at 72 hr. and 8 at 96 hr. after treatment, while eight of the 13 remaining heifers had cervical mucus indicative of heat.

Another method to synchronize heat is to use progesterone coils to suppress oestrus for seven days and then give a single injection of prostaglandin on removal of the coils to cause regression of the corpus luteum. This treatment gives good synchronization of oestrus in cycling animals and also results in normal fertility to A.I. (Roche, 1976a).

Field trial results with heifers

Friesian dairy replacement heifers were given a double injection of Estrumate 11 or 12 days apart and were inseminated at different times after the second injection. Control heifers were inseminated at oestrus. The results in Table 8 show that a single insemination at oestrus or two inseminations on a fixed time basis 18 to 24 hr. apart gave normal fertility. A single insemination on a fixed time basis 48, 60 or 72 hr after the second injection of Estrumate resulted in significantly lower fertility than that of the controls.

Field trials were also carried out on Hereford cross beef cows (Roche, 1967a) allocated as follows: (i) a control group with animals inseminated at oestrus; (ii) a group given the double injection of Estrumate 11 or 12 days apart; (iii) a group which received silastic coils impregnated with progesterone for seven days followed by a single injection of Estrumate. Both groups of treated cows were inseminated 72 and 96 hr. after treatment. There were no differences in fertility between control cows and cows which received the double injection of Estrumate (Table 9). However, significantly more cows were inseminated and calved following the progesterone+Estrumate treatment than in either the control or double injection treatment. This demonstrated the beneficial effect of progesterone treatment in post-partum beef suckler cows. A comparison of control and synchronized cows showed that significantly more synchronized cows were bred during the first 14 days of the breeding season and subsequently calved down than in the control cows, demonstrating that synchronization brings calving forward.

Table 8

Effect of time of insemination on fertility in heifers after the double injection regimen of Estrumate 11 days apart

Treatment	No. of heifers	No. bred	Time of AI	No. pregnant	% of those bred pregnant	% of total pregnant
Trial 1						
PG	20	20	48 hr	2	10	10
PG	16	12	72	3	25	19
PG	16	12	48+72	6	50	38
Controls	16	10	at oestrus	6	60	38
Trial 2						
PG	35	35	60	10	29	29
PG	36	36	60+74	19	53	53
PG	81	73	at oestrus	48	66	59
Controls	24	24	at oestrus	11	46	46
Trial 3						
PG	72	72	72+96	33	46	46
PG+GnRH	75	75	72	24	32	32
PG	17	17	72	9	53	53
PG+GnRH	17	17	72	7	41	41

Table 9

A comparison of pregnancy rate in beef suckler cows following the double injection of Estrumate and progesterone + Estrumate treatment

	Control	Double injection of Estrumate	Prog. + Estrumate
No. treated	107	278	204
No. bred	90	234	196
No. pregnant	42	93	107
% bred pregnant	47	40	55
% treated pregnant	39	33	53

Comparison of progesterone and prostaglandin treatments

The pregnancy rates after the 12-day progesterone treatment (Abbott Labs., U.S.A.) and the double injection of Estrumate (ICI Ltd) were compared in 321 mainly Friesian heifers at pasture and in 274 Hereford cross suckler cows at pasture. Animals treated with progesterone were inseminated at 56 and 72 hr. after treatment while animals treated with Estrumate were inseminated at 72 and 96 hr. after treatment. There were no differences in pregnancy rate following either treatment in heifers where an overall 52% pregnancy rate was obtained. In the post-partum suckler cows, significantly more cows became pregnant following the 12-

day progesterone treatment (55% pregnant) than following the double injection regimen of Estrumate (32% pregnant). This effect of progesterone was explained by the fact that 30% of the suckler cows in these trials were diagnosed as having inactive ovaries at the start of treatment and in these cows response to Estrumate was poor whereas the response to the 12-day progesterone treatment was as good as in the cows diagnosed as having active ovaries. The double injection regime of Estrumate is effective in synchronizing oestrus in heifers or beef cows that are cycling. It will not initiate resumption of reproductive activity in anoestrous cows and the results obtained in a group of heifers or cows will be directly related to the number that are cycling. In addition, it will induce abortion in pregnant animals up to five months, so every precaution must be taken to ensure that pregnant animals are not treated with Estrumate. If there is doubt as to whether a cow is pregnant or not, a veterinarian should carry out a pregnancy diagnosis before treatment, and for this reason it is available commercially through veterinary surgeons.

Other methods of synchronizing oestrus

A synthetic progestagen, similar in action to progesterone, and administered by a small ear implant has been developed by G. D. Searle & Co. (Wishart and Young, 1974). The recommended treatment consists of a 9-day treatment with the ear implant and an injection of oestrogen and the progestagen at the time of insertion of the implant. Results from the Agricultural Institute, Belclare (Mulvehill and Sreenan, unpublished data) of farm trials using this method are given in Table 10. Results from the use of an intravaginal sponge containing 3 gm progesterone inserted for 10 days and an oestrogen-progesterone injection given at the start of treatment (Sreenan, 1975) are also presented in this table. Both of these methods are effective in synchronizing heat. To date, they have been used mainly on heifers and suckler cows.

Table 10

Calving rate following sponge pessary or ear implant treatments (Sreenan & Mulvehill, 1976, unpublished data)

	Heifers		Beef cows	
	Calved to fixed time[1] AI		Calved to fixed time[1] AI	
	No.	%	No.	%
Pessary	365	62	270	48
Ear implant	17	71	181	65

1 = AI at 48 and 72 hr

Advantages and disadvantages of synchronization

Synchronization of heat allows one to appoint the time of A.I. weeks in advance. There is no need for heat detection. It will also eliminate the problem of silent heats if the progesterone method of synchronization is used. It will allow the breeding programme to be planned in advance. By treating cows two weeks in advance of the breeding season, it is possible to inseminate over half of the herd on the first day of the breeding season and obtain normal fertility in these cows. Thus, a large batch of cows calving early in the breeding season is obtained. This should ensure that sufficient replacement heifers for the herd are born early and these can breed earlier the following year than in the case of a herd with a normal calving pattern. In the case of summer milk production, all cows can be dried off at the same time in preparation for calving.

Many farmers with large dairy herds are not using A.I. because of the problems with heat detection and consequently poor calving results. However, I feel that synchronization should allow these farmers to use fixed time A.I. with as good results as natural mating. They would then be able to use high genetic merit A.I. bulls on enough cows to have sufficient heifer replacements of better genetic merit. The advantages of being able to use A.I. on a beef herd is that the farmer will have a wide choice of breed of sire and will be able to use fast growing bulls, identified for low frequency of difficult calving.

Farmers must not expect synchronization to solve the problems caused by poor management and feeding. Particularly in dairy heifer and suckler beef cows the results obtained are directly related to body weight and plane of nutrition of the animals at time of treatment. Animals should be on a rising plane of nutrition and be of sufficient body size to ensure that they are cyclic. This applies in particular to autumn and early spring calving herds that may be on a low plane of nutrition at time of mating. Synchronization is an aid to the reproductice management of a herd, and not a substitute for good husbandry. It is important that the conditions under which synchronization works are known to farmers, veterinary surgeons, agricultural advisers and people involved in the A.I. service, so that these techniques will be used under the proper management situations. Advanced planning for calving time is essential. Cows inseminated on the same day have a 10 to 20-day calving spread due to variation in gestation length.

The reproductive problems associated with beef suckler cows were highlighted in these trials. Behavioural symptoms of oestrus were difficult to detect and there was a long post-partum anoestrous period. The interactions between suckling and nutrition are obviously important in determining the time of initiation of reproductve activity after calving. The effect of the progesterone treatment and post-partum interval on fertility needs to be defined more clearly. Since all potential breeding animals in a herd are not showing regular oestrous cycles at the same time synchronization must involve regulation of heat in cyclic animals and induction of fertile heat in non-cyclic animals capable of responding.

Effect of synchronization on calving pattern

The present calving pattern in a herd and the interval from calving to treatment will determine the number of cows that can be synchronized in a herd at any given time. Assuming the calving interval and pattern found by Cunningham *et al.* (1976) are representative of the national spring calving dairy herd, and that cows can be treated at a minimum of 35 days after calving (Table 6) the effects of synchronizing different proportions of the herd on the calving pattern can be determined. In the case of the last one-third of the cows, treatment is started two weeks earlier than normal in attempts to induce heat in some of these cows. In Table 11, the calving pattern is shown following synchronization of (1) the

Table 11

The effect of synchronization using the 12-day progesterone treatment 35 or more days after calving on the calving pattern of a herd of spring calving dairy cows.

Month of calving season	Normal pattern (Cunningham et al, 1976)	Synchronize		
		1st 30%	1st 30 + last 30%	All
1	7	19	19	19
2	24	6	21	43
3	38	44	51	25
4	24	24	4	8
5	7	7	5	5
Mean calving date	27/3	25/3	14/3	10/3

first 30% of cows calved; (ii) the first and last 30% of cows calved and (iii) the whole herd in three batches of 30%, 30% and 40% as they calve. It is apparent that treating the early batch and then treating the late calvers is probably the best approach as this results in more cows calving early with a consequent decrease in the number of late calvers. Individual farmers will require different calving patterns to suit their own particular systems. It is important to stress that provision be made for more silage of higher quality, or more early grass or increased use of concentrates if more cows are going to calve early. This approach to the use of synchronization in the cow herd in conjunction with earlier calving of heifer replacements also through synchronization, will allow more culling of the smaller number of late calvers so that a 12-week calving season could be obtained within a few years. This is the type of calving pattern we must aim for nationally in order to increase milk and beef output from our existing cow numbers.

OTHER DEVELOPMENTS IN REPRODUCTIVE PHYSIOLOGY

Pregnancy diagnosis

Detection of non-pregnant animals as soon as possible after mating is important if a 365-day calving interval is to be achieved. Failure to repeat three weeks after mating is generally taken to mean that a cow is in calf.

The level of progesterone which can be measured by radioimmunoassay (Gosling, Parker and Fottrel, 1975) in blood, 21 days after mating is different in pregnant and non-pregnant cows. It may be possible to use this difference as a simple pregnancy test. In farm trials, blood samples were taken 21 days after insemination and the level of progesterone was measured at University College, Galway. Animals with levels less than 2.9 ng./ml. were diagnosed as being non-pregnant while animals with higher progesterone levels were diagnosed as being pregnant. From the results in Table 12, it is apparent that this test is accurate in picking out

Table 12

Accuracy of early pregnancy test in cows and heifers 21 days after insemination

	Diagnosed not pregnant		Diagnosed pregnant	
	No.	% accuracy	No.	% accuracy
Cows	80	99	122	74
Heifers	91	88	68	76

non-pregnant animals. The accuracy in picking out pregnant animals is affected by the fact that not all non-pregnant animals repeat three weeks after mating. From the analysis (Table 13) of the interval from first insemination to the repeat insemination in 757 Friesian cows, it is seen that about 70% of animals repeat between day 17 and 24. However a second peak of repeats occurred 36 to 45 days after insemination suggesting the possibility that these were missed at the three week stage or that they had a silent heat. The use of the progesterone test 21 days after mating might help to pick up the majority of the cows in this latter peak.

Table 13

Interval from the first insemination to the repeat insemination in 757 Friesian cows

Interval after 1st insemination (days)	No.	%
2 - 10	37	4.8
11 - 16	19	2.4
17 - 24	535	70.4
25 - 35	66	8.6
36 - 45	98	12.8
>45	8	1.0
	757	100.0

In dairy cows, progesterone determination can be carried out on milk samples and the commercial application of this test may help to shorten the calving to fertile service interval. The capital cost of equipping a laboratory for this work will be high. It is possible that a service could be operated economically from the Agricultural Institute research laboratories or the individual A.I. station.

The application of synchronization in conjunction with the early pregnancy test would mean that it would be possible to inseminate a large group of cows on the same day, then in 21 days a blood or milk sample would be taken and the non-pregnant cows diagnosed. These would then be given a single injection of prostaglandin and inseminated 72 and 96 hr. later. In this way, a farmer should get 75% of the group of cows in calf to A.I. within 30 days without any need for heat detection. These are the kind of technological advances possible within a year but the major limitation will be the cost involved.

Induction of twinning in cattle

The twinning rate in a survey of 3,381 cows in Ireland was 1.68%. Obviously, if twinning rate could be increased it would be one of the most important ways to increase beef production from the suckler beef herd and from the dairy herd. Work in progress at The Agricultural Institute, Belclare under Dr. J. Sreenan and at University College Experimental farm at Lyons Estate under Prof. I. Gordon has made tremendous progress towards the development of a simple non-surgical transfer technique. The cattle insemination equipment used at present by A.I. stations has been adapted to allow the placement of a 5 to 6-day old fertilized egg into the non-pregnant uterine horn of a cow or heifer while the second uterine horn carries the cow's own fertilized egg. Results obtained to date by these workers are shown in Table 14. If these results are repeatable,

Table 14

Pregnancy rate following non-surgical transfer of fertilized eggs in Ireland

	Bred recipients	
Authors	% pregnancy rate	% twinning
Sreenan & Mulvehill (unpublished data)	58	36
Boland, Crosby & Gordon (unpublished data)	60	38

it may be possible to have a high percentage of cows producing twins. It may also be possible to increase greatly the number of calves produced from really top class proven cows by superovulation and transfer of their eggs to heifer recipients. However, much research work needs to be done on appropriate levels of feeding in late pregnancy of the twin bearing cow, the mortality rate of twins and subsequent reproductive performance and longevity of twin-bearing cows.

Cystic ovaries

During the course of farm trials in 1974, 20 dairy cows were diagnosed per rectum to have follicles greater than 3 cm. which were assumed to be cystic. These cows were given an intramuscular injection of 100 ug. of gonadotrophin releasing hormone (GnRH) which causes an immediate large increase in LH which is the hormone responsible for ovulation. The majority of these cows returned to heat about three weeks later and following insemination at heat, normal fertility was obtained. Recent reports from the U.S. indicate also that GnRH injection is an effective method of rupturing follicular cysts.

Conclusions

The low average milk yields (580 gals. in 1975: An Bord Bainne, Dairy News No. 173, Jan. 31, 1976) are caused by (i) low level of feeding; (ii) late calving of 40% of our herd and (iii) low genetic merit of replacement heifers. Recent developments in new technology in reproductive physiology in Ireland now make it possible to influence the latter two points. In our spring calving dairy herd, the calving pattern can be influenced by:

1. Synchronizing the first and last one-third of the herd with the 12-day progesterone treatment (Table 11). This will result in more cows calving earlier and the mean calving date of the herd will be brought forward by 11 days. In the economic terms, this represents 15.4 extra gallons of milk per cow giving an extra output per cow of £4.92.
2. Synchronizing and inseminating 20% more heifer replacements than required on the first day of the breeding season. If, say 15 are required, and 20 are treated, then 11 to 13 will go in calf to the fixed time A.I. and it will be easy to get 3-4 more heifers in calf at the repeat heat in three weeks time. Thus, sufficient replacements are in calf within the first three weeks of the breeding season.
3. Synchronizing the first 30% of the cow herd. These cows will calve down 11 days earlier giving enough heifer calves born early for replacements (15% replacement rate). If we assume they go in calf at the same age the following year, then they will produce 11 days extra milk. On a per cow basis in the herd over five lactations, this is equivalent to $11 \times 1.4 \times 5 \times 15 \div 100 = 12$ gallons of milk extra produced by the heifers. This is worth an extra £3.70 per cow.
4. Increase usage of A.I. without the problems of heat detection. The genetic gain from using one of the proven sires on the panel of special bulls available through A.I. in Ireland has been calculated to be worth £7.50 per insemination (Prof. E. P. Cunningham, personal communication).

Other advantages accrue from the use of synchronization which are more difficult to cost. These include reduced labour required for heat detection, systematic planning of breeding, feeding and calving programmes, elimination of problems of getting replacements in calf and the possibility of reduced cost of A.I. If one assumes these other advantages will pay for the cost of the treatment, then the net calculated value to a farmer using A.I. at present is £8.62 whereas the value to a man not presently using A.I. is £16.12.

In the beef herd, reducing the calving interval by 11 days will result in an extra 22 lbs. liveweight of calves at weaning. The extra growth rate from the use of the fast growing continental breeds with a history of low calving difficulty should result in an overall 10% increase in growth rate, resulting in about 44 lbs. extra gain. The total extra gain at weaning would be in the order of 66 lbs. If this extra gain were valued at £18 per cwt. in the autumn, it would be worth £10.62 per calf. This increase would be much more critical to the suckler man than to the dairy man due to relatively low returns from suckler beef production at present.

In conclusion, I think that the benefits of synchronization are worth the cost of using it both to the individual farmer and to the country. The present decline in the use of A.I. is disturbing and I believe that the development of synchronization will prove to be the biggest breakthrough in reproductive physiology since the discovery of A.I. and frozen semen. A slow educational process to develop its use will be required, as in the use of A.I., but it is understandable that the farmer will require overwhelming evidence of the benefits before committing his source of income to the test.

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NUTRITIONAL EFFECTS ON CARCASS GROWTH AND COMPOSITION IN BEEF CATTLE

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A combined comparative slaughter and nutritional balance trial was used to compare the effects of two levels of energy and three levels of protein on carcass growth and composition in Friesian steers over the range 120-400 kg. liveweight. Higher energy levels significantly increased ($P<0.01$) carcass gains at all protein levels but high protein diets significantly ($P<0.05$) increased carcass gains only at the higher energy levels. This latter effect was due in part to improvement in digestibility of fibre. The higher energy diets significantly increased separable and total fat in the carcass. The higher protein diets had no effect on lean meat per cent but preliminary results suggest a small increase in the protein content of the meat. The results are discussed in relation to the efficiency of current methods of feeding beef cattle.

BOVINE EATING BEHAVIOUR IN WINTER AND SUMMER

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A radio-telemetric technique for recording time per day spent eating, ruminating and resting by cattle is briefly described. Cattle spent 4-5 hours/day eating during winter (Dec./Jan.). The type of silage, method of feeding or location had little effect on this result. During summer (July/Aug.) animals spend 7 to 8 hours/day eating.

The results suggest that the time beef cattle spend eating is related to day length. The short winter days contribute to the poor performance of cattle on silage in winter.

MIXED GRAZING OF CATTLE AND SHEEP

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Most studies of mixed v separate grazing used an equivalent ratio of cattle to sheep to represent equal grazing pressure. This approach confounded any effects of mixed grazing with selection of the appropriate equivalent.

In a three year experiment which included three sheep only, three cattle only and seven mixed cattle and sheep groups, methods were developed which avoid these problems. Fifty yearling cattle and 280 weaned lambs were used from mid-July to the end of the grazing season in each year.

Under mixed grazing, gain for each animal species is related to the stocking rate for each species. By fitting regression equations to cattle and sheep gains, the results showed that about 4.25 lambs would replace one cattle beast and preserve sheep performance but about 8.79 lambs would replace one cattle beast and preserve cattle performance. The substitution rate varies depending on which output is considered.

Mixed grazing benefited individual lamb performance (6-31%) in all years and individual cattle performance in the first two years (9-33%). In the mixed treatments, both lamb and cattle performance improved as their respective proportions in the mix decreased. A 10% increase in output per unit area was recorded in one year.

REPLACEMENT OF FISHMEAL AND SOYABEAN MEAL BY DRIED MICROBIAL CELLS (PSEUDOMONAS METHYLOTROPHA) IN THE DIETS OF WEANLING PIGS

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A meal (Pruteen) made from the dried cells of pseudomonas methly-lotropha growth on methanol was made available by I.C.I. (Ireland) Ltd. Samples of the product were analysed for protein and amino acids as well as for fat, calcium, phosphorus, sodium and ash. Twenty-four pigs were used in 5-day digestion trials to determine the digestible energy (DE) of the meal.

On the basis of the above information 560 pigs weighing 8 kg. and weaned about one week were used in a growth trial. Treatments consisted of a control diet containing 5% fishmeal and 14% soyabean meal and experimental diets in which the fishmeal, soyabean meal and fishmeal + soyabean meal were replaced on an isolysine basis by 5.6, 7.7 and 13.2% Pruteen respectively. Diets were balanced for DE, lysine, sulphur amino acids, calcium, phosphorus and sodium. Pigs were fed *ad libitum* over a 35-day experimental period.

The inclusion of Pruteen in the diet improved feed intake, FCE and growth rate. The greatest improvement over the control was observed at at the highest level of inclusion of Pruteen and amounted to 4.3, 9.2 and 13.8% respectively in daily feed intake, FCE and daily gain.

THE GROWTH OF PREGNANT FEMALE LAMBS AND THEIR PROGENY IN RELATION TO DIETARY PROTEIN AND ENERGY INTAKE DURING GESTATION

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One hundred and twenty-eight ½ Finn ½ Galway ewe lambs, 40 kg. liveweight and about eight months old, were individually penned from 5-6 weeks after mating until parturition. The experimental treatments applied during this period consisted of two levels of energy (8.0 and 12.0 M J ME per day) with three levels of crude protein (110, 155 and 220 gms./day) at each energy level. A series of nitrogen balance trials was carried out on six lambs from each treatment during the final 90 days gestation (1.61 lambs/ewe). Increasing protein intake from the low to intermediate level was accompanied by a significant increase in maternal liveweight gain; there was however no response to increasing protein intake from the intermediate to the high level. The ewes on the high energy level were significantly heavier than those on the low level at all times between 60 days pre-parturition and weaning at 10 weeks post lambing. There was a significant interaction between protein and energy with respect to lamb birth weight; at the lower energy level lamb birth weight tended to increase with increasing protein intake but the reverse occurred at the higher energy level. There was a significant increase in the level of nitrogen retention associated with increasing protein and energy intake.

INDUCTION OF PARTURITION IN GILTS AND SOWS USING A PROSTAGLANDIN ANALOGUE (ICI 80996)

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This experiment involved 50 animals (8 gilts and 42 older sows) on each of three treatments as follows:

A Control.

B Parturition induced by IM injection of 166 μg prostaglandin analogue (ICI 80996) at 9 a.m. on day 111 of pregnancy.

C Induced by injection on Monday, Wednesday or Friday when 111 or more days pregnant.

Parturition commenced 29.4 ± 6.5 hrs. (B) and 27.3 ± 5.2 hrs. (C) after injection. Six animals, all gilts, farrowed 60-154 hrs after treatment and are omitted from the above; control animals farrowed 90 ± 32 hours after 9 a.m. on day 111 of pregnancy. Sixty-five per cent of treated animals commenced farrowing during the working day compared with 50% of control animals. Birth weights were marginally higher (not significant) among control animals while the number of litters of low average birth weight (1 kg. or less) was A-1, B-5 and C-4. Litter size at birth was higher among the controls and this was maintained to weaning. There are indications that some litters perform poorly following induction which may be due to poor milk production.

THE IMMUNE STATUS OF DAIRY COWS FOLLOWING INDUCED CALVING

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Corticosteroids have been successfully used to induce parturition two to three weeks before the expected calving date. This may be used to advance late calving cows and, as the calves will be smaller, difficult calvings can be avoided.

Corticosteroids are anti-inflammatory in their action and the large doses required might be expected to lower antibody production by the cow or inhibit its absorption by the calf. In addition the time available for colostrum production is shortened and the calf being weaker might not be able to suckle effectively.

Blood samples were taken from thirty-nine calves born to induced cows and twenty three full term calves at one day old. The blood serum was subjected to the zinc sulphate turbidity test. There was no difference in the levels of immune globulins in the two groups of calves.

FIXED TIME ARTIFICIAL INSEMINATION IN SHEEP

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Set-time A.I. in conjunction with progestagen-PMS treatments has been applied to several thousand sheep in field trials over the last three years at U.C.D. Results from the first years work show no significant difference in pregnancy rate following A.I. and natural service (68.5% and 71.4% respectively). A.I. was carried out on a much larger number of sheep in the second year and pregnancy rates following a double insemination confirmed earlier work with an almost identical result (68.6%). Refinement of technique to a single insemination using a higher concentration of sperm has given non-return rates very similar to natural service (76% vs. 83%) in the third years work. Various factors, such as progestagen treatment, PMS dose level, timing of insemination and insemination equipment are examined.

REPEATABILITY AND HERITABILITY OF OVULATION RATE IN SHEEP

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Information on the number of corpora lutea (ovulation rate) of mature Finn, Galway, Fingalway and High Fertility ewes was obtained during the breeding seasons of 1973 through 1975. Repeated ovulation rates were either within the same breeding season (intra-year) or in adjacent breeding seasons (inter-year). The average ovulation rate for Finn ewes was 4.0 compared with 1.6 for Galways. The Fingalway ewes averaged 2.4 and High Fertility ewes averaged 2.7. Repeatability of ovulation rate differed significantly among the breeds with a value of 0.2 for Galway and Fingalway ewes compared with 0.7 and 0.8 for Finn and High Fertility ewes, respectively. The degrees of freedom for these estimates ranged from 32 to 104. There were no substantial differences between intra- and inter-year estimates. The heritability of ovulation rate was estimated to equal 0.3 in Finns but the estimate was slightly negative in Galways.

These results together with information from egg-transfer work are discussed in relation to selection for ovulation rate and breed differences in litter size.

INDUCTION OF SUPEROVULATION IN THE BOVINE

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An important prerequisite in any egg transfer programme in cattle is that reliable methods should be available for obtaining a predictable supply of fertilised eggs. Recent experiments at Belclare have compared three methods of superovulation—(1) Prostaglandin + PMSG (Pregnant Mares' Serum Gonadotrophin), (2) Prostaglandin + PMSG, (3) Norgestomet (SC 21009) + PMSG.

Oestrous responses of 96.7%, 80.4% and 90.6% respectively, were obtained following the use of the three methods. Oestrous synchronization was best with Prostaglandin treated animals, 84.2% of which showed oestrus over a 24 hour period, compared to 40.2% and 39.3% following the Progesterone and the Norgestomet, respectively. There was an effect of PMSG—oestrus interval on the proportion of follicles ovulating. The mean number of ovulations using 2000 iu PMSG was 14.7, 11.2 and 12.7 following Prostaglandin, Progesterone and Norgestomet respectively. A dose-response relationship was evident.

FERTILITY IN CATTLE FOLLOWING SHORT-TERM (10-DAY) OESTROUS CYCLE CONTROL TREATMENTS

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A practical method for controlling the bovine oestrus cycle would have numerous advantages in both beef and dairy herds. Work on the development of methods for controlling the oestrous cycle, based on the use of progestagens, has resulted in the development of a number of short-term (9-10 day) treatments.

A series of studies examining the efficiency of a number of progestagen treatments were initially carried out. This included a study of the effects of treatments on endogenous hormone levels, oestrous response and degree of synchronization and subsequently a series of field-trials were undertaken to evaluate these short-term progestagen treatments. A total of 2,650 animals were treated during the 1974 -'75 breeding seasons. The treatments were progesterone and cronolone (SC-9880) applied by intravaginal pessary and norgestomet applied by subcutaneous ear implant.

Retention rates of 100% were obtained with the SC-21009 implants in both heifers and cows. Retention rates of 97% and 90% in heifers and cows, respectively, were obtained with intravaginal pessaries. Calving rates of 60%, 50% and 54% for progesterone, SC-21009 and control animals respectively, were obtained with heifers following a fixed-time A.I. procedure. In suckler cows calving rates of 48% and 56% were obtained following progesterone and SC-21009 treatments, respectively.

The application of gonadotrophin (H.C.G.) or gonadotrophin releasing hormone (Gn-RH) in combination with the progesterone treatment resulted in a more precise control of ovulation. However Gn-RH or H.C.G. did not affect fertility when a double insemination routine was applied. Reducing the number of inseminations to one reduced fertility.

TWINNING IN BEEF CATTLE BY AN EGG TRANSFER TECHNIQUE

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The establishment of twin pregnancy in beef cattle by surgical and simple non-surgical egg transfer techniques was reported. Fertilized eggs were provided following hormonal induction of super-ovulation using PMS and HCG—a technique that has yielded a mean of about 8 fertilized eggs per donor treated. Recipient animals were inseminated at a spontaneous oestrous, and eggs transferred 5 or more days following breeding. An overall pregnancy rate of 62.5% and 61.5% was obtained following surgical and non-surgical transfer respectively. The corresponding twinning rates were 48% and 41%. Regardless of method of transfer, pregnancy, twinning and egg survival rates were higher following a period of storage in the rabbit oviduct. Various factors including site of transfer, medium used and ease of transfer are discussed.

EGG TRANSFER IN THE COW : EFFECT OF SITE OF TRANSFER

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The application of single or twin egg transfer techniques in the cow depends ultimately on the development of a simple non-surgical transfer procedure. Success in non-surgical attempts to date has been lower than following surgical transfers. To determine the effect of site of transfer, fertilized eggs were transferred either bilaterally or singly to each uterine horn. Eggs were transferred both ipsilateral to the CL and contralateral. Survival in single pregnancies following bilateral transfer was 65% ipsilateral to the CL and 35% in the opposite horn. Following single egg transfers, survival was 61.3% ipsilateral to the CL and 18.1% in the contralateral horn. When eggs were deposited near the uterotubal junction survival rate was similar to eggs transferred near the common body (60% and 65%).

THE PERFORMANCE OF LAMBS AND HOGGETS ON ON CONCENTRATE DIETS

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The results of a series of experiments on the performance of early weaned lambs (aged about 7 weeks) and of hoggets (aged about 10 months), fattened *ad libitum* on unpelleted concentrate diets were reported.

It was observed that the liveweight gain and the food conversion ratio were very similar between Finn-Dorset and Suffolk cross lambs. For all lambs the average liveweight gain was 250g/d and the average food conversion ratio was 3.3 g DM/g gain. Hoggets on the same dietary treatments had lower weight gains (184 g/d) and had a higher food conversion ratio (5.8 g DM/g gain).

The weight gain of lambs was slightly higher with ground maize than with ground barley as the sole cereal source. Whole barley as the sole cereal source resulted in the same performance of lambs as ground barley. Supplementation of barley based diets with 10% oat hulls or chopped hay (10 or 20%) or chopped straw (7.5 or 15%) reduced liveweight gain of the lambs. Problems relating to this system of lamb production were disscussed.