FUTURE TECHNIQUES FOR EFFICIENT PASTURE UTILISATION

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Efficient pasture utilisation is all too frequently considered to be simply a matter of getting as high a proportion as possible of the pasture grown inside a grazing animal by fair means or foul. But this is only half the story; indeed it may be less than half the story. Animal husbandry techniques designed to ensure that the pasture consumed is converted to animal produce with the highest possible efficiency are no less important and are equally a part of the overall picture of efficient pasture utilisation.

By pinpointing weaknesses in both grazing management and in animal husbandry plans it should be possible to show how we must act if we wish to improve the efficiency of pasture utilisation.

GRAZING MANAGEMENT FACTORS

There is no doubt that we have reached a position of stalemate in grazing management as it affects pasture utilisation. The situation at which we have arrived after 30 or more years of scientific endeavour can fairly be assessed by looking at the contents page of a recent review article by Wheeler (1960). This review examines' the three main types of grazing management comparison which have been made:

(1) Continuous (A) versus rotational grazing (B).

(2) Continuous (A) versus strip grazing (B) .

(3) Strip (A) versus rotational grazing (B).

In comparisons of types (1) and (3) experiments are reviewed showing that (A) may be better, worse, or no different from (B) . In type 2 comparisons, of which there have been a much smaller number, the most common result has been that there is no appreciable difference between management systems in output of animal products per acre.

The main clear, classically simple, and very powerful technique to emerge from the great mass of research into grazing management in recent years is that, irrespective. of system of grazing, better utilisation of pasture and higher output of animal products per acre will be achieved by carrying more stock, even to the extent of accepting a slight depression in per-animal production.

Recently at Ruakura the writer has studied the utilisation of pasture directly, by measuring the pasture available to stock immediately before grazing and that left behind in the paddock immediately after grazing. The work was done with two herds of dairy cows each on a rotation around 15 paddocks. One herd was stocked at the rate of approximately 1 cow per acre; the other at 1.2 cows per acre. Pre- and post-grazing pasture samples were taken from four trial areas (at each stocking level) grazed in the normal course of each rotation around the farms. The data presented are average values over three years.

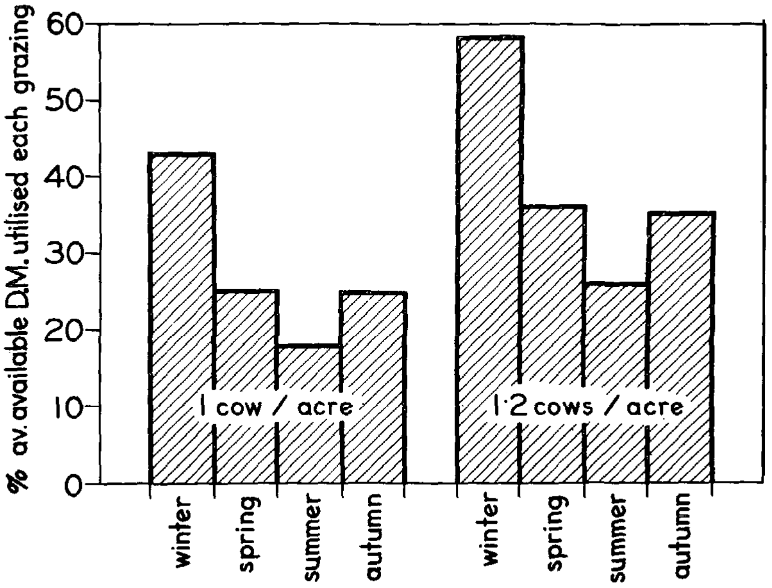

Fig. I-Percentage utilisation of available dry matter. Each seasonal column is the average of 6 or 7 grazings of 4 replicates over 3 years.

The pastures in question were producing about 11,000 lb of dry matter (D.M.) per acre per annum. Fig. 1 shows? for each of the four seasons (winter beginning on 1 June) the average percentage of the pasture D.M. available at each grazing which was actually utilised at each grazing. These percentages of utilisation were quite high in winter (43 - 59 per cent), but fell to surprisingly low levels in spring and summer, even though for some part of this period 35 to 40 per cent of the area of each farm was closed for silage and hay. The percentage utilisation considered here is that on the grazed portions of the farms only and, therefore, subject during the conservation period to grazing intensities considerably higher than the nominal 1 or 1.2 cows per acre.

The consequence of these low levels of periodic utilisation on the quality of the pasture in summer and autumn may be judged from Fig. 2, which shows the average percentage of dead material (as estimated by botanical analyses of cut samples) in these pastures before grazing each month. Even intensive grazing (1.2 cows/acre) coupled with conservation on a high proportion (35 - 40 per cent of the farm) allowed dead material to build up until it constituted 36 per cent of the total D.M. available to the grazing animal.

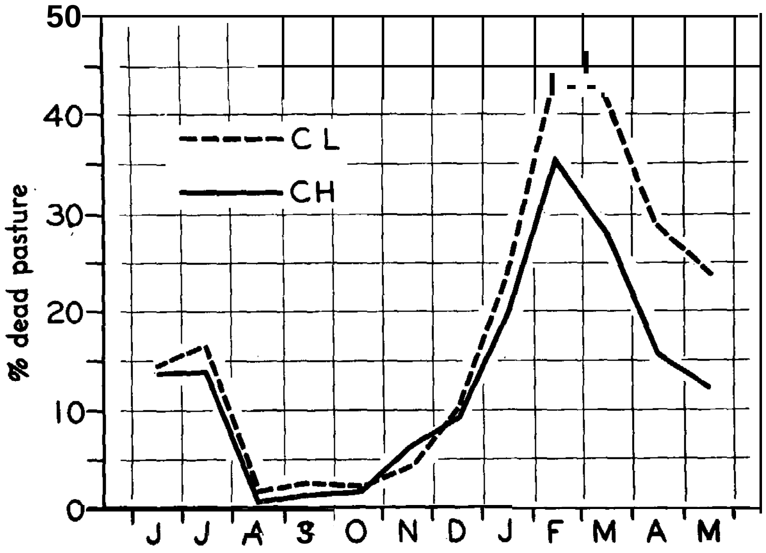

Fig. 2-Percentage of dead material in pregrazing pasture samples. Each monthly point is the average of approximately 2 samples per month from 4 replicates over 3 years. CL = controlled rotational grazing at 1 cow/ac. CH = controlled rotational grazing at 1.2 cows/ac.

There is much of interest in the study of this dead material, its build up, and decay. It is the home of ***Pithomyces chartarum,*** which causes facial eczema. Again, it must intercept a certain amount of incident light energy and 'lower the photosynthetic efficiency of the whole pasture by the extent to which it does so. It may consequently be one cause of the "summer slump" in pasture growth. But our interest here arises because it constitutes a considerable direct source of loss and shows how difficult it is going to be to eliminate all loss from this source merely by further increasing stocking rate. Some other manipulation is clearly necessary.

This manipulation might take the form of further increasing the proportion of the farm closed. for conservation, but losses associated with conservation are also high-12 per cent at a minimum (Dr D. J. Minson pers. comm.), but in practice probably considerably more-and for this reason alone it seems desirable to reduce conservation to the bare minimum.

Recently Dr J. B. Hutton (Hutton, 1963) of Ruakura has pointed out that cows produce milk with greatest efficiency (that is in terms of milk energy produced to feed energy consumed) early in lactation. Efficiency declines steadily from about 30 per cent in the first few weeks of lactation to about 15 per cent at the end of lactation 42 weeks later. He has further suggested that it would be preferable, in terms of pasture conversion efficiency, to utilise all the spring and summer growth directly through the animal by considerably increasing stocking rate, calving down in early September (when the spring flush is starting), grazing off the sping flush completely by cows at the peak of their efficiency, and restricting the length of the lactation to 6 months. Silage might then be saved from the autumn flush.

This might indeed be more efficient, but from our knowledge of the seasonal pattern of pasture production it would seem that the 20 to 25 per cent of annual pasture yield obtained in the six months from March to August would only allow for the maintenance of about 1 cow per acre through the winter. This, clearly, does not allow for a high enough stocking rate to graze off all of the 75 to 80 per cent of annual pasture yield produced between September and February.

Dr Hutton's suggestion, then, poses substantially the same problem as do the earlier utilisation and dead material data from the writer's own work, but in a more aggravated form.

The problem is, as it has been for a long time, how to carry through the winter sufficient stock to utilise most of the spring and summer pasture, when the stock are converting it at peak efficiency, and thus substantially avoid wastage through declining digestibility, death and decay of pasture, or through conservation losses.

The question may be put another way. How much longer will we allow our antipathy to cropping for winter feed to impair the utilisation of our pastures in spring and summer? And the answer, so far as the North Island is concerned, is probably just so long as cropping and regrassing are such hit or miss affairs. We must seek better answers than exist to the problem of cropping in the North Island. To be worth while such crops must produce at least 5 or 6 tons of D.M. per acre, and it must become possible to crop with reasonable assurance of success, and to reinstate a productive pasture within weeks of using the crop.

Since this is a speculative sort of paper it may be permissible to suggest that the answers to successful cropping in the North Island may lie in greatly improved cultivation, overcoming late spring nitrogen deficiency, and possibly also through recognising that we employ for our major root crops species which originated in higher latitudes in the Northern Hemisphere, chiefly in Europe, where summer day lengths are much greater than ours and average temperatures are lower. There may be crops better adapted to short summer day lengths and high temperatures; or breeding and selection of existing crop species in the North Island and not only at Lincoln may be necessary to produce varieties more suited to our lower latitudes.

ANIMAL HUSBANDRY FACTORS

The animal husbandry factors which contribute to the overall efficiency of pasture utilisation are today well understood; indeed, they were made clear and were succinctly discussed in relation to the pattern of New Zealand farming more than 10 years ago (Wallace, 1953). Even so, it seems they are not as widely acknowledged or put into practice as are those of grazing management. Practical action on many of the most important animal husbandry factors still seems to lie in the future. In a few cases, though principles are understood, their application to New Zealand farming practice still merits, and is receiving, further investigation by research workers. . .

The factors of importance here are, briefly, that animals of different species and breeds, different ages, and in different condition, vary widely in their efficiency as converters of pasture to human food. A certain irreducible minimum of feed is required to maintain an animal. This constitutes a fixed overhead charge which has to be met whether or not the animal produces nothing, or a small quantity, or a large quantity; one product or two. The more thinly this fixed overhead can be spread over the total output the greater will be the gross efficiency of the productive process. Again, there are differences in the efficiency with which animals convert. the pasture which they consume into the different human food products.

Let us consider the various types of stock in turn and examine their strengths and weaknesses.

Dairy Production

Once dairy cows come into milk they are the most efficient converters of pasture to human food. They convert between 20 and 30 per cent of the energy in pasture to human food energy.

However, early in their lives they are considerably less efficient. The double conversion of pasture to milk and milk to calf is particularly inefficient. Early weaning is not only a convenience to the harassed farmer, nor is it only a way of increasing salable milk fat; it is a pasture-sparing technique also. From weaning to first calving is also a relatively unproductive stage, and dairy heifers should not be allowed to compete with dairy cows for the use of our relatively limited areas of highly productive dairying land if we are aiming for maximum efficient use of our pastures. Because of this unproductive period in their lives their lifetime efficiency of pasture conversion increases with each lactation. Furthermore Dr Hutton at Ruakura has demonstrated that mature cows are more efficient converters of feed than 2- and 3-year-old cows within a milking season, Though Dr Hutton has also demonstrated that higher producers are more efficient converters of feed than lower producers, clearly the advantages of culling low producers and replacing with high producers must be weighed against the initially lower lifetime efficiency of the higher producers. Here, if any were needed, are additional reasons for culling only for productive traits, and making sure that the progenitors of the replacement stock are likely to produce offspring substantially better than those being culled.

Again the same worker has shown that placing a restriction on intake improves the pasture conversion efficiency of milking cows. Milking cows could suffer a $7\frac{1}{2}$ per cent reduction in intake compared with their identical twin mates on ad lib. feeding before their production was depressed. This, of course, is probably a part of the explanation of increased per-acre production from increased stocking rate.

Beef Production

As a converter of pasture to human food the beef animal is only about half as efficient as the dairy cow. Only 10 to 12 per cent of the food energy ingested is converted to edible human food energy. Now this in itself is bad enough; it is a biological fact we have to accept, but incomparably worse, and lowering the pasture-conversion efficiency of the industry practically to vanishing point, is the means of breeding the beef-type calves for fattening. If the cost of pasture fed to the cow during gestation is taken into account and added to the pasture cost of rearing and fattening the calf, the overall efficiency of beef production must be only 7 or 8 per cent.

In 1960, 1,140,000 breeding cows and heifers were run throughout New Zealand for the main purpose of providing one calf each subsequently to be fattened at the low efficiency of 10 to 12 per cent.'

In this same year 1,050,000 bobby calves from dairy farms were slaughtered and returned only 48s. 11d. each to the dairy farmer. The pasture overhead of producing these bobby calves is incidental to the annual production of milk. These calves will continue to be produced so long as there is a dairy industry. They are a by-product, but they should not be wastefully used for all that.

In terms of efficient pasture utilisation consider only this: At a conservative estimate it would take more than 500,000 acres of first-class dairying country to run beef breeding cows to produce the same number of calves which we now get free of debt from the dairy industry and wantonly slaughter.

Now, of course, the national beef breeding herd does not occupy first-class dairy land. The breeding cows are mainly used as animated scrub crushers on the hills and to control sheep pastures on steeper country, and in so doing they have a contribution to make which goes beyond the production of one calf per year.

Nevertheless, in South Auckland, for example, a significant number of breeding cows are still run on fat lamb farms. Mr C. P. Tebb of the Meat and Wool Board's Economic Service has kindly supplied the following data from his sample of fat lamb farms in the South Auckland District.

TABLE l-BREEDING COWS ON A SAMPLE OF FAT LAMB FARMS IN THE SOUTH AUCKLAND LAND DISTRICT

	Total Cattle on Sample Farms	% of Farms with Breeding cows	Ratio Cows : Total Cattle as a Percentage	No. of Breeding cows
Early 1950's	2,300	50	26	605
Early 1960's	3,500	30	16	551

In other words, although fewer fat lamb farmers are running cows and although the proportion of cows to total cattle in the district has declined quite rapidly in the past 10 years, there is still a considerable and fairly static number of breeding cows utilising inefficiently the highly productive fat lamb pastures.

But quite apart from these considerations there must be scope for increased beef production and increased national beef production efficiency through the use of surplus dairy calves of mixed parentage-either Jersey X Angus, Jersey X Hereford, or Jersey X Friesian.

Many dairy farmers who would like to increase their productivity and incomes via increased herd size but who cannot increase their milking herds sufficiently to justify an extra employee could, without much extra trouble, take up the slack by running cross-bred beef calves to sell as weaners to fattening farmers, or to carry to the vealer stage on skim milk, or to carry to the light-weight beef stage of about 800 lb live weight at 20 months of age.

Again, considering the efficiency of pasture utilisation by the beef animal it must constantly be remembered that to use grass to put on flesh in the second spring and summer of the animal's life and then to carry the animal through the second winter in falling condition as a store reduces still further the already low natural efficiency of the beef animal as a converter of pasture. Every hundredweight of live weight lost in this way is probably equivalent to a minimum loss of 1,400 lb of pasture D.M.-a minimum loss because the cost of regaining that lost hundredweight in the older animal in the following spring and summer will be greater (Hammond, 1935) than the cost of producing it in the younger animal.

The Sheep Industry

Some part of the annual maintenance cost of the breeding ewe may be offset against her annual wool clip, but a proportion of the pasture consumed by the ewe must be charged as an overhead to the pasture-conversion efficiency of the lamb. And the greater the number of lambs reared by a ewe the more thinly will this ewe-maintenance overhead be spread; the more efficient will be each lamb as a lifetime converter of pasture.

Greater fecundity in our ewes would not only reduce the ewe-maintenance overhead per lamb but would most probably improve pasture utilisation efficiency directly by synchronising better the animal-requirement curve and the pasture-production curve and ensuring that a larger proportion of the spring and summer pasture was eaten directly by the young, rapidly growing, more efficient animal.

Is it not then remarkable that, dependent as we are to such a large extent on efficient lamb production, we continue to employ as our major breed one which is so lacking in fecundity? While investigation and application of techniques to improve fertility and reduce lambing losses in Romneys are praisworthy, the speed and extent of improvement in lambing percentages by these means is likely to be limited, and one is forced to the conclusion that a more inherently fecund breed of sheep, or a more fecund strain within the Romney, still having desirable wool characteristics, would be of inestimable value not only in the expansion of meat production but in the improvement of pasture utilisation also.

Again, in the fat lamb industry the ewe-maintenance overhead and the cost of the inefficient double conversion of pasture, first to milk and then to lamb, could be spread over a much greater amount of meat if the lamb could be carried to a heavier weight without, of course, becoming over fat. This would involve the use of a breed other than the Southdown as the fat lamb sire. In our chief market our hands may be tied to a great extent; the demand in Britain may be for lightweight lambs, though the evidence for this is more dogmatic than scientific. But at least in new and developing markets where we are now attempting to encourage a taste for lamb we should be directing our efforts towards selling the relatively more efficient heavier lamb. The way in which we mould consumer preference in these markets by our lamb-promotion advertising will have a direct bearing on the future efficiency of conversion of our limited pasture resources.

NEW TECHNIQUES

Mechanical Extraction of Protein

Since we are looking to the future it will do no harm to allow our imagination to run a little ahead of our present knowledge.

In a world where malnutrition, particularly protein deficiency, is commonplace our domesticated ruminants are kings indeed. Each year our national dairy herd alone must, on quite conservative estimates, consume at least half a million tons of plant protein more than it requires for productive purposes. This is considerably more than our total meat exports.

Methods, such as the Chayen Impulse Renderer process (Chayen et al. 1961), exist for the cheap and rapid extraction of protein from green plant material. The nations of Africa and India, and some on the fringes of Europe (Turkey, Israel, and Greece) are investigating this and other processes as a means of providing protein for human consumption. Can we as one of the world's most abundant producers of cheap plant protein afford to lag behind?

Clearly, here is a technique we should now be investigating. Here is a method of pasture utilisation which in its own right might be economic, but which might be made doubly economic if it could be used to provide our grazing ruminants with a ration standardised to a moderate protein level and permit us to skim off the surplus protein for sale in some other form.

Whether we be actuated by commercial motives or concern at the world's hunger this is a technique we cannot continue to ignore.

CONCLUSIONS

The various factors involved in efficient pasture utilisation may best be summarised in tabular form (Table 2).

Animal husbandry is no less important than grazing management in ensuring full and efficient use of pasture. More speculative techniques should be investigated now so that we may take advantage of any benefits they offer for the future.

TABLE 2-EFFICIENT PASTURE UTILISATION

PASTURE MANAGEMENT	ANIMAL HUSBANDRY
(1) Stock heavily.	(1) Use dairy cross calves for beef.
(2) Equate supply with demand. Crop; A.S.P.; Conservation; New Species; Fertiliser.	(2) Increase fecundity and fertility.
(3) Subdivide for better control.	(3) Wean early.
(4) Feed high proportion of pasture: (a) To most efficient animals. (b) Direct to final producers.	(4) Fatten fast.
	(5) Finish at heavier weights.
	(6) "Store" on less productive land.
	(7) Equate demand with supply: Time of parturition; fecundity; fertility.
	(8) Cull cows sparingly, but
	(9) Cull for low production.
	(10) Restrict intake slightly.

SPECULATIVE TECHNIQUES

(1) Mechanical extraction of plant protein.

(2) Lower protein residues for ruminant feeding.

(3) Fibre for industrial use.

Acknowledgements

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DISCUSSION

Q. (D. B. Edmond): Would Mr Campbell nominate areas where he considers a winter crop necessary for successful dairying?

A. I don't think a winter crop is necessary anywhere, in the North Island at least, for successful dairying-success being judged by current social or economic standards. But if, as Dr Hutton has suggested (*loc.* cit.), 15,000lb D.M. wholly converted at 20 per cent efficiency should yield 713 lb butterfat (and 891 lb at 25 per cent efficiency), successful and highly efficient production are clearly not the same. (For simplicity I assume that maximum yield per acre and efficiency are the same, but you will realise that this is a limited definition). When a farmer is already highly successful by present standards but still wants to progress even further it may be necessary then to think along the lines of my speculative suggestions.

Q. (Dr Brougham): What species of pasture plants would Mr Campbell envisage in the system outlined for efficient utilisation of pasture, i.e., six months milking and six months dry period?

A. All species show the same sort of variability in production from one season to another. Much effort has been expended in attempts to breed new strains having more uniform seasonal production, but progress in this direction has not been spectacular. Until more progress is made towards bending pasture production patterns towards animal requirement patterns it seems worth while examining the alternative possibility of modifying animal requirements to meet the biological facts of seasonal variability in pasture growth. Differences between the better species and strains would only marginally affect the situation.

Q. Is there any evidence to suggest that use of crops in North Island would increase our production as compared with grassland dairying?

A. I do not know of any evidence, but this may be lacking only because we tend to grow rather poor crops.

Q. Has Mr Campbell taken into consideration the fact that crop area will be out of production for the cropping and cultivation period?

A. Yes.