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WINTER FEEDING TRIALS WITH BEEF CATTLE

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SUMMARY

The response of growing steers to the winter feeding of various combinations of autumn-saved pasture and conserved fodder was recorded in two trials.

In the first, mixed-age Aberdeen Angus cattle were fed for 116 days on either maize silage, grass silage or hay *ad lib.* while stocked on autumn-saved pasture at either 2½ or 5 beasts per acre. Ten beasts were used in each treatment sub-group and the trial was replicated once. Stock fed maize silage grew more rapidly during the winter feeding period at the lower stocking rate. Hay-fed groups declined in growth rate during a post trial common grazing period and had 19 lb lower carcass weights at slaughter. The largest treatment differences (29 lb carcass weight) occurred between the two stocking rates on autumn-saved pasture.

The second trial compared maize silage and hay fed during winter in conjunction with either 1 kg or 3 kg dry matter of autumn-saved pasture. Forty-one yearling crossbred steers were stall fed for 114 days. No significant differences in growth rate were found between the fodders, but a highly-significant difference of 0.34 lb per day (39%) occurred between the two levels of pasture feeding.

A trial is also reported where three groups of 10 crossbred steers were differentially fed over a period of 88 days to induce liveweight differences of 175 lb and 180 lb, respectively, between two poorly-fed and one well-fed group. During a 168-day realimentation period, all beasts were stall fed on cut pasture. The previously high-level and one of the low-level groups were fed *ad lib.*, while the other low-level group was rationed to the dry matter intake of the previously high-level group. At the end of the realimentation period, the *ad lib.* group had compensated for 38%, and the rationed group for 21% of the induced liveweight differences.

The relevance of these findings to intensive beef production is discussed.

THE basic problem in devising systems for the efficient conversion of grass into beef is that of achieving an effective compromise between the conflicting requirements of the animal and the pasture. A great deal of emphasis has been given in recent years to the necessity for high stocking rates in order to achieve high outputs of animal produce per acre. This is principally a matter of having sufficient animals available to harvest efficiently the full potential of pasture for the production of di-

TABLE 1: EFFICIENCY OF LIVEWEIGHT GAINS
For Animal of 700 lb Liveweight

Liveweight Gain (*lb/day*)	*kcal/lb*
0.1	52,800
0.5	12,700
1.0	7,500
1.5	5,730
2.0	4,750

gestible material. The contrary principle is equally well known, but has been largely overshadowed by the drive for higher and higher stocking rates. This is that the intake of an animal needs to be sufficient for it to utilize effectively its potential for growth. If high stocking rates reduce per-animal intake too far, the overall efficiency of the farming system will decline very rapidly. This is demonstrated in Table 1 where data presented by Roy (1958) are extrapolated to illustrate the magnitude of the losses in efficiency of production associated with low growth rates, and the consequent channelling of a high proportion of the gross intake into maintenance requirements.

Thus, the beef producer's dilemma is to find a balance between the efficient utilization of his pasture and the efficient utilization of his stock.

There are many other factors that help to complicate this dilemma. Dominating these is the extreme seasonality of pasture growth within the year. This is illustrated in Fig. 1 where the availability of digestible dry matter (D.M.) from pasture (Joblin, 1966) is compared with the requirements of cattle growing at 1 lb per day throughout nine months of the year and increasing to 2 lb per day from September to December (Roy, 1958). The relative positions of these two lines will be a function of the stocking rate chosen, but the disparity in shape will remain. A low stocking rate will reduce the problems of autumn and winter deficits in feed availability, but will lead to very large surpluses of pasture in the spring and summer. Conversely, the higher the stocking rate the more serious the problem of seasonal shortages will become. Given that a reasonably high stocking rate is essential for the achievement of high outputs of beef per acre, the examination of the resultant periods of feed deficiency becomes an important research priority.

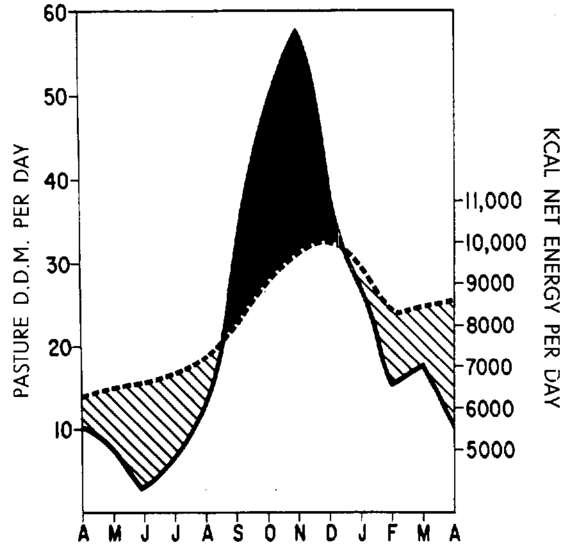

Fig. 1: Seasonal production of digestible D.M. from pasture and energy requirements of fattening cattle.

Attention has been focused on the winter deficiency period because the late summer and autumn shortage can be alleviated in good seasons by carrying forward pasture surpluses *in situ,* and by slaughtering stock at lighter weights in the poor years. This latter point further underlines the importance of wintering beef stock well, as this enables them to be sufficiently well grown in mid-summer to be salable, should a shortage of grass make this necessary. The carrying of stock through a second winter for sale as 2-year-olds is inefficient, as wintering will always be expensive, and the extra weight of the older animal results in extra feed being used for the non-productive function of maintenance.

COMPENSATORY GROWTH

One hopeful aspect of the winter management of beef stock is the capacity of cattle to follow periods of under-nutrition with periods of accelerated growth, when their nutritional status is subsequently raised. Thus, it could be more efficient to keep winter feeding down to cheap

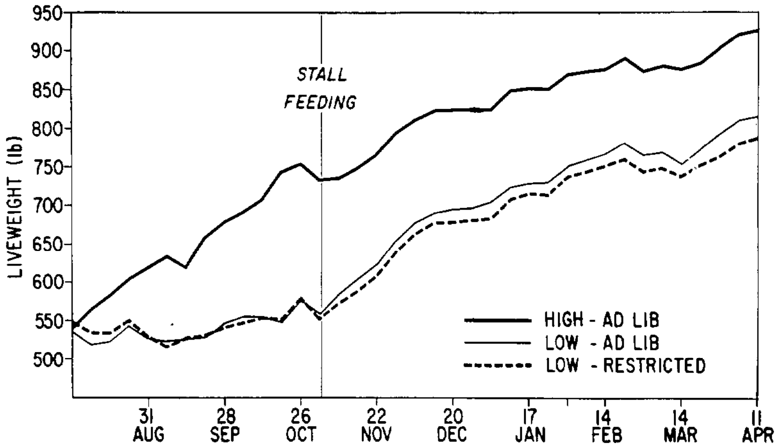

Fig. 2: Compensatory growth trial—changes in liveweight of cattle.

roughages offered at maintenance levels and to rely on compensatory growth in spring to make up the potential growth lost during the winter.

To investigate this possibility a trial was carried out where two groups of 10 crossbred yearlings were kept at or about maintenance for 88 days in late winter and early spring, while 10 others were grown rapidly on autumn-saved pasture and long spring regrowth. From November 1 to mid-April all three groups were individually fed in stalls on cut pasture. The previously well-fed group were fed *ad lib.* in the stalls as was one of the previously poorly-fed groups. The second low-level group was restricted to the intake of the high-level group. Thus, the trial provided a measure of the capacity of compensating cattle to grow faster through increased consumption of grass and through improved utilization of a restricted quantity of grass.

The growth rate pattern is illustrated in Fig. 2 where it can be seen that compensatory growth was most marked in the first 8 weeks of the trial, and, although it did continue at a lower level into the autumn, it never enabled the previously low-level beasts to make up the size deficit they incurred in the differential feeding period. The low-*ad lib.* group reduced an initial difference of 175 lb liveweight by 67 lb (38%) to 108 lb while the low-restricted group made up 37 lb (21%) of an initial difference of 180 lb.

TABLE 2: COMPENSATORY GROWTH TRIAL
Appetite and Production Data

Feeding Field Stalls	*D.M. kg/day*	*Intake g/day/kg L.W.$^{0.75}$*	*L.W. Gain lb/day*	*Feed Conversion Efficiency kg D.M./kg L.W. Gain*
High *Ad lib.*	7.34	84.8	1,22	13.4
Low *Ad lib.*	7.61	99.3	1.64	10.3
Low Restricted	7.09	94.2	1.44	10.9

The data in Table 2 show how the compensatory growth period was associated with a marked improvement in conversion efficiency, and in D.M. intake relative to liveweight. The absolute intakes of the low-*ad lib.* group were only slightly (0.27 kg per day or 3.7%) above those of the high-*ad lib.* group, but this appetite stimulation was both remarkably consistent and persistent (Fig. 3). It was apparent to varying degrees in each of the first 17 weeks of the trial, and must have represented a large increase in the relative degree of rumen fill in these smaller animals.

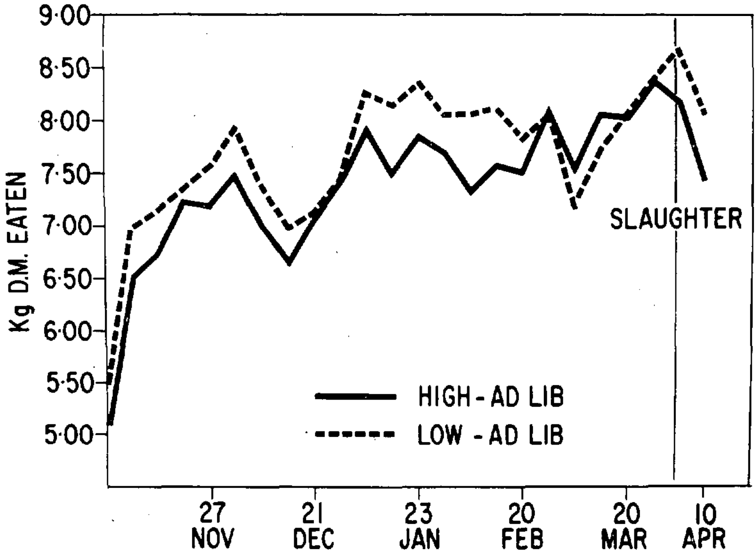

Fig. 3: Compensatory growth trial. Pasture D.M. consumption (kg/day) of cattle fed ad lib. *in stalls.*

TABLE 3: COMPENSATORY GROWTH TRIAL
Carcass Weights (lb)—Corrected for Initial Weight

Feeding *Field*	*Stalls*	*Carcass Wt.*	*S.E. of Difference*
High	*Ad lib.*	501.9	
Low	*Ad lib.*	409.3	± 8.1
Low	Restricted	392.3	

The overall loss in carcass weight resulting from 88 days of differential feeding (Table 3), indicated that the capacity of these animals to make up for a major check in growth (175 to 180 lb liveweight) was somewhat limited. Thus, these results would suggest that the problem of winter feeding of cattle cannot be conveniently ignored in high-producing farms, and economic and effective methods of maintaining growth during this period must be found.

FEEDING TRIAL—1 (1966)

This trial aimed at comparing maize silage, grass silage and hay when fed to cattle stocked on autumn-saved pasture at 2½ and 5 beasts per acre. Two replicates were used with 10 beasts (6 two-year-olds and 4 yearlings) per treatment sub-group on either 2 or 4 acre paddocks, making a total of 120 beasts on 36 acres. Fodders were fed in covered racks and the pasture was fed off in daily breaks. This phase of the trial lasted for 116 days from June 10 to October 3. The cattle were then grazed together in complete replicates until slaughter, which commenced on November 22 and was completed on March 3. At the beginning of the trial, animals were blocked into uniform groups of six and allocated at random to the six treatments; slaughter priority was decided on the total weight of these "animal blocks".

The grass silage and hay were very similar in digestible D.M. composition, but the maize silage was appreciably poorer in digestible crude protein (Table 4) and also somewhat inferior in digestibility of D.M. and percentage digestible organic matter. The intakes of grass silage were lower than those for the other forages, with the result that consumption of digestible organic matter was lower for grass silage than it was for maize silage, despite the higher percentage D.O.M. in the latter (Table 5). In the case of digestible crude protein the increase in intake of the maize silage was insufficient to compensate for the lower protein content of this product. Perhaps surprisingly the highest digestible protein intakes occurred with hay feeding (Table 6).

In contrast to the intake data, the liveweight gains of the cattle during the winter feeding period (Table 7) demonstrated a small but significant gain from feeding maize silage. The apparent superiority of maize silage arose entirely from the performance of the stock at the lower stocking rate on autumn-saved pasture. However, the dominating feature of the trial was the difference in growth rate between the two pasture stocking rates. The low stocking rate beasts outgrew those on the higher stocking rate by 0.34 lb per day or 40%. In the subsequent fat-

TABLE 4: WINTER FEEDING TRIAL—1
Composition of Fodders

		Dry Matter		
	% D.M.	*% Digestibility*	*% D.O.M.*	*% D.C.P.*
Maize silage	24.0	50.1	48.4	4.52
Grass silage	20.2	55.1	51.9	6.91
Hay	84.1	55.3	51.9	6.54

TABLE 5: WINTER FEEDING TRIAL—1
Intake of D.O.M. from Fodders (lb/day)

Stocking Rates on A.S.P.	*Maize Silage*	*Grass Silage*	*Hay*	*Average*
5 beasts/acre	4.93	4.46	5.19	4.86
2½ beasts/acre	4.44	4.06	4.50	4.33
Average	4.68	4.26	4.84	4.59

TABLE 6: WINTER FEEDING TRIAL—1
Intake of D.C.P. from Fodders (lb/day)

Stocking Rates on A.S.P.	*Maize Silage*	*Grass Silage*	*Hay*	*Average*
5 beasts/acre	0.46	0.59	0.65	0.57
2½ beasts/acre	0.41	0.54	0.57	0.51
Average	0.44	0.57	0.61	0.54

tening period on grass (Table 8) the hay-fed cattle did not perform as well as either of the silage-fed groups, and the high stocking rate beasts showed no evidence of any compensatory growth relative to the low stocking rate groups. The only groups where this compensatory growth response occurred were those fed on maize silage, whereas an opposite effect was recorded in the hay-fed cattle.

The effects of these treatments on carcass weights of the animals at slaughter are shown in Table 9. The animals fed on the two silages were significantly ($P<0.01$) heavier than those wintered on hay, but, as indicated from the growth data, the largest effect was the difference of 29 lb or 6.4% ($P<0.001$) in carcass weights between the beasts on the different stocking rates on autumn-saved pasture.

TABLE 7: WINTER FEEDING TRIAL—1
Liveweight Gains (lb/day) on Trial

Stocking Rates on A.S.P.	*Maize Silage*	*Grass Silage*	*Hay*	*Average*
5 beasts/acre	0.83	0.81	0.88	0.84
2½ beasts/acre	1.37	1.16	1.02	1.18
Average	1.10	0.98	0.95	1.01

TABLE 8: WINTER FEEDING TRIAL—1
Post Trial Liveweight Gains (lb/day)

Stocking Rates on A.S.P.	*Maize Silage*	*Grass Silage*	*Hay*	*Average*
5 beasts/acre	1.93	1.87	1.54	1.78
2½ beasts/acre	1.67	1.88	1.80	1.78
Average	1.80	1.88	1.67	1.78

TABLE 9: WINTER FEEDING TRIAL—1
Carcass Weights (lb) Corrected for Initial Weight

Stocking Rates on A.S.P.	*Maize Silage*	*Grass Silage*	*Hay*	*Average*
5 beasts/acre	468	461	444	458
2½ beasts/acre	494	492	475	487
Average	481	477	460	472

FEEDING TRIAL—2 (1967)

The previous trial highlighted the apparent superiority of autumn-saved pasture as a winter feedstuff for beef cattle, but provided little information on the intakes and quality of this material. An interesting feature of this trial was the highly significant ($P<0.001$) interaction between stocking rates on autumn-saved pasture and fodders. This came about principally as a result of maize-fed steers growing faster than the other groups at the lower, but not at the higher stocking rate.

The 1967 trial was designed to obtain further information on these points. A 2 × 2 factorial layout was used with autumn-saved pasture being offered at 1 and 3 kg D.M. per day, and hay and maize silage *ad lib.* Forty-one yearling crossbred cattle were stall fed for 114 days from June 6, and slaughtered at the end of the feeding period.

The growth rate data (Table 10) demonstrated the importance of level of pasture feeding. The cattle offered 3 kg of pasture grew 0.34 lb per day (39%) faster than those offered 1 kg of pasture. This difference was highly significant ($P<0.001$), but the small advantage of maize at the higher intake of pasture (0.07 lb per day or 6%) was not significant.

The D.M. intakes (Table 11) show that the stock failed to consume the 3 kg D.M. of pasture offered, but the hay-fed beasts ate 0.24 kg D.M. per day more grass than those offered maize silage. The intakes of maize silage were higher than those for hay, particularly at the lower level of pasture feeding. Once again, the largest effect was associated with the level of pasture feeding, with the cattle offered 3 kg D.M. of pasture consuming 0.51 kg D.M. per day (10.4%) more total D.M. than those offered 1 kg D.M. of pasture. These higher intakes were associated with more efficient conversion of dry matter into liveweight gain (Table 12). The difference of 2.7 kg D.M. consumed per kg liveweight gain (26.5%) between pasture levels was highly significant ($P<0.001$), whereas the differences

TABLE 10: WINTER FEEDING TRIAL—2
Growth Rates (lb/day)

Daily Quantity of A.S.P. Offered	*Maize*	*Hay*	*Average*
1 kg	0.87	0.88	0.87
3 kg	1.24	1.17	1.21
Average	1.06	1.02	1.04

TABLE 11: WINTER FEEDING TRIAL—2
Dry Matter Consumptions (kg/day

Feed				
A.S.P.	*Fodder*	*A.S.P.*	*Fodder*	*Total*
1 kg	Maize	0.95	4.15	5.10
	Hay	0.93	3.75	4.68
	Average	0.94	3.95	4.89
3 kg	Maize	2.19	3.24	5.43
	Hay	2.43	2.95	5.38
	Average	2.31	3.10	5.40
Overall	Maize	1.57	3.70	5.27
	Hay	1.68	3.35	5.03

TABLE 12: WINTER FEEDING TRIAL—2
Food Conversion Efficiencies

Daily Quantity of A.S.P. Offered	*Maize*	*Hay*	*Average*
1 kg	14.3	11.7	12.9
3 kg	10.0	10.3	10.2
Average	12.1	11.0	11.6

between fodders and the interactions between pasture levels and fodders were not significant at any level.

DISCUSSION

When considering the relevance of these results to farming practice in this country, it is important to remember that the experiments described can offer no more than rough estimates of what is likely to happen under field conditions. Apart from the normal limitations of attempting to generalize from experiments carried out at one site in one season, the parameters examined are themselves subject to wide variations. Compensatory growth responses are affected by a variety of factors, such as the age of the animal, the length of severity of the period of feed restriction and the quantity and quality of the feed offered during realimentation (Lawrence and Pearce, 1964; Meyer *et al.* 1965; Wilson and Osbourne, 1960). Thus, the fact that in the Ruakura trial cattle fed *ad lib.* were able to compensate for only 38% of an initial difference of 175 lb, when fed on pasture of an average D.M. digestibility of 61.5%, does not necessarily mean that smaller initial differences followed by more favourable grazing conditions could not be eliminated through compensatory growth. However, the results of this trial, coupled with other Ruakura data (MacDonald, 1957; Joblin, 1966) do indicate that compensatory growth cannot be relied on to make up for deficiencies in winter management of beef cattle, and close attention must be paid to this winter period in highly-productive beef units.

Similarly, the comparisons made in this paper between the feeding values of maize silage, grass silage, hay and autumn-saved pasture are valid only to the particular samples of these highly-variable products used in these trials. The term "autumn-saved pasture" is itself somewhat misleading in this context, as this truly described only the pasture fed in the earlier stages of the trials; in the later weeks, winter and early spring regrowth was being utilized. Nevertheless, the data presented do strongly suggest that the maximum possible use should be made of pasture in the wintering of beef cattle. This material has given a consistent and sizable growth-rate response, whereas the differences between fodders have been relatively minor, and are more likely to serve as a stimulus to scientific curiosity than to major changes in the pattern of feeding beef cattle. This is not to say that their role as primarily maintenance feeds, at a time when it would be extremely wasteful to use pasture for this purpose, is not an important one in the industry. It is also possible that yield data from these, or other crops of only moderate feeding value, will justify their use in farming systems designed to make the maximum possible use of climate, soil and farming initiative.

Finally, it is probably relevant to discuss the possible role of high-quality grain feedstuffs in the wintering of beef cattle in this country. There is ample evidence that, in periods of pasture shortage, stock will respond to grain feeding (Conway, 1965; Forbes *et al.*, 1966; McVey *et al.*, 1964; Musangi *et al.*, 1965) but there is no evidence that these gains would be economic under New Zealand conditions. With food conversion efficiencies of the order of 10 lb D.M. per pound liveweight gain (Table 12) the return per pound of carcass weight would need to be round 16 times the cost of the concentrate, to cover the feed costs. As such a price structure can be described, at best, as improbable, we must continue to look for cheap alternative feed-stuffs to meet the shortage of winter feed associated with adequately high stocking rates. The evidence of these trials is that pasture remains the most effective and economic feedstuff available.

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