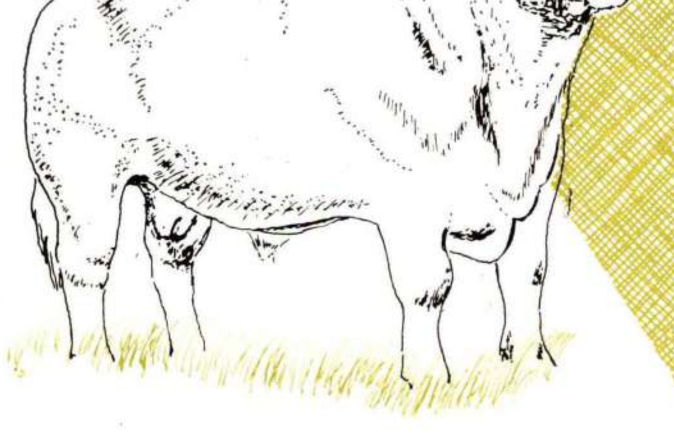
IRISH GRASSLAND AND ANIMAL PRODUCTION ASSOCIATION JOURNAL



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CONTENTS

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Current Trends in Grassland Management Research

by

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Introduction

The objectives of grassland management are (a) to ensure an adequacy of digestible plant material throughout the growing season as cheaply as possible, and (b) to utilize the material grown as efficiently as possible without impairing the productive capacity of the sward. It is the task of applied research to provide information on all major elements of any grassland management system and to incorporate the key factors into a workable farm plan. Such a structural plan for dairying has been evolved at Moorepark. The opening sections of this paper will be concerned with an examination of its grazing management components. I will then discuss the possible role of Italian ryegrass as a further step in intensification. Finally, I will illustrate how a more detailed knowledge of plant response to defoliation may lead to a more rational basis for grassland management.

When does the winter feeding period end?

It is advisable on a dairy farm to allow lactating cows onto grass, their cheapest source of feed, as early as possible in spring when two conditions are fulfilled. These are: (a) the amount of herbage present must be sufficient to maintain or increase current milk production; (b) grazing should not have any depressing effect on subsequent grass growth.

We have examined the influence of three dates of starting grazing in spring on the regrowth of a perennial ryegrass pasture. Stock were used for grazing only i.e. no animal production data was recorded, and each grazing was completed within a day.

The dates of grazing were chosen to represent a range from normal (at Moorepark) to extremely late. The interval between successive grazings was three weeks and the initial nitrogen application was made five weeks before the earliest time of starting grazing.

Table 1
Effect of time of initial spring grazing on sward productivity

Treatment	Quantity of grass present at initial grazing (lb dry matter/acre)		Total grass production (lb dry matter/acre)	
	1971	1972	up to 22/6/71	21/6/72
T_1 (7– 8/3) No	480	490	4510	4380
N_{40}	640	640	6830	7540
T_2 (28–29/3) No	1090	430	4530	3730
N_{40}	1410	790	6720	7640
T_3 (19–20/4) No	2050	1350	4850	4430
N_{40}	3050	3190	6670	7980

The results obtained are shown in Table 1. There were substantial differences between the amounts of herbage present at the three times of initial grazing. However, despite that fact there was no difference in total herbage production (up to late June) in these trials. Although we have no animal production data available to underwrite the recommendation for an early start to grazing, a simple calculation from the results shown gives an indication of how available herbage matched animal requirement.

Let us assume that an 1,100 lb. cow yielding 35 lb milk daily has a dry matter intake of 3.0% of bodyweight. This is equivalent to 33 lb dry matter per day. In early March (T_1 in Table 1) using nitrogen, 640 lb dry matter per acre was the amount of feed on offer. In the context of a 100-cow unit on an 80-acre farm, i.e. a stocking rate of 1.25 L.U./acre, using 16×5 acre paddocks there was sufficient feed present for 60 cows in each paddock for one day even when allowance is made for only 65% utilization of grass by the grazing animal. It is realistic to regard this as a regularly attainable target and the practice of early turnout a desirable one particularly at lower stocking rates. It would be worth while to examine this feature of grazing in an animal production trial.

How many paddocks?

All dairy farms should be sub-divided into paddocks for ease of management alone. Early work by Walshe at Moorepark indicated that as stocking rate reached 1 cow/1.1 acres with low N usage there was a production advantage of the order of 15% by adopting a controlled system of grazing (in his case a 16-paddock layout) versus a set-stocked system. The more obvious questions which arise with regard to any rotational grazing system are the number of paddocks necessary and the rate of movement of stock around these paddocks.

There is little agreement at present as to how many paddocks are needed nor is there any greater measure of agreement as to whether animals should or should not be changed daily. Much of the debate on both questions has been subjective and so we designed an experiment this year to help clarify the situation.

A 10-paddock system was compared with a 30-paddock system using cows at two stocking rates—2.22 (M) and 2.86 (H) cows per acre—in the absence of conservation. On the 10-paddock farmlets animals spent three days per paddock at each grazing whereas on the 30-paddock farmlets stock were moved daily. All systems were managed uniformly and the pastures received 240 lb N per acre. Milk yields for the duration of the trial (28 March/28 August 1972) are shown in Table 2.

Table 2
Effect of number of paddocks in a rotational grazing system on milk production of dairy cows

Treatment	Mild Yield (gals/acre)
M_{30}	896
M_{10}	845
H_{30}	950
H_{10}	927

The effect of increasing the number of paddocks from 10 to 30 ranged from 6% at a medium stocking rate (2.22 cows/acre) down to 2% at a high stocking rate (2.86 cows/acre). The results are interesting when we

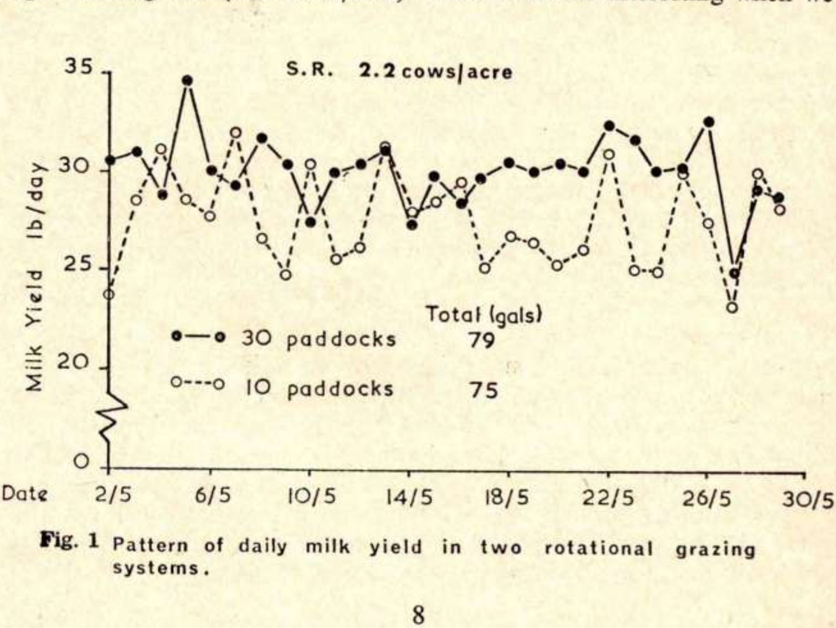

Fig. 1 Pattern of daily milk yield in two rotational grazing systems.

examine the seasonal yield pattern which illustrates clearly, in this case at the medium stocking rate, the fluctuations which occur in average daily yields when occupation time per paddock is three days rather than one day (Fig. 1). The difference between maximum and minimum daily yields on the 3-day system was 4-6 lb regularly while the comparable figure for the daily change system was usually 1-3 lb. However, despite this fact the overall difference between the two systems remained small since there was a partially compensating effect in the 3-day system of yield on the first day which was generally in excess of that of the 1-day system. Nevertheless, it requires only a marginal increase in yield per cow from a system based on a larger number of paddocks to counteract the additional fencing costs incurred through further sub-division. At present we would suggest that a farm should be laid out in 10–12 paddocks initially with provision for doubling the number as stock numbers are increased.

To speed up or slow up the grazing rotation?

The next section will be devoted to a consideration of the most appropriate speed of grazing rotation. There are many published studies on the effect of frequency of cutting on grass production but none that I am aware of has been concerned with the more important effect of grazing frequency on animal production. At Moorepark we have examined this aspect over several years.

(a) Grazing interval—bullocks

The first trials were carried out using bullocks. A 13.5 (F)—day grazing interval (15-day cycle) was compared with an interval of 27.0 (S) days (30-day cycle). Two stocking rates—2.0 (L) and 2.75 (H) bullocks per acre—were used and these were maintained throughout the grazing season (March–October). Animals were rotated around ten blocks so that those on the fast (13.5 days) rotation spent 1.5 days per paddock whilst those on the slow (27 days) rotation spent 3.0 days in each paddock. The area received 280 lb nitrogen per acre in 7 equal applications.

Table 3

Effect of length of interval between grazings on liveweight gain of bullocks (lb/acre)

Stocking Rate (bullocks/acre)	2.0	2.0	2.75	2.75
Interval (days)	13.5	27.0	13.5	27.0
Year 1	700	630	680	800
Year 2	830	850	920	1050
Year 3	860	770	730	770
Mean	800	750	780	880

The results are shown in Table 3. Overall differences were 6% in favour of **fast** rotation at **low** stocking rate and 13% in favour of **slow** rotation at **high** stocking rate but these differences were not significant. It appeared that extending the grazing interval did not result in any advantage in liveweight terms until the stocking rate was raised to 2.75 bullocks per acre. Increasing stocking rate depressed per animal performance by 24% which indicated that amount of feed on offer at the higher stocking rate was limiting output. It was only then that slowing the rotation increased animal output.

(b) Grazing interval—cows

The second series of grazing interval experiments was carried out with Friesian cows (1969–71). The general layout was similar to that adopted for the trials with bullocks.

The same grazing intervals—13.5 and 27.0 days—were compared. The stocking rates in 1969 and 1970 were 1.11 and 1.43 cows per acre. Sufficient silage was conserved from these areas to provide adequate winter feed for the herds. In 1971 conservation was excluded and stocking rates were doubled to become 2.22 and 2.86 cows per acre. As before, a 10-paddock rotational grazing regime was operated. When portions of each treatment area were withdrawn for conservation purposes the constant interval between grazings was maintained by increasing the access time in the reduced number of paddocks remaining. The level of fertilizer application averaged 240 lb nitrogen per acre.

The results are shown in Table 4. The most striking features once again are that the influence of grazing interval depended on stocking rate and that all differences recorded were small. At the lower stocking rates in each year moving the animals around rapidly resulted in slight increases in milk production whilst a slower rotation gave higher output of milk at the higher stocking rates.

Table 4

Effect of grazing interval on milk production of cows (gallons/acre)

Stocking Rate	Medium	Medium	High	High
Interval (days)	13.5	27.0	13.5	27.0
1969	410	415	445	490
1970	570	535	625	585
1971	1075	1005	1005	1090

The practical implication from these studies is that interval between grazings is not a major determinant of animal productivity. However, small differences due to change in management practice should not be disregarded when the input cost is zero.

There was no indication in any of the trials of a seasonal swing in favour of the slower rotation at either stocking rate. Furthermore, in vitro digestibility analyses carried out on herbage during 1970 and 1971 demonstrated close similarity rather than differences in feed quality on different treatments.

Italian ryegrass—has it a place?

When the full productive capacity of existing pastures has been utilized the search for plant material and management practices which will raise output further is necessary. According to N.I.A.B. ranking lists the highest yielding grass species is Italian ryegrass. Two varieties were selected for assessment over a range of management systems at Moorepark in 1972. We are specifically interested in the possibility of utilizing the earliness of spring growth of Italian ryegrass by grazing and following this with a sequence of conservation cuts designed to provide a reasonable balance between dry matter production and digestibility.

The swards used were direct sown in late August/early September 1971 at a rate of 27 lb per acre. Blanca white clover (2 lb/acre) was included in the mixture but its establishment was very poor. The following treatments were imposed: (a) A 4-cut system in which the first cut was taken at an early date in May (S_e) or two weeks later (S_l) followed by 3 cuts at 7 week intervals—G_0; (b) Two grazings at three-week intervals preceding a 4-cut system as in (a)—G_2; (c) Three grazings at three-week intervals preceding a 4-cut system similar to (a) but with first cut timed for three weeks later on both S_e and S_l–G_3. Total fertilizer input to all systems was 380 lb N, 32 units P, and 100 units K per acre. The results are presented in Table 5.

Table 5
The influence of management system on dry matter production of two Italian ryegrass varieties lb./acre

Treatment	RVP	Lema (Lembkes)
G_4S_e	19900	18800
G_0S_l	19200	19000
G_2S_e	18600	18000
G_2S_l	19000	19500
G_3S_e	18100	16600
G_3S_l	18300	17500

Production from both varieties was exceptionally high—top yields were equivalent to more than 50 tons green matter per acre—and in most instances was a little better from RVP. It was particularly encouraging to record such a high total production from a pasture which received 2–3 early grazings *vis-a-vis* an area which was exclusively cut. These results, provided they are consistently repeatable, help to clarify the role which Italian ryegrass would have on intensive dairy farms. When managed to provide early 'bite' before being set aside for at least two successive conservation cuts and then reintroduced into a grazing system these two varieties appear to be superior in terms of dry matter production to any other grasses currently available. This suggests their use on 20–25% of the total farm area, particularly if it were possible to regenerate such swards with minimum expense, disturbance, and loss of grazing. Sod-seeding of RVP into an existing RVP sward (in late September 1972) using a Bettinson drill has resulted in satisfactory establishment.

However, there are limitations to the usefulness of Italian ryegrass. Information is required on such factors as its longevity in the sward, total dry matter and digestible dry matter productivity with time, response to nitrogen, and performance under intensive grazing. For example, work at Moorepark indicates very strongly that if RVP is subjected to frequent severe grazing it can be rapidly eliminated from a pasture and so a relatively lenient grazing management strategy will have to be adopted.

Studies on plant development under different defoliation regimes

I mentioned earlier that considerable attention both in this country and elsewhere has been directed towards establishing the output of pastures under varying frequencies of cutting. In most reports the results have been in agreement—the more often a grass sward is cut the lower the total dry matter production. We have obtained the following data (Table 6) in cutting trials on swards similar to those where the grazing experiments were conducted.

Table 6

Effect of frequency of cutting on the dry matter production of a grass sward

Cutting interval (days)	No. of cuts	lb dry matter/acre
15	14	7900
21	10	9600
30	7	10700
42	5	13100

Results such as these might have been expected to give a useful guide to the optimum length of grazing interval but in fact as we have already seen a similar pattern of response did not hold for animal production when grass was grazed in situ. There is an evident need for studies which will help to define the relationship between sward productivity and agency of defoliation, i.e. whether cut or grazed, at any given frequency of defoliation. With a view to obtaining information on the characteristics of grazed pastures a supplementary study was superimposed on one of the experiments from which results have been presented already. Concurrently a similar study was begun on a cut pasture.

The underlying reasons governing such an approach are briefly as follows. A grass sward undergoes structural changes in response to varying frequencies of defoliation. These changes are expressed mainly by alterations in plant density and in canopy structure. The development of a prostrate-type plant under frequent defoliation and an erect-type plant with infrequent defoliation is probable. Morphological adaptations of this kind may confer relative advantages in production potential terms of particular sward types under particular conditions of grassland management. It was with these considerations in mind that the measurements described were made.

Stubble samples from grazed and cut swards were separated into a number of fractions. For the purpose of the present discussion consider three features mainly—(a) the density of the sward as indicated by the tiller population; (b) the make-up of individual tillers as indicated by their relative amounts of leaf and stem; (c) the quantity of non-green plant material present in the stubble. There was a considerable degree of intra-sample variation but this is by no means unexpected on permanent pasture.

Table 7
Structure of grass stubble after grazing at two periods of the season

Treatment	Mean dry weight (g/sq. m.)			
	late May/June		late July/August	
	Leaf	Stem	Leaf	Stem
Low S.R. 14-day	58	128	58	90
28-day	52	161	50	125
High S.R. 14-day	40	95	43	59
28-day	34	103	30	73

In all instances (Table 7) there was more residual leaf on frequently defoliated swards than on those defoliated infrequently. A similar situation obtained in cut swards. Nevertheless, as we have seen from the cutting data in particular, this apparent advantage was still associated with a considerably lower total yield of grass dry matter. In the results from the grazing experiment one could conclude that at the **low** stocking rate the increased amount of leaf remaining on the **fast** rotation treatment (though differences were marginal) may have accounted partially for the increase in output achieved. But a similar ratio of leaf/stem obtained at the higher stocking rate, yet the treatment with most leaf on the stubble (**fast** rotation), gave lower total animal production. Therefore, a more important consideration appeared to be the effective leaf area duration. It does seem that some factor or factors other than residual leaf or even total stubble weight must account for the poor growth of frequently defoliated swards. Conversely there is no obvious correlation between leaf and stem parameters and the relatively disappointing performance of the longer interval in animal production terms.

Table 8

Tiller densities from swards subjected to varying length of interval between grazings

Treatment	No. of tillers/15×15 cm	
	late May/June	late July/Aguust
Low S.R. 14-day	440	590
28-day	330	450
High S.R. 14-day	370	440
28-day	330	400

The tiller population or density (Table 8) of frequently defoliated swards was invariably higher than that of those defoliated less frequently. The amounts of senescent material present (Table 9) increased progressively on all treatments during the sampling period and there was little evidence of either large or consistent differences between the two frequencies of defoliation. Again there is no indication of a causal relationship between either parameter and total production.

Table 9

Quantity of non-green material present in grass stubble after grazing at two periods of the season

Treatment	Mean dry weight (g/sq. m.)	
	late May/June	late July/August
Low S.R. 14-day	98	118
28-day	110	155
High S.R. 14-day	101	97
28-day	88	118

Despite this virtual impasse there remains an obvious visual contrast between the sward types which were induced by the treatments imposed. In the belief that structural differences between swards treated in the manner I have discussed already are implicated in the differences in productivity recorded, we are currently pursuing a line of investigation parallel to the one I have just outlined. Because of the complexity of permanent pasture, both from the sampling and interpretative viewpoints, these further studies are being carried out on newly-sown perennial ryegrass swards. More intensive measurements are being made on the swards within a growth analysis framework; animals are being used to graze appropriate treatments.

If a clear behavioural pattern could be detailed for a grass sward when subjected to contrasting systems of management then perhaps a best-fit management system could be devised (i.e. optimum defoliation regime) or alternatively it would be possible in any given situation to predict the deviation from the ceiling yield (under optimal defoliation conditions). To have real practical value it would be necessary to know how much growth actually occurs under any particular system of grazing management and whether herbage production changes with changes in stocking rate.

Sward parameters need to be characterised so that variation in management can be related to plant productivity. It is necessary to investigate the method of defoliation employed by the grazing animal in conjunction with the treading effects incurred by the plant and to examine their joint influence on sward growth. In addition the length of interval between successive defoliations has considerable influence on the rates at which leaves senesce and decompose. When this information becomes available it should be possible to define the efficiencies of cutting and grazing and to quantify the relationship between animal production, plant growth and utilization. I would conclude by suggesting that it is only when the techniques of applied plant physiology are integrated into current grass/animal production experimentation that definitive answers to the outstanding problems in grassland management will be attained.

Why Use Straw in Beef Cattle Diets?

by

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Before attempting to pursue the question posed in the title, it is necessary to ask and hopefully answer the following relevant questions:

(a) Do we have a need for straw as a diet?
(b) Do we have feeding situations suitable for its use?
(c) Is straw cheaper than alternative feeds?

Need

One of the major limitations to increasing beef production in this country is a shortage of winter feed. Indeed, with present stock numbers a severe winter followed by a late spring often results in serious losses due to shortage of feed. Under these circumstances, it seems ironic that much of the straw produced in the country is burned or destroyed in one way or another. This straw, if properly supplemented, would be capable of over-wintering up to a million yearlings or half a million cows. While the provision of high quality hay and silage capable of supporting rapid liveweight gains may be a desirable goal, we must face the reality that such material is in short supply and that much of the hay in the country is little better than straw in feeding value.

In addition, the judicious use of straw in wintering cattle would allow pastures to be rested during the winter thus ensuring greater productivity during the subsequent season. Therefore, more extensive use of straw as a winter feed would enable more cattle to be carried all the year round.

Suitable feeding situations

In our pattern of beef production where animals are usually 2 years or more at slaughter, there seems little justification in feeding expensive rations to overwintering yearling cattle. Average daily gains of ½ to ¾ lb are usually quite adequate and such gains are easily obtained on poor quality roughage (e.g. straw) properly supplemented. This should enable us to use our excellent grass potential to exploit the phenomenon known as 'compensatory growth'. Compensatory growth refers to the ability of animals to respond in term of increased growth when a high plane or nutrition is introduced following a period of under-feeding. Most evidence would indicate that if yearlings are gaining in the region of ½ to ¾ lb. per day during the winter they will 'compensate' at grass compared with comparable animals fed to achieve greater gains during the winter. It should, however, be recognised that the performances indicated are not adequate in all cases e.g. feeding replacement heifers intended for mating at 15 months or perhaps in animals destined for sale in the spring. It must also be stressed that underfeeding of calves in the hope of gaining increased growth rate subsequently is not recommended; such underfed calves are often at a permanent disadvantage.

Another area suitable for the utilization of poor quality roughage is in the feeding of pregnant cows. If beef production based on single suckling becomes more widespread in the future, there seems every possibility of devising systems whereby intensive cereal growing and grassland would be integrated using high quality grass and cereal grains for the calves and making maximum use of cereal straw for the breeding stock.

Value of straw

Nutritional considerations: Straw diets can only be justified if they are cheaper than alternative diets. Before dealing with this aspect it is necessary to look at the composition and nutritive value of straw (barley straw is discussed here but similar considerations apply to oat straw) and to decide on appropriate supplementation. In supplementation, the aim should be to eliminate specific deficiencies. Relative to the animal's requirements and to good quality hay (which is the alternative diet discussed here) barley straw is deficient in protein, calcium, phosphorus, energy and probably trace minerals and vitamins (see Table 1).

Table 1

Composition of barley straw and good quality hay

	Barley Straw %	Hay %
Crude Protein	3.0	9.5
Crude Fibre	40.0	30.0
Calcium	0.3	0.6
Phosphorus	0.08	0.25
Magnesium	0.10	0.24
Starch Equivalent	23	35

It is often argued that protein is the primary deficiency and that a dual response will result from protein supplementation:

(1) increasing digestibility as a result of supplying the rumen bacteria with a nitrogen source, thus enabling them to breakdown fibre, and

(2) increased intake, since digestibility of roughages is positively correlated with voluntary intake.

A survey of the literature reveals that spectacular responses have on occasion resulted from protein (nitrogen) supplementation, while in other cases results have been disappointing. Where good responses have been obtained the roughages in question have been of low digestibility due to inadequate nitrogen but of high potential digestibility given the optimum supplementation (e.g. tropical forages). Where poor responses (from nitrogen supplementation) have been obtained the roughages in question have usually been of low potential digestibility, presumably highly lignified (e.g. some cereal straws).

In an effort to get information on the effect of supplementation on the feeding value of barley straw, a trial was conducted at Lyons Estate involving four treatments—two based on conventional concentrate supplements and two using proprietary urea supplements. Results of this trial are summarised in Table 2.

Table 2

Effect of urea and protein supplementation on the feeding value of barley straw

	Supplement			
	37% Protein[1] Concentrate	16% Protein[2] Concentrate	6% urea[3] Lick	10% urea[3] Molasses
Barley straw	ad lib.	ad. lib.	ad. lib.	ad. lib.
Supplement/hd./day	2 lb.	2 lb.	ad. lib.	1 pint
Minerals	—	ad. lib.	—	ad. lib.
Initial wt.	632	622	647	644
Days on trial	80	80	80	80
Daily gain (lb.)	0.8	0.8	0.0	0.0
% Crude protein in diet (DM)	10	6	—	—

[1] 80% soyabeans, 10% grassmeal, 10% minerals/vitamins.
[2] 20% soyabeans, 40% barley, 40% milo.
[3] Commercial products.

The reasons for the poor performance with the urea supplements (which were fed in accordance with the suppliers instructions) will be discussed later, but a surprising result was lack of response from the 37% protein concentrate as opposed to the 16% protein concentrate. The level of dietary crude protein with the 16% crude protein concentrate was lower than is often considered necessary for maximum fibre digestion and voluntary intake (A.R.C. 1965) and yet no apparent response resulted from feeding the 37% protein concentrate.

A series of experiments were therefore undertaken to investigate the effect of protein level on performance. When concentrates (based on barley/soyabean meal and ranging in protein from 9 to 29%) were fed at a level of 3 lb per head daily, in addition to barley straw *ad lib.* to yearling cattle, the following results (Table 3) emerged (for more detail see Lyons *et al.* 1970).

Table 3
Effect of supplementary protein on straw intake and performance

	Concentrate Supplement			
	B	LP	MP	HP
% Protein in concentrate	8.9	13.6	19.1	29.2
Concentrate intake (lb./hd./day)	3.0	3.0	3.0	3.0
Straw intake (lb./hd./day)	7.9	9.7	9.9	9.9
% Protein in complete diet (D.M.)	4.8	5.8	7.2	9.9
No. of animals	10	10	10	10
Initial weight (lb.)	596	576	612	588
Days on trial	112	112	112	112
Average daily gain (lb.)	—0.5	+0.1	+0.1	+0.3

As can be seen from Table 3, a 25% increase in straw intake resulted from increasing the protein level of the concentrate from 9.0% to 13.6% but no further increases in straw intake occurred with higher protein levels. Digestibility was not materially increased by increasing the protein content of the supplement beyond 13.6% (LP) (Table 4).

Table 4
Effect of supplementation on straw digestibility %

Supplement	Organic Matter Digestibility	Crude Fibre Digestibility
none	50	60
B	46*	54
LP	50*	60
MP	51*	61
HP	52*	63

*Calculated by difference, assuming digestibility of 90% for concentrates.

It was concluded that, under the conditions of this experiment, energy rather than protein became the limiting factor at the higher protein levels. It should also be noted that straw digestibility was not greatly increased by protein supplementation, i.e. relative to the unsupplemented material. This latter consideration probably accounts for the poor response from the urea supplements (Table 2). Urea contains readily available nitrogen (precursor of protein) but is devoid of energy and is most useful in diets rich in soluble carbohydrates (e.g. cereals, etc.) or roughages of high potential digestibility but deficient in protein. Since the barley straw referred to was not of high potential digestibility, one would not expect a great response from urea in the absence of some cereal feeding.

Since the real justification for imposing stringent dietary regimes on yearlings during the winter is the expectation of exploiting their enhanced growth potential (compensatory growth) with 'cheap' but high quality grass during the subsequent grazing season, consideration of the data in the following table (Table 5), which summarises the performance of the cattle (referred to in Table 3) during the winter and grazing season, is relevant.

Table 5

Winter and grazing performance

Number of animals	40
Mean weight at start of winter	595 lb.
Weight at end of winter	594 lb.
Weight after 180 days grazing	982 lb.

Performance at pasture was, as expected, extremely good. Although the winter performance obtained (Table 5) was lower than the targets ($\frac{1}{2}$ to $\frac{3}{4}$ lb/day) referred to earlier it is of interest that the performance achieved here was consistent with having the animals ready for slaughter at around 2 years of age.

Economic considerations

It is often convenient to compare feeds in terms of their energy content and apply monetary values accordingly. For example, let us suppose an animal requires 3.5 lb starch equivalent daily for a particular function. This can be supplied by feeding 10 lb of the hay or 15 lb of the straw referred to in Table 1. Thus, the value of straw would be roughly two-thirds the value of good hay.

However, a fallacy in the above reasoning is that it ignores the important consideration of voluntary intake. If an animal consumes 10 lb of hay when fed hay *ad lib.*, this same animal is unlikely to consume more than 7–8 lb straw (if offered straw *ad lib.*) rather than the 15 lb which would be required to maintain a similar energy intake. In the author's view a more rational approach to the problem is to determine how much concentrate must be added to the straw to make it equivalent to the hay. It would appear that 5 parts of straw plus 2 parts of concentrates would replace 7 parts of good hay in most feeding situations. Thus, the value of straw will depend on the price of hay and the price of supplementary concentrates. Table 6 illustrates this relationship.

Table 6
Value of straw per ton

Price of hay £/ton	Price of concentrates (£/ton) 35	40	45
10	£0	—	—
15	£7	£5	£0
20	£14	£12	£10

In general terms the data in Table 6 may be expressed as:

$Y = 1.4x - 0.4z$, when
Y = value of straw (£/ton),
x = price of hay (£/ton), and
z = price of concentrate (£/ton).

Of course, this equation is simplified if we are using poor quality hay in that hay and straw will be of equal value!

Poor quality hay

With poor quality hay (at least the one referred to in Table 7), similar considerations with respect to energy/protein ratios obtain as with straw i.e. energy becomes limiting at relatively low dietary protein levels. As can be seen from Table 7, the response from protein supplementation was as great with high protein (high quality) hay as with low protein (low quality) hay forming the basal diet, thus suggesting that protein and energy came into equilibrium at a much lower dietary protein level with the poor hay.

Table 7
Effect of quality of hay and concentrates on performance

	Treatments 1	2	3	4
Diets				
Hay type[1]	good	good	poor	poor
% Protein in concentrate	10	16	10	16
Hay intake (lb./day)	11.0	11.6	8.3	8.7
Concentrate intake (lb/day)	3.0	3.0	3.0	3.0
Performance				
Initial weight (lb.)	439	440	434	433
Daily gain (lb.)	1.28	1.49	0.41	0.55
Final weight (lb.)	601	630	486	503

[1] 'Good hay'—65% digestibility, 10% crude protein
'Poor hay'—50% digestibility, 6% crude protein.

It should be stated that most of the difference which existed at the end of this period had disappeared by the end of the subsequent grazing period i.e. animals fed on poor quality hay 'compensated' at grass.

Straw in different feeding programmes

Probably the most convenient way of utilizing straw would be to use a 'straw balancer' to balance straw in terms of essential nutrients and to feed additional cereals or cereal replacements (e.g. molasses plus protein, swedes, beet tops, etc.) to give the desired level of performance. The composition and level of feeding of the straw balancer will depend on the type of cereal replacements used. Table 8 gives the composition of a 'straw balancer' using barley as the supplementary feed.

Table 8

Composition of straw balancer (40% crude protein)

	%
Protein concentrate (e.g. soybeans)	90
Cattle Minerals[1]	10
Vitamin A (i.u./ton)	20 million
Vitamin D (i.u./ton)	1 million

[1] Minerals %: Dicalcium Phosphate 60; sodium chloride 35; calcined magnesite 3.4; ferrous sulphate 1; manganese sulphate 0.5; copper sulphate 0.02; zinc sulphate 0.02; potassium iodide 0.03; cobalt sulphate 0.005.

The choice of protein concentrate in straw balancer is governed by economic considerations, price per unit protein being the determining factor. With increasing protein prices the possibility of using urea to cheapen the ration deserves consideration. It is outside the scope of this paper to discuss the feeding of urea. In general, however, urea should only be used in preference to conventional protein when economics dictate; urea is unlikely to be superior in terms of animal performance. Urea is best utilized in high energy diets requiring relatively low levels of total crude protein (e.g. beef cattle on high concentrate diets).

The winter feeding programmes outlined in Table 9 may be taken as broad recommendations for specified categories of cattle. In these, expected barley straw intake (D.M.) will be about 1.5% of body weight.

Comment on diets

Programmes A and B are intended to exploit compensatory growth. With programme A it is intended that animals will go through subsequent grazing and winter fattening periods before being ready for slaughter while programme B envisages a *minimum* of 10 weeks grazing before slaughter.

Table 9
Recommended feeding programmes using barley straw

A. Yearlings intended for grazing and subsequent fattening	
	lb/hd./day
Barley straw	ad. lib.
Straw balancer (Table 8)	0.75
Barley (or equivalent)	2.25
B. Stores intended for fattening at grass	
Barley straw	ad lib.
Straw balancer	1.25
Barley (or equivalent)	3.75
C. Winter fattening	
Barley straw	ad. lib.
Straw balancer	2.0
Barley (or equivalent)	8–10+
D. Pregnant cows	
Barley straw	ad lib.
Straw balancer	1.25
Barley (or equivalent)	3.75
E. Cow suckling calf over winter	
Barley straw	ad lib.
Straw balancer	3
Barley (or equivalent)	7

Programme C was included for completeness but every effort should be made to replace this in practice by high quality roughage.

The cow feeding programmes (D.E.) should ensure normal growth and development of calf and good reproduction in the cows. Less concentrates may be used in certain circumstances (when the cow can draw on her reserves) but these are unlikely to be satisfactory in protracted feeding situations.

Good quality straw can be a useful feed in many situations. We should make every effort to use it to supplement and complement good grassland management.

References

A.R.C., 1965. The Nutrient Requirements of Farm Livestock, No. 2, Ruminants, Agric. Res. Council, London.

Lyons, T., Caffrey, P. J. and O'Connell, W. J. (1970) Anim. Prod. 12:323.

Sources and Levels of Proteins in Cattle Feeds

by

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Proteins are complex compounds found in all living tissues—animal, plant and bacterial. The structural units from which proteins are formed are nitrogenous compounds called amino acids. More than 20 amino acids have been identified, and various combinations of these are involved in the formation of the several different proteins found in living tissues. In addition to nitrogen, proteins contain carbon, hydrogen and oxygen. Sulphur and phosphorus are also constituents of some proteins.

On average, protein contains 16% nitrogen. When feed-stuffs are being chemically analyzed, the percentage nitrogen present is multiplied by 100/16 to give the percentage 'crude protein'. The term 'crude protein' is used since nitrogenous substances other than proteins, e.g. nitrates, urea, ammonia, may contribute to the result. To distinguish the real protein content of a feedstuff, the 'crude protein' value may be subdivided into 'true protein' and 'non-protein' nitrogenous fractions.

Sources of Protein

Dietary protein for cattle may be supplied by feeds of plant or animal origin. Commonly used feed ingredients and their protein contents are listed in Table 1. In these ingredients and in most cereal seeds, true protein constitutes 80% to 90% of the crude protein.

Table 1
Feed Protein Sources of Plant and Animal Origin

Feed Ingredient	Crude Protein (%)
Plant Origin:	
Cottonseed cake	41
Groundnut cake	49
Guar meal	40
Linseed meal	35
Soyabean meal	44
Sunflower meal	38
Animal Origin:	
Fish meal	61
Meat and bone meal	50

Protein Digestion

The ruminant has a complex digestive system in which the stomach is divided into four distinct compartments. The largest compartment, known as the rumen, is similar to a large fermentation chamber, and becomes functional within a few weeks of birth. In the rumen, protein is both decomposed and synthesized. The presence of rumen microorganisms enables the animal to utilize simple nitrogenous sources to synthesize protein which can be digested and absorbed.

Urea as a protein source

One of the most commonly used sources of non-protein nitrogen is urea. Per pound of digestible protein urea is considerably cheaper than any plant or animal source of protein. With conventional protein feeds becoming increasingly expensive, the use of urea as a cattle feed ingredient is likely to receive much more attention.

The addition of urea to cereal-based rations can cause unpalatability, and over-ingestion of urea may result in ammonia toxicity. It is important that urea be combined with palatable feed ingredients and to ensure thorough mixing. Sugar cane molasses, a palatable liquid with a low crude protein content, makes an ideal base for the addition of urea.

A trial was designed with Fresian heifers to determine the effect of incorporating 1.0% and 2.0% urea in molasses at the expense of plant protein. Twelve animals were randomly assigned to each of the three treatments shown in Table 2.

Table 2

Percent Composition of Molasses Mixtures and Protein Supplements

	Treatment		
	1	2	3
Molasses mixtures:			
Molasses	94.0	94.0	94.0
Urea	0.0	1.0	2.0
Water	6.0	5.0	4.0
Protein supplements:			
Barley	—	31.3	62.7
Soyabean meal	94.0	62.7	31.3
Mineral-vitamin mix.	6.0	6.0	6.0

The digestible protein intakes on each of the three treatments were estimated to be equal. Half the daily allowance of 10 lb of molasses mixture and 2.2 lb of protein-mineral-vitamin supplement was fed in the morning, and half in the afternoon. Barley straw was used as roughage, all animals being fed 6.6 lb per day. The animals were individually fed during the experimental period of 84 days.

The straw intakes and liveweight gains are showin in Table 3. No concentrate refusals were recorded after the first few days of the trial, and straw intakes were similar for the three groups. The daily liveweight gains were not significantly different ($P > 0.05$). This observation indicates that the levels of urea used in treatments 2 and 3 were efficiently utilized.

Table 3
Effect of Dietary Urea on Animal Performance and Straw Intake

	Treatment		
	1	2	3
Initial bodywt. (lb)	581	581	581
Daily gain (lb)	1.11	1.01	1.01
Daily straw intake (lb)	6.5	6.4	6.5

Blood samples were taken from the jugular vein of four animals on each treatment at 1 hour, 2 hours and 3 hours following consumption of the morning feed. These samples were analyzed for plasma urea-nitrogen content. The results are presented in Table 4. There was no evidence of elevated plasma urea-nitrogen due to the feeding of urea at any of the three times of sampling.

Table 4
Effect of Dietary Urea on Plasma Urea-Nitrogen

	Treatment		
Hours Post Feeding	1	2	3
		mg urea N/100 ml plasma	
1	15.8	17.5	9.6
2	8.9	9.2	10.8
3	8.6	6.3	7.5
Mean	11.1	11.0	9.3

Protein Supplementation of Silage

One of the advantages claimed for silage harvested at an early stage of growth is a high crude protein content. The proportion of the crude protein present as true protein is dependent on the material ensiled and quality of preservation. The data in Table 5 show that the ratio of true protein to crude protein in silages harvested at different stages of growth can vary widely.

Table 5
Crude Protein and True Protein Contents of Silages Harvested at Three Stages of Growth

	Stage of Growth at Cutting (weeks)		
	6	9	12
Crude protein (%)	13.4	9.4	8.0
True protein (%)	7.3	6.5	6.0
True protein + Crude protein $\times 100$	55	69	75

There is a limit to the amount of non-protein nitrogen that can be fed without depressing animal performance. Because of the high proportion of non-protein nitrogen in some silages, the importance of a high crude protein content should not be over-emphasized. When deciding on the source and level of protein to use in the concentrate ration, the protein composition of the silage should be known.

Feeding urea with silage—experiment 1

Ten Friesian bullocks of about 950 lb bodyweight were assigned to each of the following two treatments for a period of 88 days:

(1) Restricted silage plus molasses-urea mixture.*

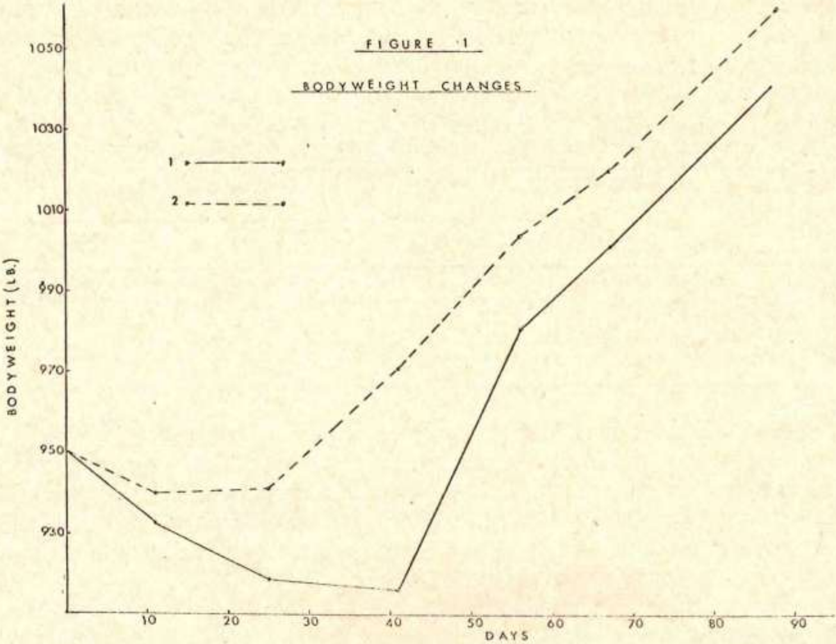
(2) Restructed silage plus 8 lb barley.

*Percent composition: Molasses, 90.5; Urea, 2.5; Water, 5.0; Minerals and Vitamins, 2.0.

The daily silage allowance was restricted to 1 lb of silage dry matter per 100 lb bodyweight. The animals had access to the molasses-urea mixture for 8 hours per day. The animals were group fed and wintered outdoors in acre-sized paddocks.

The silage fed was poorly preserved (pH 5.2). The dry matter, crude protein and true protein were 19.7, 14. 0 and 7.4%, respectively. During the first 41 days of the trial, the animals on treatment 1 consumed 10.7 lb of molasses-urea mixture per day and lost 0.88 lb of bodyweight per day. During the same period, the animals on treatment 2 gained 0.50 lb per day. Both groups were fed 45 lb of silage per day during this time.

Because the animals on treatment 1 were rapidly losing bodyweight, it was decided to alter the treatment after 41 days. To determine whether there would be a response to feeding a source of true protein, the animals on treatment 1 were fed 2 lb of soyabean meal per day from days 42 to 88. It is apparent from Figure 1 that there was an immediate and very



pronounced response to the feeding of vegetable protein. The daily intake of molasses-urea mixture during the period 42 to 88 days increased to 15.6 lb per animal, and at the same time, the animals in both groups were being fed 50 lb of silage per day. During this period the animals on treatment 1 gained 2.67 lb per day while those in group 2 gained 1.90 lb per day.

Feeding urea with silage—experiment 2

A trial was conducted to compare soyabean meal and urea as protein sources when molasses was used as an energy supplement to silage. Forty Friesian bullocks, weighing about 560 lb were used for the trial. Ten animals were randomly assigned to each of the four treatments shown in Table 6.

Table 6
Experimental Treatments

Treatment	Ration Composition*	Feed/day (lb)
1	Barley-soyabean (12% C.P.)	4.4
2	Molasses	6.0
3	Molasses with 2% urea	6.4
4	Molasses	5.0
	Soyabean meal	0.9

*All animals were fed 40 g per day of a mineral-vitamin mixture.

The daily silage allowance was restricted to 1.5 lb of silage dry matter per 100 lb bodyweight. The animals were individually fed once daily and refusals recorded during the experimental period of 91 days.

The silage fed was of average quality (Table 7). The relatively high pH indicates poor preservation, and the high acid detergent fibre content shows that the material was harvested at a mature stage.

Table 7
Chemical Composition of Silage

	%
Dry matter	17.5
Crude protein	11.0
True protein	7.8
Acid detergent fibre	45.2
pH	4.7

The mean daily silage dry matter intakes and bodyweight gains are presented in Table 8.

Table 8
Bodyweight Gains and Silage Intakes

	Treatment			
	1	2	3	4
Initial wt. (lb)	559	562	564	562
Daily gain (lb)	1.11[a]	0.50[b]	0.54[b]	0.93[c]
Silage D.M. intake (lb/day)	6.8	6.4	6.9	6.7

Within comparisons, values with different superscripts are significantly different ($P<0.05$).

No concentrate refusals were recorded. There were no significant differences ($P>0.05$) in silage dry matter intakes. When designing the trial, all four treatments were estimated to supply equal amounts of energy while treatments 1, 3 and 4 were estimated to be equal in digestible protein content. The liveweight gains on treatments 1 and 4 were significantly greater ($P<0.01$) than on treatments 2 and 3. There was no significant difference ($P>0.05$) between treatments 2 and 3. The results of this trial show that there was no benefit from the addition of urea to molasses while there was a significant response ($P<0.01$) to the addition of soyabean meal. The bodyweight gain on treatment 4 was significantly ($P<0.05$) less than on treatment 1. Further addition of soyabean meal to treatment 4 may have eliminated this difference.

Effect of supplementary protein on milk production

A trial was conducted to examine the effects of feeding concentrates with various protein contents to lactating cows being fed silage *ad libitum*.

Forty-eight Friesian cows in early lactation were used for the trial. From date of calving, the animals were individually fed 11 lb per day of a 15% crude protein ration plus silage *ad libitum*. After a minimum period of 21 days post-calving, the cows were blocked into groups of 4 according to calving date and milk yield. One animal from each of 12 such blocks was randomly assigned to each of the four treatments shown in Table 9.

Table 9
Percentage Composition of Rations

Ingredient	Treatment 1	2	3	4
Sugar beet pulp	98.0	91.9	82.6	73.2
Soyabean meal	—	6.1	15.4	24.8
Mineral-vitamin mix.	2.0	2.0	2.0	2.0
Crude protein	9.3	11.6	13.5	16.3

All rations were fed at 11 lb per day during the experimental period of 56 days. The animals were individually fed, silage being fed once daily and concentrates twice daily. Milk production was recorded daily, and milk composition determined weekly. Bodyweights were recorded once weekly.

The chemical analysis of the silage (Table 10) showed it to be of average quality.

Table 10
Chemical Composition of Silage

Dry matter	18.5%
Crude protein	11.5%
True protein	5.8%
Acid detergent fibre	42.2
pH	4.4

Values for silage intakes, bodyweight changes, milk production and milk composition are presented in Table 11. There were no significant differences ($P>0.05$) in silage dry matter intakes. Bodyweight loss tended to be reduced as dietary protein increased.

Table 11
Silage Intakes, Bodyweight Changes, Milk Production and Milk Composition

	Treatment			
	1	2	3	4
Daily silage D.M. intake (lb/100 lb bodyweight)	1.33	1.37	1.34	1.32
Bodyweight change (lb/day)	—1.3	—0.7	—0.5	—0.4
Daily milk yield (lb)	30.4[a]	32.2[a]	33.4[abc]	34.5[bc]
Fat %	3.79	3.72	3 .80	3.82
Protein %	2.67[ab]	2.65[a]	2.76[bc]	2.84[bc]

Within comparisons, values with different superscripts are significantly different ($P<0.05$).

The values for mean daily milk production, fat percentage and protein percentage, are adjusted for pre-experimental values. Daily milk yield increased with increasing dietary protein. Milk fat percentage was not affected by the treatments imposed. The milk protein percentage on treatment 4 was significantly higher ($P<0.05$) than on treatments 1 or 2, and the protein percentage on treatment 3 was significantly higher ($P<0.05$) than on treatment 2.

From these results it is evident that the protein content of the dairy concentrate ration can be of great importance. This area of work needs to be continued using different levels of concentrate feeding, various quality silages and different sources of protein.

Summary

The quantity and quality of protein required in the ruminant concentrate ration is dependent on the quantity and quality of protein in the roughage being fed. Because of the high cost of plant and animal protein feeds non-protein nitrogen will be used more extensively in the future to supply some of the protein requirements of ruminants. When properly used under the correct feeding conditions, the incorporation of urea in concentrate feeds can result in a considerable saving for the farmer. The use of urea in concentrates fed to supplement silage needs to be closely examined.

Supplementation of Silage with Protein for Beef Cattle

by

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In this country, animals for beef are predominantly wintered on conserved grass in the form of hay or silage. Barley and oaten straws are also used as a feed to a small extent.

In addition to roughage, an energy supplement may also be fed during the winter period. This will, however, depend on the quality of the roughage fed and the proposed time of sale for the animals. The energy supplements generally fed are barley and oaten grains (rolled or ground) and molassed beet pulp. Root crops such as swedes are also used to a small extent. These energy supplements contain approximately ten percent crude protein and the question is often asked should a high protein supplement such as soya bean or meat and bone meal be included with the energy supplement? Because protein supplements are more expensive than energy supplements, they increase the cost of the total ration. In addition, if the ration is purchased already mixed, then a charge is made for mixing which further increases its cost.

Why is protein required?

Ruminants have an advantage over non-ruminants in that the microflora present in the rumen can utilize non-protein nitrogen sources to synthesize the protein for their own bodies which can later be utilized by the animal when broken down to amino acids. However, the extent to which non-protein nitrogen can be utilized as a source of protein is limited and depends on the diet fed to the animal.

Protein requirements

The protein requirements of beef animals depend mainly on (a) the weight or age of the animal and (b) the rate of daily liveweight gain (1). Table 1 shows that as the weight of the animal increases then the percentage of protein required in the diet declines.

Table 1
Percent protein required in diet in relation to weight of animal

*Weight (lb)	330	440	660	880
Percent Protein	12.2	11.0	10.0	8.9

*Weight gain=1.1 lb per day.

SOURCE: N.A.S. Publication. Nutrient Requirements of Beef Cattle, 1970.

At a given liveweight, as the daily liveweight gain increases the percentage protein required in the diet also increases (Table 2).

Table 2
Percent protein required in diet of a 330 lb animal in relation to weight gain

Daily gain (lb)	0.00	0.55	1.10	1.65
Percent Protein	7.8	10.9	12.2	13.4

SOURCE: N.A.S. Publication, Nutrient Requirements of Beef Cattle 1970.

A deficiency of protein is shown through decreased feed intake with a resultant decline in animal performance.

Protein supplements for animals fed silage

Using data on protein requirements and percent protein in grass silages, the level of crude protein in silage is generally adequate to meet the requirements of beef cattle when fed silage alone or with low to medium levels of energy supplementation. However, in the limited number of studies where protein supplements were evaluated with grass silage, responses in terms of animal performance were obtained from the inclusion of a protein supplement with the energy supplement (2 and 3). Thus, there may be some factor causing poor utilization of the protein in silage such as low levels of specific amino acids. Extensive changes in the form of the herbage nitrogen when preserved as silage has been demonstrated (4). It has also been shown (5) that the failure of preservation affects principally the basic amino acids especially lysine.

Studies using both finishing cattle and weanlings were initiated to obtain more information on the feeding of protein supplements with grass silage.

Fattening cattle

Two experiments were conducted at Grange in which fattening cattle were fed well-preserved high quality grass silage. In the first experiment Friesian steers were fed 6.0 lb of supplementary feed per head daily in addition to silage for a period of 99 days. The supplement consisted of molassed beet pulp alone or mixed with soya bean meal to give rations containing approximately 9, 12, 15 or 18 percent crude protein. The supplements were fed in pelleted form to groups of ten animals. The daily supplement allowance was given in one feed. The crude protein levels of the four rations obtained by chemical analysis are shown in Table 3.

Table 3
Percent dry matter, crude protein and soya bean in supplements

	Supplement (Percent crude protein)			
	1 (9.0)	2 (12.0)	3 (15.0)	4 (18.0)
Dry matter	91.5	92.2	92.6	91.9
Crude protein in dry matter	10.7	11.6	15.8	17.9
Percent soya bean meal	0	7.2	16.4	25.6

The chemical analysis of the silage fed is shown in Table 4.

Table 4
Chemical analysis of the silage fed in experiment 1

Dry matter (%)	[a]Total Crude Protein (%)	[a]Decomposed Protein (%)	pH	In-vitro dry matter digestibility (%)
19.0	14.2	1.7	4.0	69.2

[a]=percent in dry matter.

The low values for decomposed protein and pH show that the silage was well preserved. The figure for in-vitro dry matter digestibility of 69.2 percent shows that the material was of high quality.

Table 5
Mean daily dry matter intakes (lb) per animal during experiment 1

	Treatments			
	1 (9% Protein)	2 (12% Protein)	3 (15% Protein)	4 (18% Protein)
Silage	12.08	12.18	12.17	12.49
Supplement	5.49	5.53	5.56	5.51
Total	17.57	17.71	17.73	18.00

Table 5 shows that the daily silage dry matter intakes were quite similar for all four groups as was total dry matter intake.

The mean initial weight of the animals was approximately 880 lb (Table 6). The daily liveweight gains of the animals fed supplement 4 were significantly ($P<0.05$) greater than the gains of those fed supplements 1 and 2. All other treatment differences failed to reach significance at the five percent level.

Table 6
Mean initial liveweights and weight gains (lb) during experiment 1

	Treatments			
	1 (9% Protein)	2 (12% Protein)	3 (15% Protein)	4 (18% Protein)
Initial wt.	883	883	873	879
Total weight gain	172	167	189	211
Weight gain per day	1.74	1.68	1.91	2.14

At the end of the study, the animals were slaughtered and the mean killing-out percentages for all four groups were similar (Table 7).

Table 7
Mean killing-out percent, hot carcass weight and carcass gain during experiment 1

	Treatments			
	1 (9% Protein)	2 (12% Protein)	3 (15% Protein)	4 (18% Protein)
Killing-out percent	53.2	53.5	53.1	53.2
Hot carcass wt. (lb)	562	562	564	580
[a]Carcass gain (lb)	111	111	118	131

[a]=Calculated by assuming a killing-out percent of 51.0 on initial liveweight.

The mean carcass gains of the two groups receiving supplements 1 and 2 were similar at 111 lb (Table 7). Animals fed supplements 3 and 4 gained 7 and 20 lb more respectively in terms of carcass than their counterparts in groups 1 and 2.

In the second experiment five groups of ten Friesian steers were fed for a period of 98 days. The treatments were as follows:

Treatment 1 Silage only
Treatment 2 Silage + 5.0 lb beet pulp per head daily.
Treatment 3 Silage + 5.0 lb beet pulp/soya bean mixture per head daily.
Treatment 4 Silage + 10.0 lb beet pulp per head daily.
Treatment 5 Silage + 10.0 lb beet pulp/soya bean mixture per head daily.

All animals were fed silage to appetite. The supplement was again fed in the form of pellets. The molassed beet pulp/soya bean meal mixture fed to treatments 3 and 5 consisted of 75 percent pulp and 25 percent soya bean meal.

The molassed beet pulp contained 10.0 percent crude protein (Table 8). The corresponding figure for the molassed beet pulp/soya bean meal mixture was 21.5 percent.

Table 8
Percent dry matter, crude protein and soya bean in supplements

	Molassed beet pulp	Pulp/soya bean mixture
Dry matter	93.8	92.5
Crude protein in dry matter	10.0	21.5
Percent soya bean	0	25.0

Four different silages were fed during the experiment (Table 9).

Table 9
Chemical analysis of the silage fed in experiment 2

Silage	Days fed	Dry matter (%)	[1]Total Crude Protein (%)	[1]Decomposed Protein (%)	pH	In-vitro dry matter digestibility (%)
A	1–18	17.8	14.5	1.7	4.3	67.7
B	19–45	16.8	14.6	1.6	4.0	70.7
C	46–77	20.5	11.1	0.8	4.0	74.1
D	78–98	21.0	10.6	0.6	3.9	71.1

[1]=percent in dry matter.

The results of chemical analysis show that the silages fed were in general well preserved and of high quality.

Table 10
Mean daily intakes (lb) per animal during experiment 2

	Treatment				
	1	2	3	4	5
Supplement	0	5.0	5.0	10.0	10.0
Silage dry matter	15.8	13.9	13.8	11.7	11.1
Total dry matter	15.8	18.1	18.0	20.0	19.4
Silage intake as percent of control	100	88.0	87.3	74.1	70.3

Feeding 5 lb of supplement resulted in a decrease in silage dry matter intake by approximately 2.0 lb or 12 percent (Table 10). When 10 lb of supplement was fed silage intake was decreased by 4.4 lb or 28 percent. Percentage protein in the supplement did not have any effect on silage intake.

The mean initial weight of the animals was approximately 880 lb (Table 11). The daily liveweight gains of those fed silage alone was 1.89 lb. This again indicates that the silages fed were of high feeding value.

Table 11
Mean initial liveweight and weight gains (lb) during experiment 2

	Treatment				
	1	2	3	4	5
Initial wt.	877	878	884	872	877
Total weight gain	185	245	242	249	250
Weight gain per day	1.89	2.50	2.47	2.54	2.55

Animals fed a supplement in addition to silage gained significantly faster than animals fed silage alone. However, there was no difference in liveweight gain between any of the four groups that were fed supplements.

At the start of the study a representative group of animals were slaughtered and their killing-out percentages were used to calculate the initial carcass weights of the five experimental groups. All animals were slaughtered at the end of the experiment and their hot carcass weights were obtained shortly after slaughter (Table 12). Due to differences in killing-out percentages, liveweight gains were not a true reflection of carcass gains. Those fed a supplement were, however, again shown to gain significantly faster than animals fed silage only. Percent protein in the supplement had no significant effect on carcass gain at either level of supplementation. At the lower level of supplementation (5.0 lb of supplement per head daily) a total of 485 lb of supplement was fed to each animal and this resulted in the production of an average of 44 lb of extra carcass above those fed silage only.

Table 12
Mean killing-out percent, final hot carcass weights and carcass gain in experiment 2

	Treatment				
	1	2	3	4	5
Killing-out percent	50.8	52.2	51.7	53.5	54.6
Final carcass wt. (lb)	539	587	582	599	616
[a]Carcass gain (lb)	88	136	128	151	164

[a]=Calculated by using killing-out percentages of pre-experimental slaughter group.

Thus, 1 lb of extra carcass was produced for each 11.0 lb of supplement fed. When an additional 5.0 lb of supplement per day was fed 485 lb of supplement resulted in the production of 26 lb of extra carcass. This gave an average conversion of 18.7 lb of supplement per lb of carcass at the high level of supplementation.

Using the production data obtained in experiment 2 some financial returns to supplementation were calculated (Table 13).

Table 13
Financial responses to supplementation

Treatment	Silage (tons)	No. of Cattle	Carcase gain per animal	Total carcase gain		Returns (£)
Silage + 5 lb pulp daily	416	114	129	14,706		3,676.50*
Silage only	416	100	86	8,600		2,150.00
				Difference	=	1,526.50
		Beet pulp (24.68 tons @ £26 per ton)			=	641.68
				Profit	=	884.82

*Pulp/soya bean (Ratio 4:1) @ £36 per ton.

In order to cover the extra cost of the ration, a carcass increase of 8.6 lb per animal is required.

To obtain an economic response from the inclusion of soya bean which is similar to that achieved when feeding 5.0 lb of beet pulp, a carcass increase of 20.5 lb per animal is necessary.

It is assumed that 416 tons of silage is available which is sufficient to feed one hundred cattle for a period of 98 days when silage only is fed. The carcass (cold) gain per animal is 86 lb which at 25p per lb leaves a total return of £2,150 for the hundred animals. By feeding 5.0 lb of molassed beet pulp per animal daily the carrying capacity can be increased to one hundred and fourteen animals for a similar period of time. The carcass (cold) gain per animal is now 129 lb which at 25p per lb leaves a total return of £3,676.50 for the 114 animals. The extra return from the supplemented group is therefore £1,526.50. The total requirement of molassed beet pulp for the supplemented group is 24.68 tons which at £26 per ton costs £641.68. Thus, the total profit from supplementation is £884.82. This figure would be reduced slightly if the cost of extra housing is charged and the interest paid on the money invested in pulp and the extra animals are taken into consideration.

In order to illustrate the response required to make protein supplementation as attractive economically as was feeding 5.0 lb of beet pulp per animal daily in experiment 2, the following calculations were made. The cost of beet pulp was again taken at £26 per ton. The cost of a ration containing

4 parts of pulp to 1 part of soya bean was taken at £36 per ton. Therefore, in order to cover the increased cost of the supplement when it is fed at a level of 5.0 lb per head daily, the carcass gain required would be 8.6 lb above that obtained with pulp alone. To obtain an economic response similar to that obtained with pulp, the carcass gain required would be 20.5 lb above that obtained with pulp alone in the present study.

In conclusion, it may be stated that inclusion of a protein supplement with beet pulp for fattening cattle fed high quality well preserved silage could not be recommended on the basis of the above results.

Weanlings

Studies at Grange (6) have shown that with weanlings which will be retained for the following grazing season, rates of gain of approximately 0.5 to 1.5 lb per day should be aimed at during their first winter. The higher gains would apply to animals that are lighter at the start of winter. High quality roughage alone is adequate to provide those rates of gain. However, if the roughage fed is medium or poor in quality some form of supplementation will be necessary especially with lighter animals. In these animals, since responses to supplementation are good, the level of meal feeding required will generally be low.

In two experiments carried out with weanlings the silage fed was medium to high quality and thus only low levels of supplementation were practised. In the first experiment, two groups of thirty Hereford cross heifers were fed either a supplement of 2.0 lb of molassed beet pulp per head daily or a similar quantity of a pulp/soya bean meal mixture. The percent crude protein in the straight pulp and the pulp/soya mixture was 9.5 and 12.0 respectively. As seen from Table 14 the silage fed was of high quality and was relatively well preserved.

Table 14
Chemical analysis of the silage fed in experiment 3

Dry matter (%)	[a]Total crude Protein (%)	[a]Decomposed Protein (%)	pH	In-vitro dry matter digestibility (%)
19.7	17.4	1.8	4.3	70.8

[a]=percent in dry matter.

The liveweight of the weanlings at the start of the experiment was approximately 400 lb (Table 15). The weight gains of the two groups during the 108 day experimental period and the first 54 days at pasture were similar.

Table 15
Mean initial liveweight and weight gains (lb) during experiment 3

	Treatment	
	Molassed Beet Pulp	Pulp/soya bean mixture
Initial weight	400	407
Winter wt. gain	115	128
Daily wt. gain in winter	1.06	1.17
Daily wt. gain during 1st 54 days at pasture	2.18	2.05

In the second experiment with weanlings (experiment 4) three groups of twelve Hereford cross heifers were fed 2½ lb of supplement per head daily. Groups 1, 2 and 3 were fed supplements containing either 9, 12 or 15 percent crude protein. The supplements were part of the batch described for experiment 1 and the chemical analysis are given in Table 3. The silage fed was of medium quality and it was well preserved (Table 16).

Table 16
Chemical analysis of the silage fed in experiment 4

(%) Dry matter	[a]Total crude Protein (%)	[a]Decomposed Protein (%)	pH	In-vitro dry matter digestibility (%)
25.9	13.5	0.8	3.8	63.6

[a]=percent in dry matter.

Silage intakes were similar for the three treatments, the average daily intake per animal being approximately 48 lb.

As in the previous study, level of protein in the supplement had no effect on animal performance during the 111 day experimental period (Table 17).

Table 17
Mean initial liveweight and liveweight gains (lb) during experiment 4

	Treatment		
	1	2	3
Initial weight	395	400	396
Winter wt. gain	142	133	146
Daily wt. gain in winter	1.28	1.21	1.30
Daily wt. gain during the 1st 30 days at pasture	2.16	1.90	2.12

It can thus be concluded that at a low level of energy supplementation inclusion of protein in the supplement is not necessary for weanlings fed medium to high quality silage.

References

1. Nutrient requirements of beef cattle. Fourth revised edition, 1970. National Academy of Sciences, Washington D.C.
2. Forbes, T. J. and Irwin, J. H. D. (1970). J. Br. Grassld. Soc., **25**:96.
3. MacDonnell, J., (1971). Ir. Frmrs. J., Nov. 6:14.
4. Hughes, A. D. (1970). J. Agric. Sci. Camb., **75**:421.
5. Gouet, Ph., Fatianoff, N., Fisserand, J. L., Durand, M., Candan, M. and Zelter, S. Z. (1968). Proc. 2nd World Conf. on Anim. Prod., Session 5—Contr. Paper 125.
6. Drennan, M. J., Farm and Food Res., An Foras Taluntais, July-August 1971:93.

Optimal Use of Genetic Material to Increase Profit in Beef Production

by

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1. General information about French cattle production and animal populations

Before discussing the best methods of using genetic material to increase profit in beef production, I will describe briefly the cattle populations of France. There are about 22 million cattle in France; 11.5 million cows are bred, representing between one-quarter and one-third of cattle in the Common Market. A little less than 50% of calves born are used for veal production. This is the largest percentage, with Denmark and the Netherlands in the Common Market countries. Our veal production represents around 50% of total veal production in the whole Community. This explains why the ratio of carcass weight of slaughtered cattle (veal and beef) divided by the number of cows reared each year is the lowest; 134 kg compared with more than 200 kg (180-260) for almost all other nations in Western Europe. This is a paradox because our beef breeds are generally considered the most suitable for growth.

As far as beef production is concerned we produce around 20% of the overall production in the Community and intensive beef production (cereals, sugar beet pulp and corn silage) is increasing rapidly, though it still represents only 25% of our beef production, cows excluded. This is the consequence of a double evolution:

(a) increasing slaughter weight of calves in the veal production area (small veal production farms are replaced by dairy farms in this area);

(b) dimunition of the slaughter age and intensification of feeding systems in the beef areas.

We rear and fatten our beef on grass as in Ireland, chiefly in Normandy and Charolais but this represents a smaller part of our beef production (40% of heifers, young bulls and beef slaughtered).

Our cattle population may be represented according to type of herds and breeding systems as follows:

(a) Milking herds (75% of population) are located chiefly in the north, west and east. They are concentrating more and more in Brittany and Normandy (4.5 m. A.I. in pure breeding with Friesian Normand and Mountbeliard bulls—the latter is our dairy Simmental and has 0.5m. A.I.). Beef crossing with Charolais in milking herds is of most interest in western areas between Brittany and Central mountains.

(b) Suckling herds (25%) of population are reared in the Central mountains and south west. They are constituted by dual-purpose or multiple purpose breeds (milk, draught, meat, or draught and meat) or crossbred females bred by beef bulls (Charolais, Limousin Blonde d'Aquitaine). There are 1.5 m. artificial inseminations in these crossbred herds. Our purebred beef herds represent around 1 million cows but here the use of A.I. is lower (50%), particularly in Charolais (30%) ,than in the other types of herds (75–80%).

The proportion of purebred or crossbred dairy cows milked or suckled is based on their milking abilities. Beef production appears as a by-product of dairy cattle selection. As milk productivity increases milk production will come from a decreasing number of dairy cows. More and more less productive females (native, dual purpose) will be crossed with beef bulls, milked if their production is sufficient, not milked if not.

First generation F_1 females—native × beef, dairy × beef—are more and more used in suckling herds (around 10% of cows and 50% of beef cows in France are classified in undetermined breeds).

2. Biological basis for optimal use of genetic material in beef production

(a) Efficiency criteria

Profit in beef production depends on characters expressed or influenced by the two biological units (calf and dam) that constitute the economical unit of beef production during one year of the cow's life cycle.

These calf and dam biological characters determine the number of animals per cow bred and the quality of animals slaughtered. An analysis of beef production efficiency is presented in this way (Figure 1). It appears that the number of characters is large; they differ from dam to calf and there may be some antagonism between what we try to improve in each—

Fig.1 Selection criteria to improve efficiency of beef production.

Efficiency criteria :	Animal concerned	DAM	CALF
NUMBER OF ANIMALS	Fertility	.Ability to ovulate	Viability of embryos and foetus
	Prolificacy	.Ovulation rate	
	Calving ability	.Opening of pelvis-Uterine effect on calf size	Size and morphology of foetus
	Viability	.Maternal behaviour and milk	Vitality-Vigor
QUALITY OF ANIMALS	Growth before weaning	.Maternal ability and growth potential	Growth potential
	Growth during fattening		
	Food efficiency	.Maintenance requirements	Growth and maint. requirem.
	Carcass quality	Growth	**Growth**
Type of A.I. BULL selected		Purebreeding or crossbreeding for F_1 females	Terminal crossing

the former must have a small size (low maintenance requirements), the latter must express a high growth potential. There would be a great advantage in selecting independently these two groups of characters and, if possible, in combining dams like Jersey with calves like Charolais. If not, we can at least select 50% of calf genes independently of those of the dam by using bulls proven only on calf characters.

(b) Additive effects of genes and general combining ability

Genetic variation for all these characters (dam and calf), is very large chiefly between breeds and also, but to a lesser extent, within breeds. This is true for size, milk production, % fat, % muscle, fertility, prolificacy. Further there are many biological antagonisms between dam and calf characteristics (between and within breeds), for example muscle growth potential in the calf is associated with infertility, calving problems and low milk production in cows. It is difficult to analyse these antagonisms due to the problems which arise in expressing independently dam and calf characters. One can at least have a general approach in the same way by comparing calf characteristics between different size breeds mated with the same dam breed (Friesian for example). In this way the paternal value can be estimated. Also, dam characteristics from different dam breeds can be compared, all the dams involved being mated with the same bull. Thus, the maternal value is obtained. This approach is being adopted with our cattle breeds—some of them are used chiefly for terminal crossing (paternal breed) or in pure breeding (synthetic breed). We have tried to classify our French beef breeds in this way, using field and research data gathered in France during the last 10 years. This is a rough approach, more accurate for some breeds and characters than for others. I shall consider three groups of breeds in France:

(1) dairy and dual purpose breeds—Friesian, Normand, Brown Swiss, Simmental (dairy and beef type);

(2) native breeds—Salers, Gascon, Aubrac;

(3) beef breeds—Charolais, Limousin, Blonde d'Aquitaine, Maine-Anjou.

This classification is conventional and requires some explanation as to some expanding breeds. It appears that Simmental is never used in beef herds; it's rarely the case for the Maine-Anjou breed where cows are generally milked (Figure 2.)

French data on comparisons between breeds for beef production are given in Figure 3. As far as paternal value is concerned beef breeds prove to be the best for rate of growth and percentage of muscle in the carcass. On the other hand, however, some difficulties occur for calving ability, except with the Limousin breed, due to the large size at birth of beef breeds.

The picture is quite different for the maternal value of these breeds. Their fertility (% of non return in beef herds) is intermediate between that of native and dairy breeds—only the Limousin breed seems to have fertility close to that of native breeds. Calving ability of beef breeds is quite variable. Charolais and Maine-Anjou cows, like cows from large size dual purpose breeds (Simmental, Brown Swiss) are very poor calvers. In contrast, there are less calving difficulties with Limousin and Blonde d'Aquitaine cows which are intermediate between native and other dairy breeds. Beef cows are also poor milkers, chiefly Limousin cows. Maternal ability expressed as weaning weight of calves from different dam breeds mated with the same sire breed is the consequence of both growth and dairy genes. This is the reason why large dual purpose breeds (Simmental, Brown Swiss) give higher weaning weights than beef breeds like Charolais,

Fig.2 Some characteristics of French breeds and their use in France.

for beef production

Breed	Population size and mating type			Suckling and milking herds		Breeding systems of cows			
	cows		bulls	% of cows in suckling herds			Cross breeding with males		
	Number (thousand)	% in A.I. (1966)	A.I. Number (thousand 1970)	Total	Partial	Purebreed	Charolais	Limousin	Maine Anjou
CHAROLAIS	765	34	1526	80	20	96	X	2	-
LIMOUSIN	302	77	894	100	0	96	2	X	-
BLONDE d'AQUITAINE	150	70	194	100	0	70	4	20	-
MAINE-ANJOU	157	77	89	10	30	54	40	-	X
SIMMENTAL	234	71	111	15	5	77	8	-	-

{LIMOUSIN, CHAROLAIS : PATERNAL BREEDS.
}MAINE-ANJOU, SIMMENTAL : MATERNAL BREEDS.

Figure 3

COMPARISONS BETWEEN CATTLE BREEDS FOR BEEF PRODUCTION (French data)

- paternal value = relative mean value of sire breeds after crossing with the same maternal breed
- maternal value = relative mean value of dam breeds after crossing with the same sire breed

		ESTIMATED RELATIVE VALUE minimum	medium	maximum
PATERNAL VALUE	• Birth ability	-	MA-Ch — BR/Si — BA ——— No – Li ——— PN — Sa/Ga ——— Au	-
	• 16 MONTHS weight	480kg	Au —— PN — No — Ga —— Li — Sa —— BR-Si/BA ——— Ch-MA	600 kg
	• 16 MONTHS % muscle	-	Au — Sa-PN — Ga ——— No ——— BR — Si — MA — Ch-BA-Li	-
	• 16 MONTHS % fat	17%	PN —— Au ——— No/Ga-Sa —— BR/Si — MA – Ch — Li ——BA	7%
MATERNAL VALUE	• Fertility (%NR)	-	PN —— Si/BR BA ——— No MA-Ch ——— Li ——→ Sa Ga Au	-
	• Calving Ability	-	BR-Ch Si —— MA —— PN —— No — BA-Li ——— Ga —— Au/Sa	-
	• Milk Production	1 500 kg	Li ——— Ch.Au-BA-Ga-MA — Sa — BR — Si-No ——— PN	5 000kg
	• Weaning (3 to 7 months) Weight	-	Au ——— Li-Sa-Ga ——— PN ——— Ch – MA/No — BA —— BR/Si	-
	• Weaning (3 to 7 months) Score	-	Au ——— Sa ——— Ga PN — BR — No - MA/Si — Ch – BA —— Li	-

- Milk and duel purpose breeds: PN = French Friesian; BR = French Brown Swiss; No = Normande; Si = Pie-Rouge de l'est (Simmental)
- Beef breeds: Ch = Charolais; BA = Blonde d'Aquitaine; Li = Limousin; MA = Maine-Anjou
- Native breeds: Au = Aubrac; Sa = Salers; Ga = Gasconne

Maine-Anjou and especially Limousin. Females of this last breed give on the other hand calves having the highest weaning score.

On the whole there is a marked antagonism between paternal and maternal values, i.e. between calf and dam characters of the breeds. Thus, there is particular interest in knowing and selecting the best ones for each type of breeding—commercial crossing, pure breeding. The results point out general and important tendencies between breeds which are now popular and perhaps important for future cross breeding schemes for beef production.

(c) Heterosis effects

The importance of heterosis (hybrid vigour) effects on dam and calf characteristics is small for each of them but the effects combine in their influence on the overall profit. This overall influence can represent between 15% and 20% of this profit.

(d) Comparisons of cross breeding schemes

Comparisons have been made in different countries on cross-breeding schemes using heterosis effects on calf and dam characters and trying to combine dams of maternal breeds and bulls of paternal breeds. I present in

Figure 4 results with a native breed from the Pyrenees mountains considered as a maternal breed and two beef breeds (Charolais and Blonde d'Aquitaine as paternal breeds.

Figure 4. Crossing Schemes between dams from maternal breeds "GASCON" and bulls from paternal breeds "CHAROLAIS, BLOND D'AQUITAINE" to increase efficiency of beef production.

Type of breeding schemes	Efficiency
Purebreeding (maternal breed)	100
Commercial crossing (F^1)	107
Two-step crossing: backcross	120
Two-step crossing: 3 breed cross	114
Purebreeding (paternal breeds)	75

(e) Conclusion

It is clear from these general considerations and experimental results that two-step crossing is the best way of using our genetic material to increase beef production. Our problem now is to know what are the best maternal and paternal sire breeds to achieve this general system from a dairy cow population. This is the same problem which was studied in Clay Centre, Nebraska, U.S.A., starting from a beef cow population—Aberdeen Angus, Hereford. The problems are quite different in the two cases according to the difference of characteristics between beef and dairy foundation cows. After different experiments are carried out in several countries one can think about a great number of breeds and genetic types.

3. Selection schemes of French beef breeds for beef production

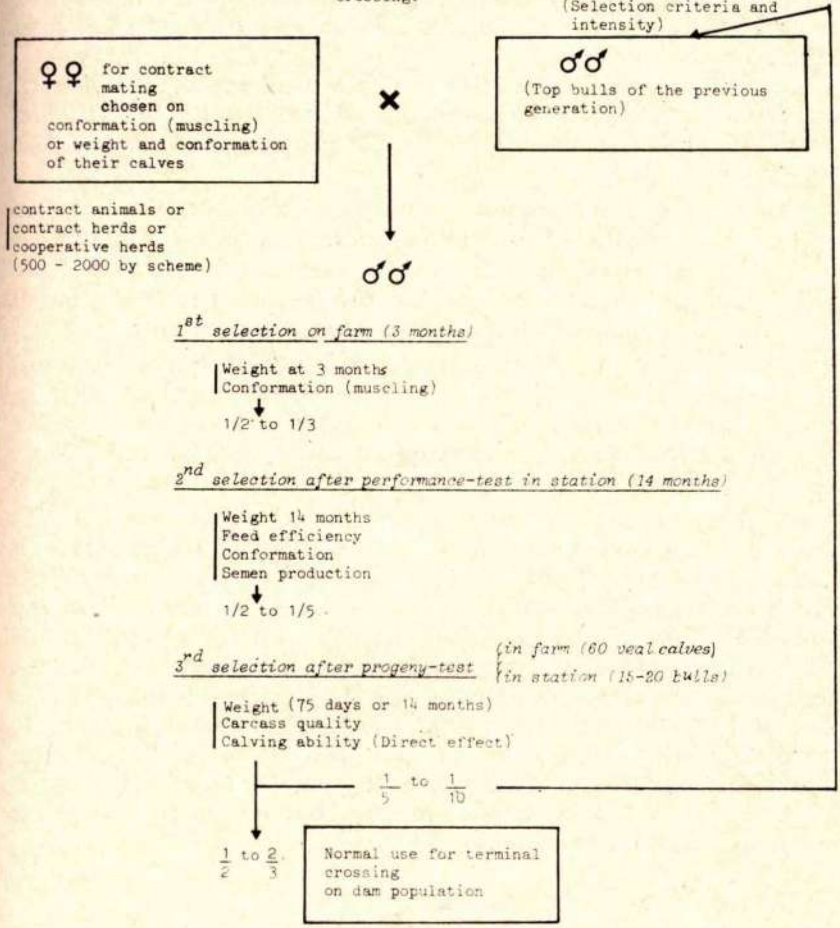
Selection schemes for bulls were developed in France from 1955–1960 to obtain and improve paternal lines as the first step, and more recently maternal lines from our beef breeds. These schemes operate chiefly under A.I. leadership owing to the large expansion of A.I. in our dairy and beef herds. I intend to describe briefly:

— the general basis of these schemes;
— research work to improve their efficiency;
— the practical situation and organisation of these schemes now.

(a) Selection schemes of paternal lines (terminal crossing)

The basis of these schemes as to selection stage, calf characters selected, selection intensity, is described in Figure 5. It looks like a horse race in three trials. In any year the animals competing for a given co-operative A.I. selection unit are the 500 bull calves born each year from contract mating between a female sample of beef cows chosen on their size and muscling and three or four top bulls from the previous generation.

Fig. 5 Selection schemes of A.I. bulls for terminal crossing.



At the beginning (1955–1960) these schemes applied on purebred and registered animals (Charolais, Limousin, Blonde d'Aquitaine). It appears logically that existing breeds and breeding objectives of herd book associations did not give the best genetic material for terminal crossing. Why in fact should past and present selection together for dam and calf characters give also the best animals for calf characters alone? In a first step (1962) we used muscular hypertrophied bulls (Culard). These bulls, used in natural service and not registered by any herd book, were competing at this time with registered normal bulls. Many farmers preferred culard Charolais bulls for commercial crossing. The overall advantage of crossbred calves by culard bulls proved to be around 3.4% over crossbreds from normal Charolais bulls. Calving difficulties appeared a little more frequently as a result of the larger size and h,gher compacity at birth of calves from culard bulls.

So, in a second step (1965–1970) we decided to produce experimental crossbred bulls, combining complementary characters of French beef breeds—Charolais, Limousin, Blonde d'Aquitaine, Maine-Anjou. This was done in two ways:

(1) by MIDATEST, which is a union of A.I. co-operative centres in the south west of France; they crossed top bulls of the previous schemes (Charolais, Limousin, Blonde d'Aquitaine) with female progeny of each other. This scheme was not involved at least at the beginning of selection with hypertophied animals;

(2) by INRA, our purpose was to cross definitely culard dams and sires from the Charolais and Maine-Anjou breeds on one side, from the Limousin and Blonde d'Aquitaine on the other. We intended to combine the large muscle growing capacities of the former breeds with the long legged and long bodied well fitted shape of the latter ones.

These are longterm experiments. All types of crossbred bulls are progeny-tested and compared with purebred ones for terminal crossing on a Friesian cow population. We used also a control line of bulls in several years for all French A.I. selection units—this permits an efficient and permanent way of making comparisons between all these genetic samples. We have little data yet and we cannot see into the future but my feeling is that we shall need several types of lines for terminal crossing according to the calving ability of the female population (heifer or adult dams) and to the type of production—veal with white meat or beef with red meat. Four to five lines perhaps will be necessary to meet these requirements which are in opposition to a large extent.

(b) **Selection schemes of maternal lines**

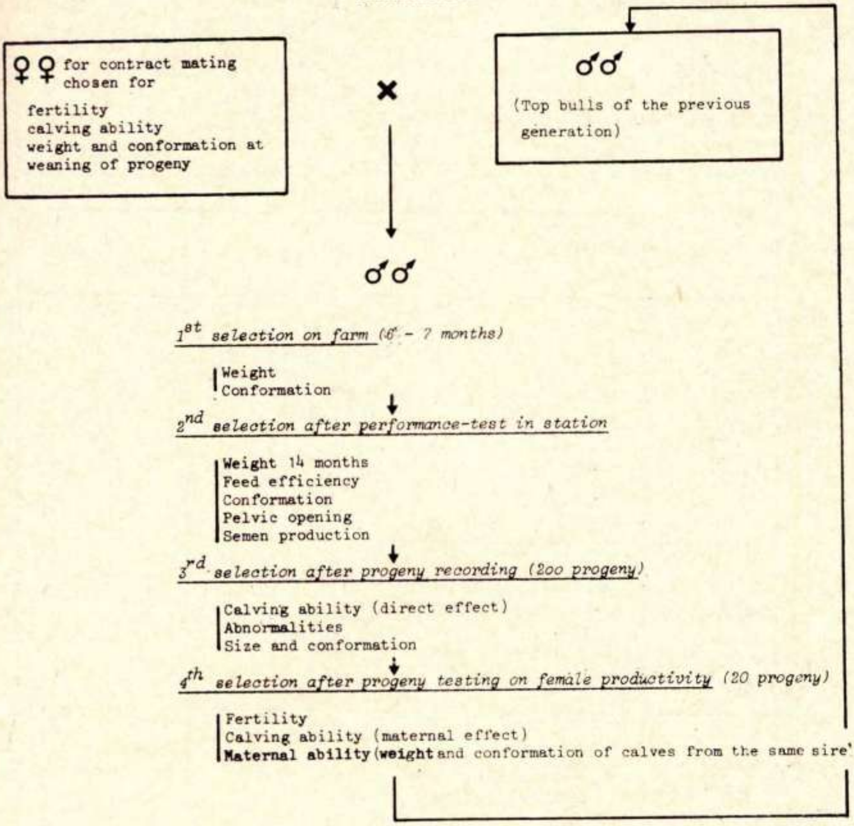
These are experimental schemes developed by A.I. units and more connected in general with traditional breeders. Selection stages and criteria are described in Figure 6. Less emphasis is given in general to calf characters. We start also from contract mating but there are four selection stages. As to the selection criteria the original points considered or studied were:

(1) measure of pelvic opening during performance test of young bulls to achieve a mass selection on this character;

(2) progeny test on farm on a large number of progeny to detect low frequency genes like cleft-palate;

(3) progeny test in station on maternal ability (20 heifer progeny per bull recorded from weaning to 30 months);

Fig.6 · Experimental Selection schemes of A.I. bulls for purebreeding (beef breeds)



Research work is conducted in several directions to improve the efficiency of this scheme:

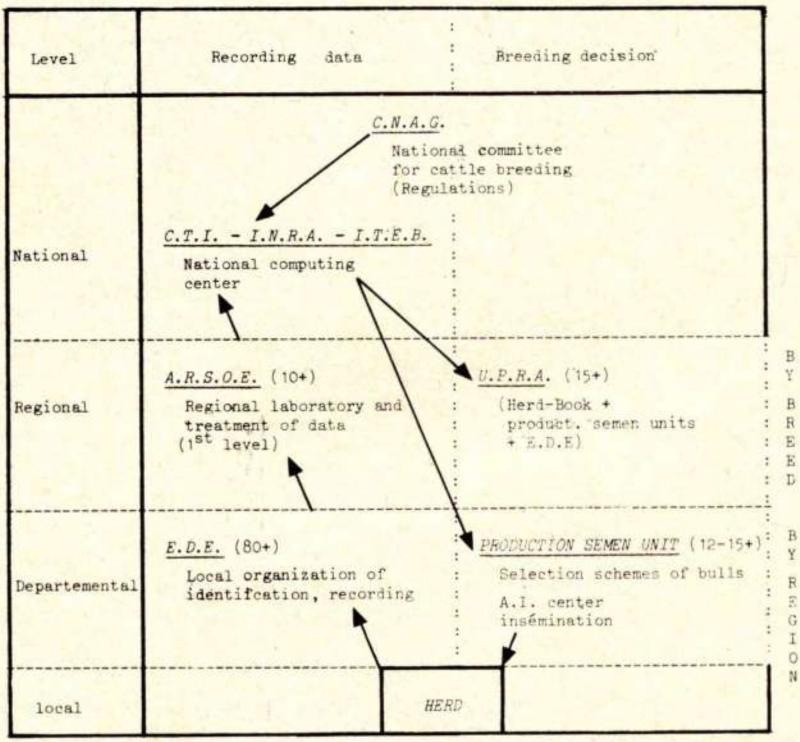
(1) we are trying to select a herd on twinning ability—Charolais and Maine-Anjou seem to have a high twinning rate (around 3% on all cow population, 10% on adult dams);

(2) we are studying also genetic differences in the ovulation rate after hormonal treatment. Artificial control of oestrus is developing and will develop more and more in beef herds. It is necessary to know accurately the sensitivity of each dam breed and line to P.M.S.

(c) Practical organisation and extension of these schemes

These schemes are carried out according to the regulations included in the law for breeding. The most important are indicated in Figure 7. We

Fig. 7 Schematic organization of cattle breeding in France.



(+) = Number in France.

separate on this graph recording, handling and treatment of data from breeding decision. Each of these two groups of operations involves people at four levels—herd (farmer), department (our administrative unit since Napoleon), region and nation. A national committee (C.N.A.G.) takes overall decisions on these schemes and solves all disagreements which emerge between organisations or people in practice.

I have presented in Figure 8 for each breed and for each type of selection scheme (terminal crossing or pure breeding) the name of the co-operative

Fig. 8 Selection schemes of A.I. bulls from beef breeds

(Organizations and A.I. numbers involved)

Type of schemes / Breeds	Terminal crossing	Purebreeding
Charolais	MIDATEST ....160 000 UNION AUVERGNE LIMOUSIN..........190 000 CENTRE EST........160 000 DIFFERENT UNITS (W) (in project)..500 000	DIFFERENT UNITS.....200 000 (in project)
Limousin	MIDATEST..........440 000 UNION AUVERGNE LIMOUSIN..........290 000	UNION AUVERGNE LIMOUSIN............100 000
Blonde d'Aquitaine and COOPELSO (93, 95)	MIDATEST..........100 000	MIDATEST............ 80 000
TOTAL	1 840 000	380 000

A.I. selection unit which operates now or will operate selection schemes in the coming years. One can consider in Blonde d'Aquitaine that the two schemes involve more and more two different populations; this is also the case for Charolais but to a lesser extent; for the Limousin breed, on the contrary, the purebreeding scheme is realised on animals previously selected for terminal crossing characteristics.

Conclusion

The evolution of cattle breeding in Ireland is quite similar to France. Further, both countries are now concerned with the same meat demands: lean meat in the same Common Market. We have to develop our beef breeding programme from the same Friesian cow population, using the same beef and dual purpose sire breeds as paternal or maternal breeds. What are the best ones for each purpose? How do we select them? We are living in the period of businessmen and promoters of exotic breeds but tomorrow farmers will ask not for red, white or yellow traditional beef breeds but for the most profitable, whatever their coat colour. New genetic combinations between existing sire breeds must be tested. This is a new and exciting but difficult goal for technicians, research workers and animal breeders. Ireland, France and also Great Britain are particularly ahead in the use of crossbreeding beef schemes from the dairy herd. So it would be natural for these nations to co-operate in this way on an international basis. It is clear indeed that the dimensions of such a programme in terms of space, time scale and money involved are largely beyond the capacities of one nation alone. We have also much to gain in comparing and selecting paternal and maternal beef strains under different environments and production schemes. Irish schemes are more influenced by use of grassland for beef production. In France production is more limited to veal and beef from corn silage and pelleted diets. The beef breeding interests of both countries are in the same direction.

Report on Study Tour of the New Zealand Dairy Industry

by

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Background information on the New Zealand farming scene

New Zealand has 43 million acres of land of which 22 million are in sown pasture, 13 million in natural grass, 1 million acres planted, 2.7 million acres in native bush and 4.2 million acres unproductive. The New Zealand population is 2.7 million people. There are 65,000 holdings in New Zealand of which two-thirds are in the North Island and one-third in the South Island. An outline of the farm size is presented in Table 1 and includes holdings larger than 10 acres.

Table 1
Farm Size

Area of holdings (acres)	Percentage of holdings in each category
10–99 acres	24%
100–749 acres	61%
750–4,999 acres	14%
5,000 upwards	1%

Seventy-five percent of the productive land in New Zealand is devoted to sheep and beef and 10% to dairying. Thirty-six percent of the 65,000 holdings are involved in dairying, 44% in sheep, 6% in beef, 10% in cropping and mixed farming and 4% in others. The livestock industry is made up of 2.2 million cows, total cattle 8.9 million; breeding ewes 43 million, total sheep 59 million; total pigs 0.6 million. The gross farming income based at farm gate values for 1970/71 are presented in Table 2.

Table 2
Gross Farm Income 1970/71

Grain & field crops	Poultry & horticulture	Wool	Mutton & lamb	Beef	Dairy-ing	Pigs	Total
£33m	£47m	£67m	81m	£93 m	£114m	£13m	£448m

Eighty-six percent of all New Zealand exports are agriculturally based. Dairy production for 1970/71 amounted to: 229,000 tons of butter, 107,000 tons of cheese, 123,000 tons of skim milk powder and 55,000 tons of casein.

Milk processing in New Zealand

A number of dairy companies were visited on the tour but an outline of two of these will be given in the Report. One is the New Zealand Dairy Co. which is the largest processing company in New Zealand and the second company was about one-tenth the size of the New Zealand Dairy Company, known as the Rangitaiki Plains Co-Op. The New Zealand Dairy Company has approximately 5,900 suppliers and each supplier is a shareholder in his company and the amount of money invested as a shareholder is related to the amount of milk supplied. His voting rights are dependent on the number of shares he holds in the company. This means that the people who are supplying the most milk and who have the largest amount of money at stake in the dairy business have the most votes in the decisions at voting time in the Company. The Company had a milk intake of 358 million gallons of 4.76% fat in 1972. Ninety-five percent of this total milk intake was collected as whole milk by the company tankers and the remainder was collected as cream. The Company had a turnover of £78 million in 1972 and manufactured 225,000 tons of dairy produce in 38 factories. The company manufactures a large range of dairy products which include butter, whey butter, anhydrous milk fat, cheese, lactic acid casein, rennet casein, lactalbumin, sodium and calcium caseinates, skim milk powder (13 different types), whey powder, buttermilk powder. They also manufacture mainly for the South-East Asia and Carribean markets, whole milk powder, cocoa preparations, a range of baby foods, ice-cream mix powder, malted milk powder and condensed milk. The 5,900 suppliers have 590,000 cows giving a herd average of 100 cows. The peak intake was 1.7 million gallons per day. This Dairy Company has money invested in many facets of farming operations such as fertiliser works, computer bureaux and allied farm interests such as meat packing plants. It is also involved in coal-mining and some of this coal is supplied to the New Zealand Dairy Company for operating its own plants. This particular Dairy Company is very large by Irish standards with an intake of milk of 358 million gallons with 4.76% fat and certainly is the largest on the New Zealand scene. This would appear to be the maximum size for efficient control and management. Generally, a company has units with an intake of 50 million gallons.

The Rangitaiki Plains Dairy Company

This company has about 550 suppliers supplying about 42 million gallons of milk per annum with a fat content of 4.65%. This company produced over 26,000 tons of dairy produce in 1971/72, including butter, roller powder, sodium caseinates, acid casein, spray skim milk powder, cheese and some other milk products including a milk biscuit. The peak intake was 216,000 gallons and the milk was processed in 7 factories. The dairy company has 16 road tankers to collect the milk from their suppliers. These 16 tankers are capable of collecting over 200,000 gallons a day. The radius of collection is 35 miles and the cost of collection which is borne by the Dairy Company is 0.3p to collect the milk and to supply the bulk tank on a farm. Each trailer is capable of making five collections in one day. When the tanker arrives on the farm a milk sample is taken each day. This sample is analysed at the laboratory at the processing plant and the analysis is returned to the farmer at the next days collection. The farmer is paid according to pounds of fat produced and fat percentage on the day of delivery. One man tests and interprets the records for 450 suppliers.

The management and committee of this Dairy Company are very well aware of the importance of quality milk to enable New Zealand to compete in international markets in the future. Only by producing high quality milk can the industry compete and sell dairy products on the world market. At present 85% of the milk produced for the Dairy Company is at premier grade and 13% is at the finest grade, so less than 2% is of inferior grade. This high grading only came about by a well planned and thought out approach to obtaining quality milk from dairy farmers. First of all, a single skinned tank with a refrigerated base was made available to all farmers. This was paid for by the Co-Op. The attitude of most of the Dairy Companies in New Zealand is that once milk leaves the dairy cow it is the property of the Company and in general they supply the tanks and collect the milk from the farm. Refrigerating milk alone does not guarantee quality as was clearly demonstrated in this Dairy Company. They initially used the methylene blue reductase test as a standard method for screening milk but this had many limitations. Milk kept in refrigerated tanks at 7°C will restrict the growth of lactic acid bacteria but will not prevent other bacteria from growing. To overcome this problem the nitrate reductase test (N.R.T.) was introduced. Under the methylene blue test 97% of the samples graded finest grade. The N.R.T. showed that 86% of these were below the required standard. Both tests are now used in combination. Premium grade involves both a 5 hour methylene blue test and a 5 hour N.R.T. The main features of the milk quality programme involved an efficient simple farm refrigeration system for all milk suppliers, an effective test to identify milk quality and an incentive scheme to induce farmers to supply quality milk. The simple single skin refrigeration-based tanks supplied by the Company are the following sizes: 500 gallon using a 1 h.p. motor; 600 gallon using 1½ h.p. motor; 750 gallon using a 2 h.p. motor and 1,000 gallon tank using a 3 h.p. motor. As an example, the actual capital coast to the Company for a 750 gallon tank is approximately £650. Thus the cost works out at £1 per gallon.

The Dairy Company has a demonstration farm which is used to test out available knowledge for intensive dairy farming. The farm is run by a farm manager and a milker. The farm has 202 cows on 164 acres. The committee of management of the demonstration farm includes the farm manager, 5 prominent dairy farmers in the area, the Department of Agriculture adviser, the New Zealand Dairy Board adviser for the area and a private consultant in the area plus the Chairman of the Dairy Company and the general manager. Close co-operation with the Department of Agriculture adviser, the Dairy Board adviser and the private consultant was in evidence in many places throughout New Zealand and all of these advisers worked in close liason with each other in their respective areas.

An important feature of the various Dairy Companies was the high level of committment by the farmer members of the Board. The Chairman and other directors of these companies were very conversant with the running and management and finance of their own dairy companies. This was clearly shown by the Rangitaiki Plains Dairy Company where the Chairman and General Manager made a study tour of 14 countries in 1972 to study production techniques and marketing trends in dairying in the main production and marketing countries. The farm directors and Chairman of the Dairy Companies clearly indicated that it was their business, that managers were their employees and that farmers made most of the decisions in very close consultation with them.

Economic position of the farming industry

The information in this section is based mainly on a report by the Agricultural Production Council of New Zealand, May 1970.

Farm production has increased by 33% between 1960/61 and 1969/70, an annual compound rate of 3.2%. The rate of increase has been declining in recent years. Dairy cattle numbers rose by 26% between 1961 and 1970 and beef cattle have increased by 52%. Butter fat production was 557 million pounds in 1960/61 and 662 million pounds in 1969/70. The price paid to dairy farmers rose by 21% between 1960/61 to 1969/70 but purchasing power declined by 5%. The proportion of dairy farms in the low farm income group dropped between 1964/65 and 1969/70. An estimated 16% of dairy farms earned a net farm income of less than £1,000 in 1969/70. About 13% of dairy farmers are estimated to earn a net farm income of more than £3,000 in 1969/70.

There has been a deterioration in the economic position of farmers relative to other sectors. Because of cost increases and fall in the price of some export products, farmers have secured very small gains from increases in production. The scale of farming has tended to increase to maintain an adequate family income. There has been an increased tendency for the smaller units to amalgamate or be absorbed into larger units. Those small units remaining in the industry do not, as a rule, have a heavy debt load but their output is no longer capable of providing a reasonable level of net income.

Due to poor returns, many farmers have attempted to meet the situation by short-term borrowing. In some cases, this is because their position has precluded long-term borrowing, and in other cases there is a reluctance to borrow further. As a result maintenance and development expenditure have been restricted. The long term solution of these problems may require an extension of financial facilities.

Lending to farmers

A committee of enquiry was set up to examine lending to farmers and the main findings are outlined below.

In 1970, agricultural produce and processing agricultural goods provided 86% of the total value of New Zealand exports. Major source of finance for farm development and increased stock comes from farm profits. However, incomes have fallen and costs increased, and some export prices have not increased. Therefore capital expenditure by farmers has decreased. With low prices and uncertain markets, farmers are slow to increase indebtedness as high farming is no cure for low prices. The total farm debt in New Zealand increased on average by 107% between 1963 and 1970, from £6,000 per farm to £12,500 per farm. However, the increase in land value has broadly kept pace with this debt increase and the relative debt burden has not changed. In 1971 the following were the sources of money available for rural property purchases: Government services provided 31.4%; Insurance companies, 8.4%; private sources 35.5%; banks 3.8%; building societies, 3.6% and other sources, 17.3%. These figures show clearly that the Government lending sources known as the State Advances Corporation which is similar to our A.C.C. provide approximately one-third of the money for the purchase price of land. Lending from private sources, which may often be the father loaning money to his son, accounts for a further third, and the banking organisations loan less than 4% of the total money for land purchase which is quite a change from the Irish scene.

Loan availability

The money for land purchase was reasonably available in 1970/71 when peak transfer of rural freehold properties took place. However, difficulty was experienced in getting adequate finance for young farmers. The State Advances Corporation (S.A.C.) policy is aimed at the settlement of efficient, trustworthy young farmers on economic units.

Land reconstruction

With reduced profitability due to increased costs, some viable farms a few years ago are now marginal lands or uneconomic units. In 1970/71 60% of dairy farms had a net income of less than £2,000. In recent years the S.A.C. has increased lending for reconstruction purposes.

In the past, profits were re-invested in farms for development purposes in order to increase the productivity of the farm. Due to falling prices and smaller net incomes, farmers are investing less of this money in re-development of the farm at the present time.

Many farmers are borrowing short-term money at high interest rates when they need medium term credit. This, in some cases could mean the sale of the farm because the farmer may not be in a position to meet his committments. The Report suggests that greater advice on farm financing should be made available to the farming community. At present, there are adequate funds for stock purchase but frequently short term credit at high interest rates is used for plant purchase and this is not recommended.

The conclusions of the Report on lending to farmers suggest the following:

(1) There is no evidence that there is a shortage of loan finance for credit-worthy borrowers but difficulty exists in the area of medium term finance for plant and stock purchase.

(2) Lack of profitability in the farming industry is the major cause of farmers financial problems rather than availability of loan money.

ı3) Farm lending from the private sector is falling and additional investment from Government sources will be required to meet the needs of the industry.

SOME KEY FACTORS IN NEW ZEALAND DAIRY FARMING

(a) The farmer

The dairy farmer is technically competent in all aspects of his farm business. He has a positive approach to the solution of problems. He has shown clearly that he is capable of borrowing money for productive purposes and most important has met his repayment committments. He has one other vital asset in that he likes a challenge and is a good inovator.

(b) Farm layout

Most roadways range from 12 to 15 ft. wide and this is adequate for herds up to 200 cows. It is important when the road is being made that the crown of the road is high to allow run-off. For herds over 200 cows there is a suggestion that the roadway should go up to 18 ft. and this appeared adequate for herds up to 400 cows. A central roadway with well fenced paddocks was a common feature of all dairy herds. This allowed minimum time for stock control. There was no clearcut decision on the number of paddocks required for a dairy herd but in general for the smaller herds, that is herds up to 100–120 cows, somewhere between 16 and 20 paddocks were considered adequate. In some of the larger herds, that is 300–400 cows, farmers frequently went for up to 56 paddocks. This allowed a morning paddock after milking and also an evening paddock when cows after the evening milking spent 12 hours in the paddock. It was alleged that the 12-hour morning and evening paddocks resulted in the cows returning to the pastures more quickly and this was considered important in the large herds. Otherwise too much time would be taken up taking herds back to pasture. The stocking density on paddocks ranged from 70 to 100 cows per acre for a 24 hour period.

The general approach to grassland management was not to over-graze at any time and to allow sufficient stubble so that rapid recovery of re-growth could take place. The length of grazing interval varied and there was quite a controversy as to what this interval should be. At Ruakura Research Centre they were happy that a 12-day rotation gave high yields whereas at the Palmerstown North Grassland Centre they recommended intervals of up to 40 days between grazing. This is mainly during the summer periods. The production obtained under both systems was impressive and the general consensus would be that grazing interval is not that critical. New Zealand farmers must allow grass to grow into the summer season in advance so as to allow feed to build up for the drought period which usually occurs during the summer months. Furthermore, the long intervals are feasible because very little feed is taken out for conservation, particularly in the first couple of months of lactation. Also, the condition of the pastures remains in a vegetative state for a longer period than would occur under Irish conditions due to the high influence of clover in the pastures. Thus, less fibrous material occurs during the early part of the grazing season. The grassland in New Zealand can be affected by pests such as soldier fly which results in some of the grass species dying off. Sod-seeding is commonly practised to drill seeds into the damaged pasture.

The grass growth pattern in New Zealand differs from that found in Ireland. We can grow as much pasture by using nitrogen, and grass growth in early summer is higher here. New Zealand farms grow grass during the winter time when the minimum growth would amount to 10 lb dry matter per acre per day. This would be adequate to support one dry cow.

Water is supplied to all paddocks. An important feature of the tanks is that they have a fast flow ballcock, which ensures that the tanks are full at all times. Cows spend less time at the water trough and therefore allow easy access for a large number of cows to drink from one tank.

(c) Milking parlour layouts

The important feature in siting a parlour is that it is sited with good topography and if possible centrally located on the farm. There should be easy access from the main roadway to the milking shed so that the tanker can have access to the milking parlour. The tanker road if possible should be seperate from the stock road, and a turning circle of 70 ft. should be provided in front of the dairy so that the tanker can enter and leave the farm without any difficulty. Other features of a suitable site include the availability of electrical current and water supplies. An impressive feature of all the sheds visited in New Zealand was their standard of cleanliness.

This was achieved by having a good yard washing system. For this, a good water supply and pump are required.

Most dairy farmers used a power washer to wash the slurry into a tank at the side of the collecting yard. From this tank water was pumped onto the pasture, anything from 500 to 1,000 yards from the milking shed. At the end of the line was a simple jet which spread the slurry direct from the milking shed onto the pasture.

(d) Types of milking parlours

The herringbone parlour was the predominant type of shed seen in New Zealand. The sheds in general were similar to the open-sided sheds that are presently being installed in this country. The features of these sheds are: easy entry for cows, generally by a circular collecting yard with a backing gate and easy access from the parlour on the other side. These sheds were so designed that most of them had a motorised backing gate so that the man did not have to leave the pit to get cows into the shed. In addition the man could operate the exit gates from within the shed, including drafting arrangements. Thus, he spent maximum time in the shed and could milk 100–120 cows on his own. A two-man unit would have 14–16 units and this would milk up to 200 cows. A number of units seen were three man operations handling between 20–24 units. In general the three man unit would only handle 20 units because the time taken to get cows into and out of the shed was excessively long with more than 20. This type of shed would allow milking of 300–350 cows and the present trends for herds of this size would be towards rotary parlours.

The rotary turnstile milking shed is now being installed on a number of farms in New Zealand. They are a fairly recent development and more studies are required before a good throughput can be obtained from them. Their output per man is only equivalent to that obtaining in herringbone parlours. These new rotary turnstile sheds are being installed only on farms with 200 cows and over. At present a 17-unit turnstile would be suitable for herds up to 200 cows with a single entry and exit. For herds that may expand up to 250 and over, a 22-unit single entry, single exit would be installed. For cow herds over 300, a 28-unit double entry, double exit would be selected.

The advantages of the herringbone are its cost, ease of construction with farm labour, easier maintenance, adaptability for extension with an expanding herd. The disadvantages of the herringbone are: more labour stress on the operator and cows, and limitations for use on the very large herds, that is, herds of 300 cows and upwards. The advantages of the rotary shed are: ease of operation for labour and less stress on cows. The future developments such as automatic washing of the cows on entry and cluster removal from the cows at end of milking may be the possible developments of the future which may improve the performance of the rotary shed in terms of output of cows per man. The disadvantages of the rotary shed are in that they are difficult to expand if insufficient units are selected during the initial installation and also the high initial cost.

The present thinking on collection yards for dairy sheds is that the circular yards are operating well and would be installed for herds up to 150 cows. For larger herds, those from 150 cows upwards, many of the Dairy Board advisers are now recommending rectangular yards for these large herds as they reckon there is somewhat less stress and easier entry into the shed with the rectangular than with the circular collecting yard.

Milk tanks

The milk tanks on the New Zealand dairy farms are standardised for most dairy companies. This offers a big advantage in terms of available parts and in terms of cost of production. The standard tanks are single skin tanks. They are used on many farms without any refrigeration but milk is pre-cooled by a single or two stage cooler. Recently there has been a tendency to include refrigerated bases to these single skin tanks and milk is pre-cooled before entering the tank. This may bring the temperature down to 58 to 60°F and it is further cooled by the refrigerated base down to 45°F. These tanks are supplied, and in most cases owned by the dairy companies, with a capital cost to the dairy company of approximately £1 per gallon. Ownership of the tanks by the dairy company is important from the farmers viewpoint because as he increases his herd size the dairy company will replace his small tank with a large one.

The milk from these bulk tanks is collected by the dairy company and the driver takes a sample at the time the milk is collected. The cost of this milk collection scheme to the dairy company is about 0.3p per gallon. The New Zealand dairy companies have an advantage in that the average herd size is 100 cows so that large volumes of milk are collected from each farm and the radius for collection from the Co-op. is generally not more than 40–50 miles.

Why is New Zealand a country of large dairy herds?

The average dairy herd in New Zealand at present is 100 cows per herd. There are a number of reasons why herds have increased rapidly over the last 20 years. The milk price in 1971 was approximately 8.5p a gallon in our terms. The price of the calf was between £8 and £10 and the value of the culled cow was about a quarter of our value for culled cows. Loans, which I outlined previously, must be repaid and high output is essential in order to meet these financial committments. In addition, approximately 49% of the milk produced is produced by share milkers. These share milkers are people who are entering the dairy business and who ultimately aim to own their own farms. They borrow a lot of money and in order to pay this they must milk a large number of cows to meet their committments. Furthermore, the New Zealand farmer does not treat farming as a way of life, shown by the fact that one farm in eight changed hands in

1972. His ambition is to have a standard of living equivalent to that of industrial workers in New Zealand. Tough market situations face the New Zealand farmer at the present time and he expects to receive less for his milk over the next couple of years. Thus, he plans to overcome these difficulties by increasing present herd size. Labour on dairy farms is difficult to obtain and is costly. Farm workers are paid between £20 and £25 a week in addition to their keep on the farm.

Animal breeding in New Zealand

New Zealand milk production is based primarily on grass grazed in situ with some conservation of hay or silage and with practically no concentrate feeding. On this cheap production system the New Zealand dairy farmer has good yielding cows with high fat tests. The high milk production obtained is due to grassland management, good overall feeding of the dairy cow, cow management including efficient milking techniques and disease control. But the primary reason for high yields must be attributed to the animal breeding programme controlled by the New Zealand Dairy Board (N.Z.D.B.). This body administers the dairy industry for the New Zealand farmers. The sire proving scheme began in 1961.

The scheme is based on an annual intake of 170–180 young bulls which are carefully selected on the basis of the superior progeny test of their sires and grandsires and the outstanding production of their dams. The young bulls are bought by the Animal Breeding Centre when 7–9 months of age and cost approximately £160 each. At one year of age they are used to inseminate approximately 350 cows in order to obtain 50 daughters for a progeny test. The bulls are then set aside until the results of progeny tests are known. This takes four years. Based on the results, five or six bulls of the original 180 enter the breeding programme. These top bulls are selected primarily on the basis of their production rating but other considerations such as anatomical defects, temperament and ease of milking are considered. The remaining bulls of the original 180 not selected are slaughtered. The farmers participating in the sire proving programme get free A.I. and in addition are paid £7 for each heifer used in the testing programme.

The bulls are also performance tested for growth rate from 11 to 20 months of age. This performance test is carried out under commercial conditions. Generally the bulls are reared on pasture, growth rate is determined and bulls are ranked on the basis of their performance over a 9 month period. There are only two A.I. centres for the whole of New Zealand covering the North and South Islands and these centres provide up to 30,000 inseminations per day in the peak period. Only proven bulls are used except for those being progeny tested. The number of inseminations per bull is 50,000 for the season and means by which this figure may be increased are being explored. Fresh semen is used except during the peak demand period when 5 or 6% of frozen semen may be used.

The Animal Breeding Centre does not organise inseminations but sells the semen at 33p a straw to the herd improvement associations. The price of 33p a straw includes the cost of transport to the various association centres and the price charged is the same throughout the country irrespective of distance from the centre. The herd improvement associations employ their own technicians. These technicians are employed for 7–8 weeks in the year and are mainly share milkers who carry out inseminations after the morning milkings. They are trained by the associations and are licensed by the Ministry of Agriculture and their performance is checked annually. During their period of employment they are paid between £25 and £30 per week. The cost of getting a cow in calf in New Zealand is approximately £1 to £1.25.

The work of the two Animal Breeding Centres is guided by a policy committee. This committee consists of one member for each of the 6 herd improvement associations, one representative from the Department of Agriculture, one from the stud managers, two members from the New Zealand Dairy Board and two members from the pedigree breeders. This broad based committee ensures that all facets of animal breeding are represented. It plans and guides the animal breeding programme for New Zealand.

Share milking

It is very evident in New Zealand that dairy farming is a young man's job and very few farmers over 50 years of age milk cows. The system by which a farmer's son takes over the farm or the way in which people from outside dairying enter farming is of interest. The system is based on what is known as a share milking agreement. The share milking involves three categories:

(1) The 29% share milking agreement. The share milker feeds, milks and manages the cows but the owner manages and maintains the farm. For the milking and feeding of the cows the share milker gets 29% of the milk cheque. This is paid by the Co-op. and 71% of the milk cheque is sent to the owner. This system allows people outside farming to commence dairying or allows the farmer's son to obtain a wage which is agreed and is a legal binding agreement.

(2) The second share milking arrangement is on a 39% basis. The share milker milks the cows, maintains and manages the farm. The owner has the land and the dairy cows. The share milker gets 39% of the milk cheque and the owner gets 61%.

(3) This is known as the 50-50 share milking agreement. The share milker owns the herd but the farmer owns the land. The share milker manages the farm and receives 50% of the milk cheque, between 50 and 100% of the value of calves and the full value

of culled cows. The owner provides the land and the facilities on the farm and receives 50% of the cheque.

A farmer's son starting as a 29% share milker would accumulate sufficient savings to enable him to become a 50-50 share milker in about 5–6 years. At that stage he would either buy a herd from the father or buy a herd from outside sources. As a 50-50 share milker it would take him another 6–7 years to pay for the herd and to accumulate some capital by which time he would then consider buying the father's farm or buying another farm. Thus, in 12–14 years, somebody starting as a share milker on a 29% basis would own a herd of cows and the land. He would have paid for everything except the land. By this method the father does not hand over the land and the herd of cows directly to the son; the son buys them from the father over a period of years and the father can then use the capital to either set up another son in farming or to provide the father with an income for his remaining years. Once the son has bought out the farm from the father he may either work on the farm with his son for a weekly wage or he may have some land for rearing replacement stock, or take a job outside farming. This system of transfer of land from father to son overcomes a lot of death duty problems in that the father has handed over his assets to his son by the time he is 50–55 years of age. This share milking arrangement also allows people outside dairy farming and quite a number of people from the towns to start as share milkers and ultimately own their land. The actual percentage distribution between the share milker and the owner is satisfactory for New Zealand but the percentages may have to change in an Irish context. However, I think the principle is a good one and should be looked at closely in the Irish context.

Research

Agricultural research in New Zealand is carried out by three organisations:

(1) The Research Division of the Department of Agriculture;

(2) The Department of Scientific and Industrial Research which is responsible for the Grasslands Division and the Dairy Research Institute;

(3) The Universities.

The Research Division of the Department of Agriculture undertakes research into all aspects of animal production and diseases, plant production, soils research and horticultural research.

The importance of grassland in New Zealand has resulted in the setting up of a separate section in the D.S.I.R. of a grasslands division which employs approximately 50 research workers and has about 2,500 acres of land. Their specific function is to examine all aspects of grassland management and involves research on both lowland and hill land development. The Dairy Research Institute which obtains half its funds from the

D.S.I.R. and half from the New Zealand Dairy Board, which is the contribution from the producer, undertakes research into aspects dealing with product development. It is divided into three divisions.

(1) Fundamental research;
(2) Applied research;
(3) Servicing division.

The research workers in the D.R.I. are grouped together according to product rather than on a discipline basis. The D.R.I. has a graduate staff of 60 and a budget of £½ million. Fifty percent of the research work is undertaken at the request of the New Zealand Dairy Board or from individual dairy companies. If a dairy company requests a research project to be undertaken it pays on a consultancy basis for the work carried out, when the results of the research are for the specific use of that dairy company However, if the work is of general benefit to the industry then there is no charge to that dairy company. At the present time approximately 50% of the research work is on products other than butter and cheese. If a new product is developed the Dairy Board will fund resources for the cost of the plant and the test marketing of the product for the dairy company who undertake the manufacture of the new product. This is a very desirable feature since the dairy companies will then accept new products and manufacture them, because if the product is not a success they are not at a total loss since the Dairy Board will have funded much of the initial cost.

Conclusions

The New Zealand farmer is a first class citizen in the community. The unity of purpose of research personnel, food processing units, servicing industries and the farmer as a producer was impressive. At the present time the New Zealanders are facing a new challenge. Much of their traditional markets are being eroded with Britain's entry into the E.E.C. Farmers accept this as a challenge and must establish new outlets for their products. They expect they will have to accept lower prices in the future for some of their products. Their aim is to search for new markets and produce, process, transport and market more efficiently.

Farm lay out is excellent and standard features are: simple and efficient milking and milk storage facilities; adequate water supplies with good yard washing and effluent disposal; central roadways and water laid on to each paddock. The farmer has his milk collected by his Co-op. and is supplied with a bulk tank at the expense of the Co.op. The N.Z.D.B. operates a very efficient animal breeding service resulting in well bred cows for the national herd.

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Pre and Post Calving Feeding of Dairy Cattle

by

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Feeding the dairy cow involves a study of feed inputs and milk outputs and an economic evaluation of this relationship. From an economic point of view an optimal milk production is not always equal to maximum production, but will depend on the price relationship between different feeds and milk. The farmer must determine the optimum feed-to-milk relationship for his system of farming. In the Irish context this involves the maximum use of grass followed by feeding good quality roughage and judicious concentrate supplementation during the winter period. Concentrates are the expensive feed input and most attention must be paid to the level of this input. The intake of silage is low relative to the requirements of the lactating cow therefore some supplementary concentrate feeding is required. In this paper the pre and post calving feeding levels for spring calving cows will be discussed in addition to a comparison of spring and autumn milk production.

Food utilisation

It is important to understand how food given to the cow is used. Initially the cow uses food to maintain herself and additional feed is used for either body gain, milk production or growth of the foetus. This means that food eaten above maintenance is partitioned between milk and body gain. This partitioning of food is influenced by the level of feeding, the milk potential of the cow and the stage of lactation.

Pre-calving feeding

The cow of good dairy merit is unable to consume sufficient nutrients to meet her requirements in early lactation. The body condition of the cow before calving is important as body reserves built up during the dry period can be utilised to support milk production in early lactation. During the last 6 to 8 weeks before calving the foetus is gaining at a rate of approximately 0.8 lb per day; thus a cow would need to gain at best that rate of gain to maintain her body condition and would require additional gain if she is in poor condition at this period. An experiment was carried out at Moorepark in 1971 and 1972 to examine the effects of two levels of feeding before calving on liveweight gain and subsequent performance after calving. Group A was fed restricted silage in the last 8 weeks before parturition and group B was fed silage plus 8 lb of concentrates per day during the same period. The cows were fed similarly after calving for 8 weeks indoors and were run on pasture as one group for the remainder of the lactation. The silage dry matter intakes are presented in Table 1 and bodyweight changes in Table 2. Silage intakes were higher in 1972 than in 1971 and this resulted in slightly greater gains in bodyweight during that year.

Table 1
Precalving—Silage DM intakes

Year	Concentrates (lb/day)	Intakes (lb D.M.) Before Calving /head/day	/1000 lb B.W.*	After Calving /head/day	/1000 lb B.W.
1971	8	13.58	1.13	14.76	1.48
	0	13.95	1.22	13.74	1.44
1972	8	17.38	1.46	16.59	1.67
	0	16.71	1.47	14.44	1.58

*Bodyweight

Table 2
Pre-calving feeding—bodyweight changes

Year	Concentrates (lb/day)	Bodyweight changes (lb) 1–6 wk. before calving (/day)	Post calving (wk) 0–8	9–16	17–24
1971	8	1.44	−1.72	0.98	0.32
	0	0.04	−0.86	1.85	0.54
1972	8	1.58	−2.70	0.05	0.55
	0	0.31	−1.63	0.96	0.70

The results show that cows fed restricted silage, cut at the 7 week stage of growth, will only maintain their bodyweight in the pre-calving period. The cows fed concentrates lost more bodyweight after calving than the silage only group. On going to grass at 9 weeks post partum the cows fed silage alone before calving gained more weight than the better fed group. These results are similar to those found in many experiments reported by Broster (1) in his review of pre-calving feeding.

Weight changes at calving are shown in Table 3. Weight losses at calving were similar for the two feeding levels except for 1972 where the 8 lb group had less weight loss. It is not possible to explain the reason for this difference. The calf weights were somewhat higher for the higher fed pre-calving group.

Table 3
Weight changes at calving

£ Year	Concentrates (lb/day)	Wt. loss at calving (lb)	% wt. loss at calving	Calf wt. as % of dams wt.	Calf wt. (lb)
1971	8	−160	13.0	7.2	88
	0	−150	13.1	6.9	80
1972	8	−128	10.4	7.1	88
	0	−149	13.1	7.5	86

Milk yields are presented in Table 4. Pre-calving feeding influenced milk yield in the 1st eight weeks after calving and the pre-calving feeding effects were still in evidence during the first 8 weeks on pasture.

Table 4
Pre-calving feeding—milk yield

Year	Concentrates (lb/day)	Milk Yield (lb) 1–8 wk. (/day)	9–16 wk. (/day)	24th wk.	Lactation
1971	8	33.1	33.1	5122	6089
	0	29.7	32.2	4914	5889
1972	8	36.6	34.0	5611	6837
	0	31.3	31.2	4977	6151

The response to pre-calving was greater in 1972 than in 1971 because the cows were higher yielding and more uniform in 1972. Although the cows were fed the same after calving the extra bodyweight loss by the better fed group (Table 3), was used to support milk production in early lactation. When the cows went to grass the higher fed group did not gain as much weight as the lower fed group and were able to produce more milk during their first period on grass.

The higher pre-calving feeding increased milk fat percent during the first 8 weeks of lactation but there was no difference for the remainder of the lactation. Feeding level did not influence protein content of the milk.

The response to concentrate feeding in pre-calving period is outlined in Table 5. The concentrates are costed at £50 per ton.

Table 5
Pre-calving feeding—response to concentrate feeding

	1971		1972	
	0–8 wk.	Over lactation	0–8 wk.	Over lactation
Lb concentrates/extra gal	24	22	15	7
Cost of concentrates (p)	53.5	49.1	33.4	15.6

The higher feeding level was totally uneconomical in 1971 and also during the early part of the lactation in 1972 but the carry-over effect in 1972 made the higher pre-calving more economical when examined over the full lactation. In the experiment, silage was restricted and cows were getting little more than maintenance. If cows were fed silage *ad lib* then the response to concentrate feeding would be less attractive economically. For spring calving cows it would appear that concentrate feeding before calving should not be necessary provided the cows are in good body condition and being fed good silage *ad libitum*, Broster (1) summarises the literature by stating that a cow in poor condition in late pregnancy will respond in subsequent milk yield to additional feeding before calving; a cow in moderate condition before calving responds less well to additional feeding at this period; a cow in good condition before calving, already well fed, will not respond to additional feeding before calving.

Post-calving feeding

The cow after calving, apart from maintenance function, partitions feed between milk and body reserves. At low levels of intake body reserves are mobilized to support milk production. As plane of nutrition increases more of the feed requirements for milk are met from the feed offered and their is a gradual change from body depletion to body tissue accumulation. At very high feed intakes the response to extra feeding results mainly in an increase in body reserves. High yielding cows direct more feed to milk than low yielding animals. There is a need in most cases to have some body reserves at the time of parturition since feed intake is low after calving and increases during the lactation.

An experiment at Moorepark in 1971 and 1972 compared three feeding levels namely 4, 8 and 16 lb of concentrates with silage in the first 8 weeks after calving. The three groups were run as one herd on pasture for the remainder of the lactation. Feed intakes, milk yields and bodyweight changes are presented in Tables 6, 7 and 8 respectively.

Table 6
Post-calving feeding—silage D.M. intakes

Year	Concentrates lb/day	Silage (lb D.M.) /head/day	Silage (lb D.M.) /100 lb B.W.
1971	16	12.69	1.26
	8	14.99	1.52
	4	15.06	1.60
1972	16	13.73	1.41
	8	16.89	1.74
	4	15.92	1.72

Table 7
Post-calving feeding—milk yield

Year	Concentrates lb/day	Milk yield (lb) 1–8 wk. (/day)	9–16 wk. (/day)	Total to 24 wk.	Total lactation
1971	16	36.8	34.4	5387	6246
	8	31.0	32.8	4983	5970
	4	26.4	31.1	4684	5752
1972	16	39.6	34.4	5810	7076
	8	33.8	32.9	5263	6487
	4	28.4	30.6	4849	5920

Increasing concentrate feeding level from 8 to 16 lb depressed silage intake by about 18 percent but little effect was found between the 4 and 8 lb feeding level. This effect on silage depression would need to be considered when the response to extra concentrate feeding is being examined.

In both years of the experiment increasing concentrate feeding level resulted in higher milk yields during the 8 week feeding period and these differences were still maintained when the cows went to grass and concentrate feeding had ceased. The carry-over effects were more marked in 1972 than in 1971 and could be accounted for by better cows in 1972. All cows lost weight during the first 8 weeks after calving but weight losses were reduced as the level of concentrate feeding increased.

These results show that the cows were partitioning the extra concentrates between milk production and body reserves. The cow with the greatest bodyweight loss during the first 8 weeks of lactation gained more weight on grass than the better fed groups (Table 8), but this extra weight gain

Table 8
Post-calving feeding—bodyweight changes

Year	Concentrates lb/day	Bodyweight changes (lb/day) 0–8 wk.	9–16 wk.	17–24 wk.
	16	−0.80	0.74	0.45
1971	8	−1.25	1.66	0.14
	4	−1.77	1.84	0.69
	16	−1.43	0.10	0.78
1972	8	−2.02	0.32	0.56
	4	−3.03	1.08	0.52

was attained at the expense of milk production. Level of feeding had no definite effect on milk fat percent but milk protein was increased during the first 8 weeks of the experiment with increased feeding levels. Each additional lb of concentrate fed increased milk protein yield by approximately 0.03 lb. The response to extra concentrate feeding is outlined in Table 9 based on concentrates costing £50 per ton. The response between 4 and 8 lb of concentrates are generally satisfactory but in 1971 the carry-over effect of early lactation feeding is somewhat disappointing. The responses to concentrate feeding are similar to those mentioned in Broster's review on post-calving feeding (2). The responses obtained between 8 and 16 lb of concentrates are poorer than the lower feeding level and would not be recommended for creamery milk production. At present prices for milk, spring calving cows should be fed up to 8 to 10 lb of concentrates with fairly good silage after calving until they go to grass. It would be difficult to justify higher feeding levels in view of the rising prices of feedstuffs. With spring milk production the aim should be to maximise grass grazing *in situ,* conserve good quality silage and supplement silage with concentrates rather than substitute concentrates for silage.

Table 9
Response to concentrate feeding after calving

Year	Level of concentrates	lb concentrates/extra gal. 0–8 wk.	Cost (P)	Over lactation	Cost (P)
1971	4 lb vs 8 lb	8.9	19.8	10.3	23.0
	8 lb vs 16 lb	13.7	30.5	16.2	36.1
1972	4 lb vs 8 lb	7.5	16.7	3.95	8.8
	8 lb vs 16 lb	13.7	30.5	7.60	16.9

Autumn and spring milk production

Approximately 80 percent of cows in Ireland are spring calving and milk is used for processing. The remaining 20 percent are autumn or winter calvers and these supply milk for liquid consumption. There has been a dramatic increase in milk production for processing recently and this increase is likely to continue. This extra milk is putting a severe strain on the available processing facilities during the peak months of production. This has resulted in very heavy investment in new processing facilities in recent times. Peak milk intake in June is approximately 12 times greater than intakes during the months of December and January (3). It is important to determine if the pattern of production should be changed to even out the flow of milk during the year and this must be based on an evaluation of the costs of production at farm level and an examination of the savings that might result from better utilisation of the processing facilities. An experiment was undertaken at the Agricultural Institute field station at Ballyragget, Co. Kilkenny in 1970 to eompare the costs of production for autumn and spring calving herds and identify the management techniques required for both production systems. The experiment involves six autumn and two spring calving herds. Each herd is a self contained farmlet providing grazing and silage for winter feed. The experimental layout is described in Table 10. The autumn calving cows have a three month calving period, August, September and October with a mean calving date around September 15th. Concentrates are fed to all calved cows from October 1st until approximately March 20th on a group basis. The spring herds calve in February, March, April with a mean calving date around March 15th. Concentrates are fed to these cows after calving until approximately March 20th each year. Management practices are similar for all herds except that 20 percent more of the autumn farmlets are closed for silage to provide extra winter feed. The experiment is still in progress but the results to date will be presented. The results for the autumn herds are presented showing the effects of concentrate feeding and stocking rates separately for ease of presentation.

Table 10
Experimental layout

Time of calving	Concentrates (lb/day)	No. of cows/ group	No. of acres	Stocking rate acre/cow
Autumn	4	21	18.3	0.87
,,	4	21	14.7	0.70
,,	8	21	18.3	0.87
,,	8	21	14.7	0.70
,,	12	21	18.3	0.87
,,	12	21	14.7	0.70
Spring	8	21	18.3	0.87
,,	8	21	14.7	0.70

The effect of level of concentrate feeding and stocking rate for the autumn calving herds are presented in Tables 11 and 12, respectively. Milk production levels for the spring herds are shown in Table 13.

Table 11
Effect of level of concentrates on Autumn milk yields (gal/cow)

Concentrates (lb/day)	1970/71	1971/72	Average
4	719	701	710
8	786	750	768
12	761	780	770

Table 12
Effect of stocking rate on autumn yields

Year	Stocking Rate	Milk yields (gal.) /cow	Milk yields (gal.) /acre
1970/71	0.87	773	888
	0.70	737	1053
1971/72	0.87	791	909
	0.70	696	994
Av. both years	0.87	782	899
	0.70	717	1024

Table 13
Spring milk yields (gal./cow)

Stocking rate acre/cow	1970	1971	1972	Average
0.87	604	780	739	708
0.70	572	753	681	669

Increasing concentrate feeding level from 4 to 8 lb per day increased milk production in both years but the response to the 12 lb feeding level had little effect on increasing production when both years are considered. As stocking rate was increased the yield per cow was reduced but output per acre increased. Milk production was low for the 1970 spring calving cows as the herd was composed of mainly young cows and heifers. Milk yields for 1971 and 1972 were satisfactory and the difference in yield between autumn and spring calving cows was no more than 50 gallons per cow. The area of land required for spring and autumn calvers is similar but 20 percent more area must be closed for silage for the autumn calvers. The response to concentrate feeding at 12 lb per day was not reflected in increased milk production but in body condition at intervals during the year. However, the difference in body condition was non-existant at the start of each lactation. The concentrate intakes for the year were approximately 6, 12 and 18 cwt for the autumn groups fed 4, 8 and 12 lb of concentrates, respectively. The spring herds consumed about 1½ cwt of concentrates. Milk protein percent was increased by increasing the con-concentrate feeding for the autumn herds but was only apparent during the winter feeding period.

Based on the available information to date, a comparison of autumn and spring milk production based on the 8 lb of concentrate feeding level and a stocking rate of 1.0 cows per acre is outlined in Table 14.

Table 14
Costs—50 cows on 50 acres

Costs (£)	Autumn	Spring
A—Variable Costs		
Fertiliser	700	700
Concentrates	1,500	187
Vet., Med. & A.I.	150	150
Silage+additives	392	313
Slurry disposal	80	60
Miscellaneous	50	50
	2,872	1,460
B—Fixed		
Car, Elect., phone	300	300
Rent & Rates	160	160
Maintenance	125	125
Machinery deprec.	220	220
Labour	1,500	1,500
Deprec. on facilities	500	450
Total	2,805	2,755
Total (A+B)	5,677	4,215

Fertiliser application is similar for both autumn and spring calving herds, 4 cwt Superphosphate (8%), 2 cwt potash and 6 cwt nitrogen (26%). The autumn herd is fed 12 cwt of concentrate and 1½ cwt for the spring herd at £50 per ton. The silage costs are higher for the autumn herd as more silage is required for winter feed. The milk output is based on the autumn calvers yielding 50 gallon more per cow in the lactation. If the price obtained for spring milk is 20p per gallon then the price for autumn milk producing herds would need to be 23.1p on each gallon. for the lactation and this is the extra cost of production mainly due to extra concentrate feeding.

Table 15
Production coefficients

	Autumn	Spring
Milk yield (gal.)	750	700
Cost/gal. (P)	15.1	12.0
Price/gal. (P)	23.1	20
Calves (45) £	50	50
Replacements (10) £	250	250
Culls	140	140
Mortality		
Cows	1	1
Calves	5	5

To achieve similar income with 50 cows on 50 acres for both systems of production an outline of the net margins is shown in Table 16. The difference in production costs (3.1p/gallon) only covers the extra inputs to give a similar income as a spring calving herd.

Table 16
Income—50 cows on 50 acres

Output (£)	Autumn	Spring
Milk sales	8,662	7,000
Calf sales	2,250	2,250
Less depreciation on replacements	1,350	1,350
Total output	9,562	7,900
Costs	5,758	4,234
Net margin	3,704	3,666

No consideration has been given to the possible difficulties in organising autumn calving herds in terms of labour, or the management practices associated with the system. If autumn calving were to be adopted on some herds for manufacturing milk then thought should be given to organising a system whereby calving would be confined to 3 months of the year and that milking should cease for 4–6 weeks around July to give the milkers a break from the 365 routine presently used with winter milk production.

The major question remaining to be answered is to determine the increased processing efficiency, if any, resulting from more milk production during the winter period. Would the possible saving be sufficient to pay the difference in production costs at farm level? At the present time some processing units are encouraging earlier calving in spring time by paying higher prices for milk in early spring. This practice increases the intake of milk in early spring but reduces the quantity in late autumn without affecting the peak intake which occurs at the end of May or early June. Only a substantial change in calving numbers to the autumn months would affect peak intake but it is unlikely that the processing units would be prepared to pay the differential in production associated with autumn calving.

References

1. Broster, W. H., Dairy Sci. Abst. 33 (4) 253-270 (1971).
2. Broster, W. H., Dairy Sci. Abst. 34 (4) 265-288 (1972).
3. Dairy News, No. 20 December 8th 1972.

Milk Composition—Future Requirements

by

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In the past, trade and marketing policies have resulted in substantial imports of milk products into the United Kingdom, and milk production has been mainly for the liquid market. Moreover, the Sale of Milk Regulations, introduced initially to prevent adulteration, have restricted liquid sales to milk "as it appears from the cow". As a consequence, in the production of milk particular emphasis has been given to meeting the legal presumptive limits of 3.0 per cent fat and 8.5 per cent solids-not-fat and too little attention has been given to the milk content of individual constituents and to their relative importance.

Entry into the European Economic Community has provided the opportunity for the marketing of liquid milks of different, defined compositions and a greater use of milk for manufacturing purposes, and the market for milk could be further developed by exploiting fully its role as a raw material for the food and other industries. Within this context, much more importance may be attached to the detailed composition of milk. Changes in the basis of payment seem inevitable and eventually schemes may be introduced which take account, not of volume linked to composition but of yields of constituents.

Recent and probable future increases in cereal prices will make systems of milk production based on grass even more economically attractive than in the past and a more extensive use of grass and grass products must be envisaged. Grazing enforces relatively simple systems of feeding management and as long as grazing is important, the past emphasis in commercial practise on the avoidance of deficiencies in composition will continue. Current research into digestion in the rumen, however, offers the prospect of improving considerably the efficiency of feed utilization and of controlling the quality of animal products. There is increasing evidence that rumen fermentation may be manipulated through the careful control of the physical and chemical form of the diet and the standardisation of feeding conditions, to minimise wasteful aspects of fermentation and to give the optimum mixture of fermentation products for a particular productive process. If these possibilities are realized, it could prove economically advantageous to adopt highly mechanised systems for the preparation and provision of feed; intensively produced grass would no longer be grazed but used as a primary raw material. The potential would then exist for producing milks for specific markets and a careful definition of desirable characteristics and the means of achieving them would be required.

Milk and its constituents

The following is a brief account of the important features of milk as a food material and the present scope for controlling or modifying milk composition.

The importance of milk in the human diet is largely in the protein, calcium, riboflavin, vitamin A and thiamine that it contains. The relatively low levels of sulphur amino acids in casein are complemented by the higher levels in the whey proteins and the mixed proteins of milk have an essential amino acid composition that compares favourably with that of the F.A.O. standard (Table 1). Milk proteins are especially rich in lysine and are thus valuable as a supplement to cereal-based diets which tend to be low in lysine.

Table 1
Essential amino acid composition of milk proteins (N as a % of total N)

	Casein	α-lactalbumin	β-lactoglobulin	FAO standard[1]
Lysine	9.4	14.6	14.2	5.1
Histidine	5.8	5.5	2.8	—
Threonine	3.2	4.2	3.8	2.1
Valine	5.3	3.6	4.7	3.1
Methionine	1.9	0.6	1.9	1.3
Cystine	0.1	4.9	2.4	3.0
Isoleucine	4.1	4.9	4.7	2.8
Leucine	6.5	7.9	10.4	3.2
Phenylalanine	2.8	2.4	1.9	1.5
Tryptophan	1.2	4.9	1.9	1.2

[1] FAO (1957).

Milk fat is a rich source of energy but it is highly saturated with a comparatively high melting-point, which in some circumstances is held to be a marketing limitation. Also, milk fat is low in polyunsaturated fatty acids (more so than human milk fat—Table 2) and has been implicated in atherosclerosis although it is open to question whether the non-polyunsaturated fatty acids of milk fat themselves promote the disease.

Table 2
The fatty acid composition (molar percentage of the total fatty acids) of the triglyceride fraction of cows' (Smith & Lowry, 1962) and human (Breckenridge, Marai & Kuksis, 1969) milk fat

Fatty acid	Molar percentage	
	Cow	Human
butyric	12.1	—
caproic	3.9	—
caprylic	2.1	—
capric	3.4	0.5
lauric	4.2	3.0
myristic	10.4	5.8
myristoleic	2.6	0.7
palmitic	23.5	26.6
palmitoleic	3.9	5.3
stearic	7.1	6.7
oleic	17.6	36.4
linoleic	2.3	11.1
linolenic	1.5	0.9
arachidonic	0.2	0.5
heptadecanoic	—	0.8
eicosenoic	—	1.0

Milk sugar, lactose, also serves as a source of energy and, as a disaccharide, is unique in that it contains galactose, an essential constituent of nervous tissue. There is, however, no evidence that galactose is a dietary essential, even in the young animal. Moreover, intestinal lactase decreases after weaning and in some populations, more particularly non-western ones, a high proportion of adults lack the ability to digest lactose and the inclusion of milk products in the diet causes diarrhoea (Kretchmer, 1972). However, lactose may facilitate the absorption of dietary calcium.

Apart from the nutritional significance of the individual constituents, milk and milk products have a unique consumer appeal and this needs to be recognized and exploited fully for marketing purposes.

Factors affecting milk composition

Milk shows wide natural variations in composition, due to factors such as breed, individual physiological variability, age, nutrition, stage of lactation and udder disease.

Breeding

Breed differences in milk composition are widely recognised but there is not as full an appreciation of the differences that can exist between herds within a breed (Table 3) and between individual cows within a herd (Table 4). Improvement in milk quality through breeding is limited by the heritability of the various milk constituents, the genetic correlations

Table 3

Ranges within breeds for annual averages for individual herds (Rowland & Rook, 1949)

Constituent (%)	Ayrshire	Friesian	Guernsey
Fat	3.57-3.87	3.32–3.72	4.31–4.90
S.n.F.	8.64–8.94	8.40–8.75	8.82–9.30
Protein	3.30–3.47	3.20–3.44	3.39–3.73
Lactose	4.37–4.68	4.30–4.60	4.57–4.73

Table 4

Ranges within two Fresian herds for weighted lactation mean values in individual cows (Walsh, Rook & Dodd, 1968)

Constituent	Herd 1	Herd 2
Fat	3.29–4.48	2.68–3.90
S.n.F.	7.82–9.23	7.50–8.96
Lactose	4.11–4.99	3.96–4.76
Protein (estimated)	2.7–3.2	2.5–3.2

between them and the range of genetic variation. Estimates of heritability of fat, lactose, and protein range from 0.3 to 0.75, reflecting the importance of environmental factors and the influence of frequency of sampling on the assessment of lactational averages. Genetic improvement would be facilitated by the development of indices of genetic potential. The lactose to potassium ratio has been proposed as an index of lactose potential (Walsh & Rook, 1964) and there is some evidence (Spooner, Mazumder, Griffin, Kingwill, Wijeratne & Wilson, 1973) that high-yielding herds have an unusually high proportion of the heterozygous form of amylase I in blood serum (Mazumder & Spooner, 1970). Comparable studies for protein and fat have not been reported.

Feeding

The effect of feeding has been studied mainly in experiments of relatively short duration in the middle of lactation. The results give a clear indication of the nature and direction of changes but may underestimate their magnitude under commercial conditions.

Dietary energy

The energy intake of the cow, which is determined both by the energy concentration of the diet and the dry-matter consumption, has a major effect on milk composition. With an increase in the plane of energy nutrition, protein and solids-not-fat contents are increased and there is

Table 5
Effect of energy nutrition on milk protein content

Basal diet	Supplement	Over or under feeding*	Change in milk protein content	Reference
—	—	−1.0	−0.21	Rowland (1946)
Hay, dairy concentrates	Concentrate mixture**	+1.2	+0.50	Balch, et al. (1955)
Silage, dried grass, hay, dairy concentrates	Dairy concentrates	+0.3 +0.8 +1.4	+0.03 +0.14 +0.21	Holmes, et al. (1957)
Hay, brewer's grains, dairy concentrates	Flaked maize	−0.5 +1.1	−0.11 +0.11	Rook & Line (1961)
Poor quality hay, dairy concentrates	Dairy concentrates	−0.8	−0.08	Wright (1970)

* Expressed as lb SE/gal. milk above (+) or beneath (−) Woodman's standard.
** Containing 50% flaked maize and substituted for whole of concentrates of diet, coupled with increased plane of nutrition.

frequently an opposite change in fat content. In cows advanced in lactation, lactose content may also be affected. Responses to extra energy tend to be greater at low than at high levels of feeding. With an improvement in the level of feeding the rise in milk protein (and solids-not-fat) content and the fall in fat content are more pronounced when the ratio of concentrates to hay in the diet is also increased; the effect is even more marked if the nature of the concentrates is changed such that they are rich in soluble starch. Of the common farm foods, flaked maize has the highest content of readily-soluble starch. Fine-grinding of the forage in the diet has a similar effect to reducing its amount. Under the most favourable experimental circumstances, increases in protein content in response to an improvement in feeding have been as large as 0.5 percentage units, but increases of 0.1 to 0.2 percentage units are more common (Table 5).

The above changes in milk secretion associated with the amount and composition of dietary carbohydrates are known to be due to changes in the production of the short-chain fatty acids, acetic, propionic and butyric, during fermentation in the rumen. An increase in the level of feeding gives an overall increase in the production of the acids but their relative proportions vary with the composition of the diet. In general, the higher the proportion of concentrates the lower the proportion of acetic acid and the higher the proportions of propionic and butyric acids, but the composition of both the forage and concentrate parts of the diet are important. An increase in ruminal acetic acid production gives a small increase in milk fat content and butyric acid a larger increase, whereas with an increase in propionic acid production fat content is depressed and protein (and therefore solids-not-fat) content increased.

Seasonally, the lowest level of fat content occurs during the early grazing period, as young succulent grass, though of high energy content, lacks the physical quality of fibrousness. A similar problem is occasionally reported in the autumn, in cows receiving kale and supplementary concentrates only. These deficiencies may be remedied by offering a small amount of hay or other fibrous material.

Solids-not-fat content is at a minimum during the period from December to April, and exceptionally low values are recorded in certain herds. These low values are in some instances the result of a high incidence of mastitis which depresses milk lactose content (see later). They may also be attributable in part to underfeeding, due to a shortage in terms of either quality or amount in the bulky forage foods and a failure to provide the necessary supplementary concentrates. Since forages normally account for a large part of the diet at that time, substantial improvements in solids-not-fat and protein contents are not readily achieved simply by improving the level of concentrate feeding; improvements need to be made in the energy value of both the concentrates and roughages on offer. In practice this means the solution must be long-term, through the production of the required amounts of good-quality, conserved foods.

Dietary protein.

Increasing the protein content of the diet above normal standards (Bulletin of the Ministry of Agriculture, Fisheries and Food, No. 48) has no beneficial effect on milk yield or composition. Decreasing the protein content to 80% of normal may depress slightly milk yield but has no effect on composition, whereas a more severe reduction, to 60%, has been reported to decrease solids-not-fat content also (see Rook, 1971).

Dietary fat

A certain amount of fat, about 3 to 4 per cent of the concentrate part of the diet, is necessary for maximum milk and fat yields but the amount of fat in the diet has no consistent effect on milk fat content although the composition of dietary fat influences both milk fat content and composition. It is well known that dietary additions of cod liver oil and certain other highly unsaturated oils may cause a severe depression in fat content, and a slight depression in fat content has been reported with diets containing 6 to 10 per cent cottonseed oil in the concentrate mixture. An interesting example of the effect of dietary fat on milk fat composition is the comparative effects of giving fats rich in either palmitic or stearic acids. Both are long-chain, saturated acids but the former gives a milk fat of high melting point, the latter one of low melting point. This difference reflects the fact that stearic acid, but not palmitic acid, is extensively desaturated in the mammary gland, causing an increase in the corresponding mono-unsaturated acid in milk fat (Table 6). Dietary unsaturated fatty acids are hydrogenated in the rumen but the inclusion in the diet of protected fats rich in polyunsaturated fatty acids increases considerably the polyunsaturated fatty acid content of milk fat (Table 7).

Table 6

Mean weight percentages of the major fatty acids in the milk fat of cows receiving either dietary palmitic or stearic acids included as 10 per cent of the concentrate mixture (Noble, Steele & Moore, 1969)

Fatty acid	Palmitic acid	Stearic acid
butyric	2.9	3.2
caproic	1.3	1.5
caprylic	1.0	1.2
capric	1.4	1.8
lauric	1.6	2.1
myristic	8.1	9.6
myristoleic	1.5	1.2
palmitic	49.8	23.9
palmitoleic	5.2	2.1
stearic	3.3	12.5
oleic	14.9	28.7
linoleic	1.3	1.6

Table 7
Effect of feeding protected polyunsaturated fatty acids on C_{18} acids in milk fat (Plowman et al., 1972)

Fatty acid	Weight per cent	
	Unprotected	Protected
$C_{18:0}$	12	8
$C_{18:1}$	40	19
$C_{18:2}$	5	31

Udder disease (mastitis)

Mastitis can have a profound effect on milk composition, particularly lactose content, but there has been much uncertainty expressed as to its importance as a cause of compositional deficiencies in commercial herds. Dawson (1971) has recently completed an investigation of lactose deficiency in commercial milk supplies in the West Riding of Yorkshire and the extent of observed differences in cell count and milk composition between infected and uninfected quarters is shown in Table 8. The depressions in the milk lactose content of the bulk milks of six commercial herds attributable to interquarter differences ranged from 0.05 to 0.20 percentage units. In a later part of the same study, two herds were subjected to remedial treatment of an improved milking hygiene and rigorous antibiotic therapy in association with improved feeding. The calculated response in milk lactose content of the bulk milk was $+0.096 \pm 0.043$ percentage units ($P < 0.05$) in one herd and $+0.243 \pm 0.050$ percentage units ($P < 0.001$) in the other.

Table 8
Mean yield, composition and cell count of infected and uninfected quarters (Dawson, 1971)

Measurement	Quarter	
	Infected	Uninfected
Yield (kg/day)	6.38	7.48
Total solids (%)	11.93	12.51
Lactose (%)	4.10	4.44
Cell count ($x10^{-3}$)	471	40

Conclusions

The legal and marketing arrangements in the United Kingdom emphasize 3.0 per cent fat and 8.5 per cent solids-not-fat as compositional standards for milk production and this has stimulated considerable research into the occurrence of deficiencies in fat and solids-not-fat content of commercial milk supplies and possible remedial measures. Changing conditions following entry into the European Economic Community and future market pressures from other sectors of the food industry may focus attention on detailed composition and bring changes in the system of payment which emphasize the yields of individual constituents. Future research effort should anticipate such changes and increasingly be concerned with the efficient production of milk constituents important in nutritional or marketing terms.

References

Balch, C. C., Balch, D. A., Barlett, S., Bartrum, M. P., Johnson, V. W., Rowland, S. J. and Turner, J. 1955. *J. Dairy Res.*, **22,** 270.

Breckenridge, W. C., Marai, L. and Kuksis, A. 1969. Triglyceride structure of human milk fat. *Can. J. Biochem.*, **47,** 761-769.

Dawson, R. R. 1971. The causes of lactose deficiency in commercial milk supplies. Ph.D. Thesis, University of Leeds.

F.A.O. 1957. Food and Agriculture Organization Nutritional Study no. 16.

Holmes, W., Reid, D., MacLuskey, D. S., Waite, R. and Watson, J. N. 1957. Winter feeding of dairy cows. IV. The influence of four levels of concentrate feeding in addition to a basal ration of grass products on the production obtained from milking cows. *J. Dairy Res.*, **24,** 1-10.

Kretchmer, N. 1972. Lactose and lactase. *Sci. Amer.*, **227**, 70-78.

Noble, R. C., Steele, W. and Moore, J. H. 1969. The effects of dietary palmitic and stearic acids on milk fat composition in the cow. *J. Dairy.Res.*, **36,** 375-381.

Mazumder, N. K. and Spooner, R. L. 1970. Studies on bovine serum amylase: evidence for two loci. *Anim. Blood Grps biochem. Genet.*, **1,** 145-156.

Plowman, R. D., Bitman, J., Gordon, C. H., Dryden, L. P., Goering, H. K., Edmondson, L. F., Yoncoskie, R. A. and Douglas, F. W. 1972. Milk fat with increased polyunsaturated fatty acids *J. Dairy Sci.*, **55,** 204-207.

Rook, J. A. F. 1971. Factors affecting the protein content of milk. *J. Soc. Dairy Technol.*, **24,** 135-139.

Rook, J. A. F. and Line, C. 1961. The effect of the plane of energy nutrition of the cow on the secretion in milk of the constituents of the solids-not-fat fraction and on the concentrations of certain blood-plasma constituents. *Br. J. Nutr.*, **51,** 109-119.

Rowland, S. J. 1946. The problem of low solids-not-fat. *Dairy Ind.*, **11,** 656-662.

Rowland, S. J. and Rook, J. A. F. 1949. *Rep. nat. Inst. Res.Dairy., Reading*, p. 42.

Smith, L. M. and Lowry, R. R. 1962. Fatty acid composition of the phospholipids and other lipids in milk *J. Dairy Sci.*, **45,** 581-588.

Spooner, R. L., Mazumder, N. K., Griffin, T. K., Kingwell, R. G., Wijeratne, W. V. S. and Wilson, C. D. 1973 Apparent heterozygote excess at the amylase I locus in cattle. *Anim. Prod.*, **16**, 209-214.

Walsh, J. P. and Rook, J. A. F. 1964. Ratio of potassium to lactose in cows' milk and its genetic basis. *Nature, Lond.*, **204,** 353-355.

Walsh, J. P., Rook, J. A. F. and Dodd, F. H. 1968. A new approach to the measurement of the quantitative effects of inherent and environmental factors on the composition of the milk of individual cows and herds, with particular reference to lactose content. *J. Dairy Res.*, **35,** 91-105.

Wright, J. A. 1970. The effect of energy undernutrition in the cow on the solids-not-fat content of her milk. Ph.D. Thesis, University of Leeds.

ABSTRACTS OF THE TECHNICAL MEETINGS HELD BY THE IRISH GRASSLAND AND ANIMAL PRODUCTION ASSOCIATION

1st DECEMBER 1972 and 30th APRIL 1973

SOME IMPLICATIONS OF DIFFERENT SOIL TYPES IN THE NUTRITION OF GRASSES

by
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There are two important soil chemical factors affecting the use and efficiency of fertilizer phosphorus for grassland:

(1) the native soil phosphorus reserves;

(2) the residual or carry-over effects of previous dressings.

The National Soil Survey has, in recent years, catalogued Irish soils into 31 categories or soil associations. Analyses of 500 soil samples from these soil associations showed considerable variation in native soil phosphorus. Degraded Grey Brown Podzolics, especially in the Galway-Roscommon area, were lowest and the Elton-type soils of Co. Limerick were highest. The soil difference was at least two-fold. During cropping with ryegrass and clover an eight-fold difference in dry-matter output was noted between these soils, without fertilizer phosphorus.

Large differences were also noted in dry-matter output of grass when 24 of the major soils were treated with superphosphate. Fertilizer phosphorus was least efficient on the acid brown earths of Wexford and Louth (Clonroche-type), due to the large amounts of iron and aluminium in these soils. Fertilizer efficiency was highest on the more neutral grey-brown podzolic soils on gravelly glacial drift covering large areas of Offaly, Laois and Kildare.

THE MEASUREMENT OF NITROGEN FIXATION BY WHITE CLOVER UNDER FIELD CONDITIONS

by

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In recent years biochemical studies on nitrogenase, the nitrogen fixing enzyme in natural systems, revealed that this enzyme is a very versatile catalyst, reducing several triple bonded substrates other than nitrogen. One of these reactions, the reduction of acetylene to ethylene, has provided a particularly suitable method for measuring nitrogenase activity, which because of its speed, simplicity, cheapness and sensitivity, is now universally used to monitor nitrogen fixation in ecological studies. Using this technique the pattern and amount of nitrogen fixed by white clover in grazed swards, including the effects of various environmental and management factors, have been studied.

In 1971 fixation remained at a very low rate until late February when it commenced to rise. The increase continued until mid-summer when a sharp decrease coinciding with flowering was observed. A second peak was obtained after flowering after which activity decreased to the low winter level, about early November. In 1972, the pattern was similar until mid-April, but thereafter much lower rates were observed. This is attributed to lower temperatures.

The quantities of nitrogen fixed in four Wexford soils in 1972 were Johnstown Castle 140 lb (230 lb in 1971) Macamore 77 lb, Rathangan 98 lb, Clonroche 113 lb and Screen 58 lb.

Fixation increases linearly with temperature until 20° is reached. There is then a broad peak and activity declines over 27°. Activity is significantly correlated with soil and air temperatures, hours of sunshine, and appearance of new nodules. Fertiliser nitrogen in the spring decreases activity almost at once and the effect remains throughout the season. There is a diurnal effect due to temperature, but overnight darkness has no effect. Fixation is severely decreased by defoliation and the rapidity of recovery depends on the degree of defoliation.

SUPPLEMENTATION OF SILAGE FOR FATTENING STORE LAMBS

by
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The use of silage in the diet of growing fattening lambs was examined in two trials, a feeding trial on a production scale in Co. Wicklow and a metabolism trial at University College, Lyons.

270 Wicklow Cheviot lambs (6–7 months old) in moderate store condition and ranging in weight from 22 to 35 kg. were divided into three groups and allocated to the following treatments:

(a) Silage *ad lib.* + 300 g concentrate per head per day;
(b) Silage *ad lib.* + 150 g concentrate per head per day;
(c) Silage *ad lib.* only.

Within each treatment the lambs were divided into blocks according to weight. The meal fed consisted of barley 50%, beet pulp 40% and soya beans 10%.

The above treatments were applied for 10 weeks after which all lambs received a similar diet—silage *ad lib.* and 600 g. meal per head per day. During the initial 10-week period the lambs on Treatment A increased weight slightly, those on Treatment B maintained weight and those on Treatment C lost slightly. Concentrate feeding had no effect on silage intake. Silage intake per unit of metabolic weight was generally higher for the lighter animals and corresponding rate of liveweight increase was also higher. During the subsequent seven-week period when feeding was increased all lambs gained weight, those which had been on Treatment B reached the same liveweight as those which had been on Treatment A and those which had been on Treatment C being slightly less. Final liveweights were (a) 36.8 kg., (b) 36.6 kg., (c) 35.1 kg. Silage intake was reduced when the extra 300 g. meal was fed.

In the metabolism trial silage was fed (a) alone, (b) with 60 g. Sodium bicarbonate and (c) with both 60 g. Sodium bicarbonate and 300 g. starch to eight 40 kg. Suffolk cross wether lambs (10–12 months old' on a blanced latin square design on (1) an *ad lib.* basis and (2) to eight similar lambs on a restricted basis.

Measurements were taken for silage intake, silage digestibility and nitrogen retention. Sodium bicarbonate did not affect significantly any parameter on the *ad lib.* diet but increased nitrogen retention on the restricted diet.

Starch reduced silage dry matter intake and digestibility but increased nitrogen retention on both *ad lib.* and restricted feeding. The combination of sodium bicarbonate and starch had an associative effect in increasing nitrogen retention on the restricted diet.

A COMPARISON OF THE EFFECTS OF DIETARY ACIDS ON CATTLE AND SHEEP

by

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The effects of hydrochloric acid (HCl) and lactic acid upon food intake and metabolism of sheep and cattle were compared in a double 5×5 Latin square design experiment. The acids were given by addition to a basal diet of pelleted grassmeal fed to five Jersey cross steers and five Wicklow wethers. Each acid was included at two levels: lactic acid at 500 and 700 mEq/kg dry matter and HCl at 300 and 500 mEq/kg dry matter, giving dietary pH's of 4.2, 4.0, 4.4 and 3.8 respectively.

Cattle feed intakes were 96.6 and 93.4 per cent of control for the low and high levels of lactic acid addition and 78.6 and 66.2 per cent of control for the low and high levels of HCl. For sheep the corresponding intakes were 94.2, 86.7, 87.0 and 71.4 percent of control. There was no significant interaction between species and diet.

Treatments did not affect rumen pH. However there were significant effects upon total concentrations and molar percentages of rumen volatile fatty acids. Blood pH and Plasma CO_2 were significantly depressed in both species by the HCl treatments. Lactic acid caused no significant depression of blood pH but plasma CO_2 in sheep was significantly depressed at the high level of lactic acid addition. These effects were discussed in relation to the values for food intake.

EFFECTS OF PERIODS OF RESTRICTED GROWTH ON SUBSEQUENT PERFORMANCE OF CATTLE FOR BEEF

by
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Numerous studies have shown that animals exhibit a remarkable capacity for growth following periods of underfeeding. This event was termed "compensatory growth" by Bohman (1955). Wilson & Osbourne (1960) pointed out that the ability of an animal to recover from undernutrition can vary considerably. The present investigation was carried out with spring born calves to determine the effects of plane of nutrition during the calf stage (first 8 months of life) and during their first winter (8 to 13 months of age) on subsequent performance.

During the calf stage, moderate and low planes of nutrition were provided which resulted in daily liveweight gains of 1.45 and 1.10 lb, respectively. In their first winter groups of moderate and low plane calves were fed either silage alone or silage plus 5.0 lb of rolled barley per head daily. All animals were subsequently treated alike until slaughtered at approximately two years old.

Both groups of animals fed silage only in winter gained 0.55 lb daily. Consequently, the moderate plane calves retained their weight advantage during their first winter and, in fact, did so right through to slaughter.

Moderate and low plane calves gave similar responses to supplementation (1 lb liveweight: 4.3 lb barley). However, only one-third of the liveweight advantage obtained from feeding barley to moderate plane calves was present at slaughter compared with two-thirds for the low plane calves. Feeding 745 lb of barley during the first winter resulted in the production of 35 and 66 lb of extra carcass with animals reared on moderate and low planes, respectively.

References

Bohman, V. R. (1955). J. Anim. Sci. **14**, 249-255.
Wilson, P. N. and Osbourne, D. F. (1960). Biol. Rev., **35**, 324-363.

A COMPARISON OF BREEDS FOR THE PRODUCTION OF STORES AND CARCASS BEEF

by

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Friesian, Hereford × Friesian and Hereford × Shorthorn calves purchased at livestock marts in Munster in spring 1969 and 1970 were used in an experiment to compare their growth rate, carcass weight, carcass composition and store suitability.

All animals were early weaned and run together on pasture getting a barley meal supplement of 2.5 lb per head per day for the first grazing season. Animals intended for the forward store trade were given 3 lb concentrates plus self-fed silage over the winter and were sold off grass in July at 16–17 months of age.

Animals intended to go for slaughter were given self-fed silage in the first winter and in their second winter were given silage plus 6 lb concentrates. These animals were sold off grass in May 1971 at 26½ months and from the yards in April 1972 at 25½ months. All carcasses were weighed and analysed.

At 17 months the Friesians were 8% heavier than the Hereford × Friesian and 9% heavier than the Hereford × Shorthorn. At 26 months the Friesians were 11% heavier than both crosses for the 1969 calf lot and 4.5% and 6% heavier respectively than the Hereford × Friesian and the Hereford × Shorthorn for the 1970 lot.

The Hereford cross animals killed out significantly better ($P < 0.05$) than the Friesians with the consequence that the Friesian carcasses though heavier (on average) than the cross bred carcasses were not significantly so.

For yield and percentage lean meat the differences were not significant. For yield and percentage of fat, the Friesian was significantly lower than the Hereford × Friesian, which in turn was significantly lower than the Hereford × Shorthorn. Bone yield was significantly higher ($P < 0.01$) in the Friesian than the crosses, among which there were no significant differences.

PERFORMANCE AND CARCASS COMPARISONS OF CHAROLAIS × KERRY, SHORTHORN × KERRY, PEDIGREE KERRY AND FRIESIAN STEERS AND CHAROLAIS × KERRY HEIFERS RAISED INTENSIVELY FROM BIRTH TO SLAUGHTER

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Six Friesian, six Shorthorn × Kerry, seven Kerry and seven Charolais × Kerry steers and heifers were used in a comparative study of the beef potential of crossbred Kerry cattle. The animals were given *ad libitum* a diet of rolled barley, soyabean meal, minerals and vitamins, and were weaned at 5 weeks of age. From approximately 13 weeks of age to slaughter 0.5 kg. hay was offered daily. The animals were slaughtered one week after reaching 400 kg. liveweight.

The Charolais × Kerrys and Friesians were significantly heavier at weaning than the other two groups; the Friesians reached slaughter weight 90, 97 and 221 days earlier than the Charolais × Kerrys, Shorthorn × Kerrys and Kerrys respectively ($P < 0.01$). Between weaning and slaughter the mean growth rates for the Fresians, Charolais × Kerrys, Shorthorn × Kerrys and Kerrys were 1.24, 0.95, 0.94 and 0.77 kg./day, ($P < 0.01$) and the feed conversion efficiencies 5.24, 5.01, 5.76 and 6.74 respectively. The Charolais × Kerrys had the highest dressing-out percentage of all groups.

The right side of each carcass was divided into 12 commercial cuts which were dissected into bone, subcutaneous fatty tissue and "meat". The latter two fractions were chemically analysed to give total fat and "lean meat" in each cut. The Charolais × Kerrys had significantly more carcass "lean meat" ($P < 0.01$) and significantly less carcass fat ($P < 0.01$) than all other groups; the Shorthorn × Kerrys on the other hand having least "lean meat" and most fat. The Charolais × Kerrys had a significantly greater proportion of "lean meat" in the round ($P < 0.01$) compared to all other breeds. The yield of high-priced cuts was similar in all breeds. The Charolais × Kerrys and Friesians had significantly less total and subcutaneous fat in cuts than the other two groups ($P < 0.01$). The "lean meat": bone ratio was greater in the Charolais × Kerrys. The Charolais × Kerrys and Fresians had significantly less fat ($P < 0.01$) in the longissimus dorsi muscle.

BULL BEEF PRODUCTION

by
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Ten years research work at Grange has shown that bulls (1) grow faster, (2) are more efficient convertors of food into liveweight gain and into lean meat and (3) have more lean meat per unit carcass weight than steers. The difference in growth rate and feed efficiency in favour of bulls ranged from 8 to 15% depending primarily on the age at slaughter. Differences in yield of lean meat also depend on age, and weight at slaughter and ranged between 15 and 30% in favour of bulls. Management of bulls has not been a problem. It was found that mains electric fencing was a valuable aid to bull management at pasture.

METHODS OF PROGESTAGEN APPLICATION FOR THE CONTROL OF OESTRUS IN CYCLIC CATTLE

by
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Effectiveness of method of administration, oestrus response and synchronisation and subsequent fertility were studied in 88 cyclic heifers following the application of two Progestagens (Progesterone and SC 9880 [Cronolone]) by:

(a) intravaginal pessary;
(b) subcutaneous implant or,
(c) intra-muscular injection.

Subcutaneous implants were retained in 100% of cases while one type of pessary was retained in 95% of cases.

Oestrus response following treatment varied from 0% in the case of Cronolone subcutaneously to 93% in the case of Progesterone by intravaginal pessary.

Degree of oestrus synchronisation (spread in days on which oestrus occurred) varied from one to three days. Observations were made on time of oestrus occurrence relative to treatment withdrawal, duration of oestrus, etc. for each treatment.

Conception rates to the treatment oestrus (following natural mating) varied from 46.6% in the case of Progesterone subcutaneously to 75% in the case of Cronolone by intramuscular injection.

IMPROVING THE FERTILITY OF EWE LAMBS

by
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Early experiments at Grange showed that only 50% of ewe lambs conceived at any one heat period. During an eight week breeding season 96% of ewe lambs were mated, 65% conceived and 56% subsequently lambed. Those animals that lambed had lower bodyweight at tupping as hoggets and consequently litter size was lower as compared with their unbred comrades.

Improving the plane of nutrition resulted in a significantly greater proportion of ewe lambs reaching puberty and conception rates were also higher. Studies on mating behaviour showed that adult ewes were mated three times more frequently than ewe lambs during heat and 40% of oestrous ewe lambs were left unmated.

The fertilisation rate of ova was 88% following handmating as compared with 45% where ewe lambs had free access to rams. Increasing the ram:ewe ratio from 1:50 to 1:10 increased the lamb crop, as determined at slaughter 10 weeks post mating, from 79% to 96%.

The time of occurrence and extent of reproductive wastage were investigated and the results were as follows:

Day 0 (heat)	100 ewe lambs yielded 132 ova.
Day 3	85 ewe lambs yielded 104 fertilised ova.
Day 56	73 ewe lambs yielded 91 normal foetuses.
Day 147 (parturition)	64 ewe lambs yielded 70 normal lambs.

INDUCTION OF BREEDING ACTIVITY IN MAIDEN AND BARREN EWES IN SPRING

by
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The oestrus response and subsequent lambing performance of 365 sheep was studied after treatment with intravaginal sponges and P.M.S.G. during the months April/May (period of early anoestrus). Two progestagen treatments were employed, each in combination with one or other of two dose levels of P.M.S.G. (500 and 750 i.u.) given either 2 days prior to removal of the sponges or the time of pessary withdrawal. 180 sheep were also given one of two dose levels of P.M.S.G. (500 and 750 i.u.) on the 15th day following sponge removal.

The percentage of sheep mated was affected by Progestagen type, dose level of P.M.S.G., timing of P.M.S.G. administration and type of animal (i.e. maiden or barren ewe); one treatment, modified Cronolone pessaries (G. D. Searle) in conjunction with 750 i.u. P.M.S.G. at pessary removal, resulted in all sheep being mated.

The highest lambing outcome followed use of the "Veramix" sheep sponge (Upjohn Co.) with 750 i.u. P.M.S.G. administered at sponge withdrawal; this treatment resulted in 69% of the sheep treated producing lambs.

Administration of P.M.S.G. 2 days before Progestagen withdrawal reduced the interval from sponge removal to the onset of heat by almost 10 hours. The incidence of matings following a second dose of P.M.S.G. on the 15th day following sponge withdrawal was low at 21% regardless of the dose level employed.

IRISH MILLED POLLARD FOR BACON PIGS

by
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As a result of earlier work, in which replacement of 20 and 40 per cent of barley by pollard had little effect on the performance of bacon pigs, a study was undertaken to define more precisely the response to pollard inclusion.

Three growth trials (with supporting metabolism studies) were carried out in which pollard replaced barley at 5 per cent increments as follows:

(1) 0 to 25% pollard;
(2) 0 and from 25% to 45% pollard;
(3) 0 and from 40% to 60% pollard.

The "O" level (barley ration) was included as a control in each trial.

As in previous work at Lyons, little depression in performance occurred until pollard formed more than 25% of the diet. However, it was noted that pollards with the same extraction characteristics but differing in chemical composition had a significant effect on performance. In general, there was a close relationship between the digestible energy densities of the various diets, and the corresponding pig performance.

RESPONSE OF GROWING-FINISHING PIGS TO LEAST COST RATIONS

by
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Least cost feeding formulation involves selecting a combination of feed ingredients that will supply a specified set of nutrient requirements at minimum cost.

The information required consists of (a) the nutritional characteristics of each ingredient, (b) the nutrient requirements for the livestock in question, (c) the range and price of ingredients available.

Experiments comparing least cost rations formulated to meet accepted standards with nutritionally proven rations have given variable results. Bowland, comparing rations formulated to meet minimum requirements or with a 15% safety margin for certain nutrients obtained better performance where the safety margin was allowed. Lloyd working with pigs weaned at 3 weeks obtained consistently better feed intake from a nutritionally proven ration than from rations formulated to meet accepted standards. The same author concluded that in the case of growing-finishing pigs lysine, tryptophane and protein were limiting growth in these standards.

The experiment reported here is designed to evaluate a least cost ration formulated to supply 16% crude protein; 0.9% lysine; 0.55% methionine plus cystine; 1.5 to 4.5% fat; 2.5 to 6% crude fibre; 0.54 to 0.95% calcium and 0.51% phosphorus. This is being compared with a nutritionally proven ration supplying the same nutrient levels and consisting of 78% barley, 20% soyabean meal and 2% mineral/vitamin mix. Feed ingredients are costed and ration formula changed bimonthly. Upper limits are placed on the inclusion of certain ingredients as follows: maize and milo 40%; wheat 30%; oats and pollard 10%; molasses, grassmeal, beet pulp, cotton seed and ground nut 5%; fat 3%; fishmeal and meat and bone meal 7.5%.

To date pigs fed the least cost diet have had 4 formulae changes involving assorted variation in the ingredients used. Performance in terms of daily gain and feed conversion is slightly better than that supported by the nutritionally proven ration.

RESPONSE OF LACTATING SOWS TO DIETS SUPPLEMENTED WITH LYSINE AND METHIONINE

by
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Ninety-six gilts were allocated to treatment at first farrowing and during each of four successive lactation were given diets based on barley (9.3% crude protein) or barley supplemented with L-lysine HCl (0.2%), lysine+DL methionine (0.05%), soyabean meal (7.5%), soyabean meal (15%) or soyabean meal (7.5%)+lysine+methionine. During gestation and following weaning all sows were given 2.0 kg per day of a barley-fishmeal-soyabean meal diet having 14.2% crude protein.

Increasing protein level reduced sow weight loss in lactation but compensation during the next gestation tended to eliminate this effect. At the end of the experiment sow weights were not significantly different nor did carcass dissection reveal significant differences in composition in sows slaughtered after four lactations.

Litter performance was not affected by treatment. As sow milk composition was similar on all treatments it can be assumed that milk yields were not affected by treatment.

Sows given barley diets during lactation had increased weaning to mating intervals following the first and, to a lesser extent, the second lactation. This effect was not removed when lysine or lysine and methionine were added.

The experiment allowed the following conclusions:

(1) Lysine or methionine are not the limiting amino acids in barley based diets having as low as 9.3% crude protein.
(2) A level of 14.2% crude protein is superadequate for gestating sows.
(3) Where inadequate levels of protein are fed in lactation, regularity of breeding is likely to be affected before milk yield or composition.
(4) Protein requirements of sows are highest in gilts and tend to decrease with advancing parity.

GENETIC IMPROVEMENT IN ACCREDITED PIG HERDS

by
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The role played by selection on testing station results in the genetic improvement of Irish accredited pig herds between 1964 and 1971 was examined.

Intensity of selection on performance test results was measured by comparing the performance of boars entering accredited herds with the performance of contemporary boars at the testing station. The selection intensity averaged about 1.3 (standard deviations) for index score, 0.8 for growth performance traits and 0.2 for fat measurements. In calculating selection intensity on progeny test results, the deviation of each boar from the contemporary mean was weighted by the number of his progeny subsequently registered as breeding animals in the herdbooks. Selection intensity averaged about 0.5 for index score, 0.2 for growth performance and 0.3 for carcass traits.

Accuracy of selection was studied by computing heritability estimates based on a comparison between performance and progeny tests on the same boar. The estimates obtained were comparable to the normally accepted values for the heritability of each trait.

The sire-offspring generation interval was found to be 28.5 months on average.

Considerable improvement has occurred in the performance of pigs at Irish pig testing stations over the past ten years. Although this improvement cannot be related directly to the selection practised, the results of the present study and the general success of the Accredited Pig Herd Scheme would suggest that the improvement has been at least partly genetic in origin.

THE INHERITANCE OF MEAT QUALITY IN PIGS

by
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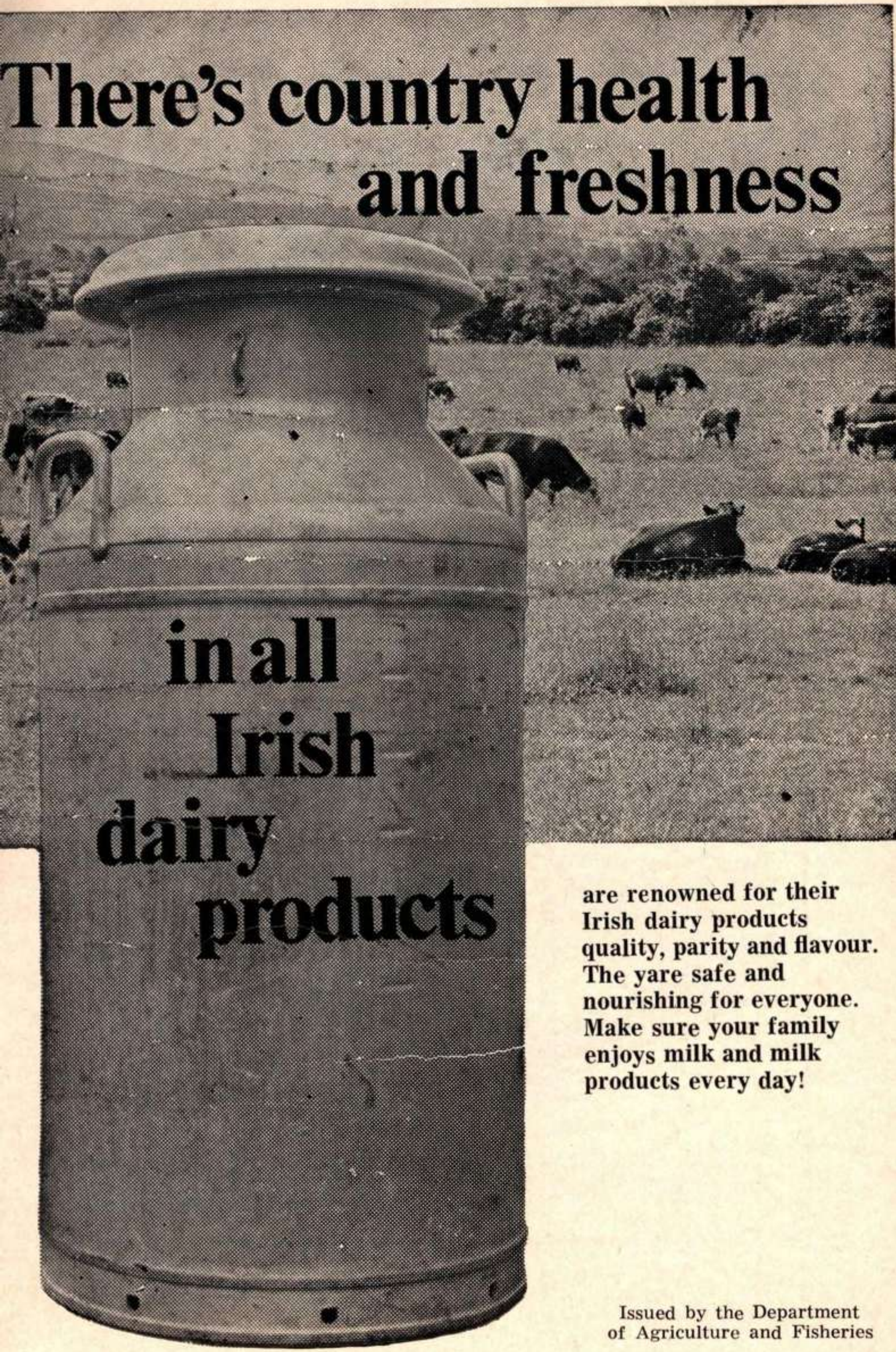
Pale, soft and exudative (P.S.E.) muscle is a serious quality defect in pig meat. The biochemistry of this condition has been investigated, and the susceptibility of a carcass to P.S.E. can be assessed by measuring the pH of the longissimus dorsi muscle 45 minutes after slaughter (pH_1). Low pH_1 is indicative of the quality defects associated with P.S.E. muscle. A study of pH_1 in Landrace and Large White was carried out using 1,154 records from the two National Pig Test Stations, where pH_1 has been recorded on all slaughter pigs since October 1970.

There was a significant difference between the mean of the two breeds; Landrace pigs had lower average pH_1 values, and a greater proportion of the values for this breed fell below 6.00, which is considered to be a critical level. The heritability of pH_1 was higher in the Landrace breed than in the Large White, and the values indicated that both breeds would respond to selection for this trait. Genetic correlations with growth rate, food conversion ratio and backfat indicated no definite relationships between pH_1 and any of these traits. There was no evidence to show that recent importations from Britain have had any affect on meat quality in Irish pigs. There was no significant difference between the pH_1 values of boars, castrates and females, nor was there any evidence of seasonal variation.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Grassland Fertilizers Ltd. Dublin/Cork/Limerick/Kilkenny/Slane.

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THE IRISH GRASSLAND ASSOCIATION was founded in 1947 with the aim of promoting the knowledge of grassland production.

In 1961, the name of the Association was modified, in recognition of the fact that good grassland husbandry is intimately associated with, and inseparable from, good livestock husbandry.

The Association provides an opportunity for those interested in modern grassland farming to gather and interchange views and ideas; it provides a platform for forward-looking farmers and scientists to expound their ideas; it fosters and encourages research into the production and utilisation of grassland, and it aims to cooperate with organisations which has in common the improvement of grassland farming.

If you or your organisation would like to join the Irish Grassland and Animal Production Association, the Secretary, 24 Earlsfort Terrace, Dublin 2, would be pleased to hear from you.