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PRESIDENTIAL ADDRESS

The Basic Efficiency of Animal Production

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AT the present time, scarcely a day passes but that each of us in some way is touched by propaganda concerning the need for a vast expansion in world food production. Even those stating the position from the narrower viewpoint of the future economic outlook for New Zealand, emphasise this need as of pressing importance. Those taking the broader, international, and more humanitarian viewpoint look with horror at the unprecedented rate at which the world's population is at present increasing, and describe the need for increased food production as one of desperate urgency if catastrophe upon a scale never before experienced, is to be averted.

New Zealand's contribution to the world food pool consists almost entirely of the products of certain fairly well-defined systems of animal production. She specialises in the production of animal fats and proteins, mainly in the form of meat, butterfat, cheese and other processed milk products.

With a world food shortage threatening, it seems appropriate that we should enquire into the question of the efficiency with which we produce these materials. The problem is obviously one which may be approached from many angles. The farmer, like most other sections of the community, is largely engaged in earning a living, and he, naturally, is mainly concerned with the monetary efficiency of the process. But, as farmers know, many having learnt from personal bitter experience, there is nothing fixed or permanent about the economic efficiency, or profitability, of any particular system of animal production. Each of our major animal industries has seen its good years and its lean years: very violent fluctuations in monetary efficiency can occur over even short periods of time. The economic efficiency of animal production is a matter of the utmost importance to all of us, but it is not with this sensitively changing and ephemeral thing that I wish to deal. Rather I shall be concerned to take a close look at the material bases of our main animal production systems—our dairy, beef, sheep, and pig industries—and to examine and compare them from the viewpoint of the efficiency with which the energy contained in animal feeding stuffs is converted into food energy available to man.

But before proceeding to finer details such as these, it is perhaps instructive that we should briefly consider, in somewhat broader perspective, the overall efficiency with which mankind battles with his environment in order to obtain the food he needs. I should like to examine the extent to which he is successful each year in wresting from nature, as foodstuffs, a proportion of that abundance of radiant energy which is annually lavished upon each acre of our farm lands. And "lavished upon us" is surely no exaggeration, for the energy reaching us from the sun is indeed tremendous. It approximates, I believe, to an amount roughly equivalent to that liberated by burning 1,000 tons of coal over every acre of the earth's surface (1). While it is probably true that the whole basis of advance of civilisation has been a progressive increase in the extent to which mankind has been able to interfere with and obtain control over nature and natural processes, it is a chastening thought that man to-day, as in the very dawn of history, in harvesting for his needs some of this vast supply

of solar energy, has still to rely upon that extraordinary natural synthetic process of plants—photosynthesis. It is small wonder that photosynthesis is widely held to be the world's most important chemical reaction. It certainly is "the sole basis of our food supply and the major factor in supplying both the raw materials and the energy of industry" (2). Plants do indeed hold the basic patents of the organic world for they alone can unite carbon dioxide and water and add nitrogen to them.

On a global scale, the photosynthetic industry is one of truly gigantic proportions. Loomis (2) has estimated that it is an industry with an annual output equivalent to 270,000,000,000 tons of glucose, with a requirement of 400,000,000,000 tons of carbon dioxide. A point not always appreciated is that the amount of photosynthesis in the ocean is quantitatively vastly greater than that upon the land (3).

I am uncertain of the precise amount of solar energy annually incident upon an average acre of our better quality pasture lands, but if it is assumed to be equivalent to about 3,300,000,000 Cals. (4) we have a basis from which to start some quite interesting calculations. Let us consider a pasture, of the type nowadays so nonchalantly produced at Grasslands, which yields 14,000lb. of Dry Matter per annum. If we assume with Maynard (5) that one pound of pasture Dry Matter yields 2000 Cals. upon complete combustion, then our 14,000lb. will contain 28,600,000 Cals. It would seem that our colleagues at Grasslands have succeeded in harvesting in the form of pasture herbage grown upon one acre of land almost 0.9% of the total energy incident upon it. This is indeed a notable achievement, for it must not be forgotten that all incident radiation is not available for photosynthetic purposes (6.) (7.). It seems probable, indeed, that Grasslands has succeeded in trapping somewhere between 2% and 4% of the light energy available for that purpose. But it is abundantly clear that there still remains some little scope for further improvement.

Let us turn our attention now for a moment toward the animal kingdom. In recent ages past, ruminant animals appear to have been most numerous amongst the larger species. The supremacy they then attained was, I believe, undoubtedly related to the fact that during the course of the evolutionary process they succeeded in developing a digestive system that is capable of dealing successfully with a vast array of plant feedstuffs. In mammals, the breakdown of cellulose is accomplished by micro-organisms, and the basic adaptation to a herbivorous mode of life is an enlargement of some part of the alimentary canal to form a suitable chamber where food is retained for sufficient time to be adequately fermented. This type of adaptation usually takes the form of enlargement of the caecum and colon. But in ruminants there is an additional enlargement and specialisation of the stomach system so that the food of these animals is subject to a period of fermentation both before and after the normal digestive process. For this reason ruminants as a group are regarded (8) as anatomically better adapted than other mammals to a herbivorous mode of life, and as a group best fitted to take immediate advantage of the plant products commonly resulting from photosynthetic action.

And as man gradually secured that measure of control of the world's food supply in consequence of which he finally emerged as unchallenged victor in the animal kingdom, he naturally domesticated those of the animals he hunted which did not compete directly with himself for food supply, but which could utilise most efficiently those feedstuffs which he himself could not digest. Thus, under domestication ruminant animals are again found to be the dominant class, while the larger carnivores survive either as zoological curiosities or as the personal friends of man. In his meddling with the world fauna, mankind has undoubtedly been influenced, perhaps unconsciously, by the material aspects of animal production.

In order to compute the efficiency with which man's chosen animals convert the feedstuffs they consume to food edible by him, it is necessary to assemble detailed information upon such things as the yield and composition of meat and milk over stated intervals of time and to possess an accurate knowledge of the amount and composition of the animal feedstuffs consumed in order to produce them. You will, no doubt, be relieved to hear that I do not intend to burden you with this sort of detail. Suffice it to say that the relative efficiency of food conversion by the various classes of farm animals has been carefully investigated by a number of people. All these are quite agreed that the dairy cow is far more efficient in the production of human food as milk than are other animals commonly used for food production in the form of meat or eggs. According to Brody, for instance, the energetic efficiency of milk production in superior dairy cattle is 33%, contrasted to about half this level, 17%, for egg production in comparable superior fowls, and 5-15% for meat production (9). The actual magnitude of the percentage efficiency values, in fact, very much depends upon whether one is considering the fate of the total calorific content of the diet or the fate of only those calories contained in the digestible portion of it. But the figures quoted from Brody do give a valuable indication of the relative efficiency of the various major types of animal production.

The differences mentioned in respect to efficiencies are substantial and it is instructive to delve a little in a general way into their origins. In that lauded process of return of dung to the land, so much approved by my colleagues at Grasslands, a high proportion of the energy content of the ingested feed is lost to the animal—amounting perhaps to 25-30% of the total in the case of pasture of average quality. This loss is high, but it does not account for the different efficiencies mentioned, for dairy cattle, beef cattle and sheep do not differ greatly in respect of their digestive capacities. Nor is there substantial evidence that maintenance requirements vary greatly between dairy and beef cattle when these are compared at equivalent weights. It does seem established, however, that in the case of lactating animals, a higher proportion of the productive part of the ration (i.e., the part fed over and above the maintenance requirement) is recovered in the form of milk energy than is stored in the body of the meat animal (10). And, of course, there is the important point that not all the energy stored in the meat animal is stored in edible parts. Nor must it be forgotten, in comparing the performance of the fattening with that of the milking animal, that the latter is normally relieved at least twice each day of the burden of her productive activities, while the former carries her accumulated burden with her until the day she is slaughtered. Meat may be harvested but once in an animal's lifetime, and the drastic nature of the harvesting process most effectively precludes any further production being obtained from the animal in the future.

There is a further aspect in which the meat animal is at a disadvantage as compared with the milk producer, and this is particularly relevant in comparing the fat lamb, beef and dairy industries. In producing milk the dairy cow provides a product immediately available for human consumption, but the breeding ewe and beef cow merely provide part of the raw materials which the lamb and the calf have still to convert to meat, and high losses are involved in this double conversion of feed. The dairy cow is in lactation normally for almost 10 months of the 12; the breeding ewe is in milk usually for only about half this length of time, and overhead costs in the form of annual maintenance are correspondingly unduly heavy. There are indeed very cogent reasons for the differing energetic efficiencies of the various systems of animal production.

While the relative financial return to be derived from alternative production systems is probably the immediately important factor in determining the use to which land is put, this latter is in large measure

governed by the material efficiency of feed conversion. Hence it is not surprising that one should, in general, find dairying concentrated upon the highly improved and naturally more fertile land. Fattening cattle are usually found located in the next best favoured environment, while sheep and run cattle are carried on less kindly country where they are farmed under more extensive conditions.

In a period of world food shortage, the relative economy of feed conversion of different animal production systems is likely to become a factor of increasing importance in determining land usage. On a national scale, the truth of this has been demonstrated to us in but recent times. During the last war, Great Britain was suddenly faced with the stark necessity of having either to become a great deal more self-sufficient in respect to her food supplies, or to starve to the extent that she failed in this. The result was an immediate and planned revolution in her agricultural economy. In this revolution, first priority was given to those crops which were grown for direct human consumption, and after this primary need had been met, those systems of animal production which yielded the greatest return of high class animal protein from the amount of animal feedstuffs available were encouraged at the expense of less efficient systems. There was first and foremost a vast expansion of liquid milk production. Every effort was made to at least maintain beef production. Flocks of sheep largely disappeared from the arable lands of Britain, and their numbers were maintained only on the hill and marginal lands where no other system of farming was practicable. Pigs were much reduced in numbers. Although, due to their high reproductive rate, relatively efficient converters of feed to meat, these animals consumed feedstuffs directly edible by man. In wartime England, swine lived largely on swill—they survived as scavengers.

It is thus no exaggeration to say that during the war the nature of Britain's agricultural economy was basically determined by efficiency of feed conversion considerations. It is now seven years since the war ended. Britain is still battling to maintain a reasonable standard of living and eating and, this being so, to me it appears only natural that there should have been no radical change in her food production policy.

In his recent presidential address to the British Association, Prof. A. V. Hill demonstrated very clearly that there were no grounds for optimism as to the ability of science and technology to increase the world's food supplies—or to develop world resources generally—sufficiently rapidly to overtake the demands of a rapidly increasing world population. The Editor of *Nature*, commenting upon his address, said: "Whatever view is taken of the possibility of controlling the expansion of population, there can be no doubt of the urgency of expanding as rapidly as possible, and with regard to long term at least as much as to short term needs, the world's food supplies and developing world resources with equal regard to such long term requirements rather than immediate exigencies."

Let us in New Zealand be quite honest with ourselves about this world food shortage problem. If it is merely a question of relieving widespread hunger and starvation, then we should be producing less, and not more, beef and fat lamb than we are to-day; we should be growing crops for direct human consumption. But if we believe, as I believe, that the hunger problem cannot ever be adequately met by even the world-wide adoption of an arable type of farming, but only by controlling the rate of increase of humanity (and with my own personal record I tread very gingerly here), and that we have a right to strive to maintain our present standards of living and civilisation generally, then we may well visualise New Zealand's role as a large-scale producer of cheap high class foodstuffs of animal origin. New Zealand, with her ideal grassland environment, is naturally splendidly endowed to fulfil such a purpose.

Having unconsciously completed, by some feat of verbal dexterity, a full turn on the roundabout of verbosity, I find myself back in the grasslands of New Zealand, and before edging off again, would like to refer back to that splendid pasture which yielded 14,000lb. D.M. per acre, and try to obtain a rough estimate of the percentage of the calories contained in it which we can expect to recover if we feed it to our most efficient type of farm animal—the dairy cow. It is, of course, immediately apparent that the answer we get will very much depend upon which cow we select for our feeding trial. In as much as we are really interested in selecting for our purpose the type of cow which will convert as much as possible of our available 14,000lb. D.M. into milk and butterfat, it is obvious that we may fall into perhaps serious error if we blindly follow in the footsteps of the Herd Recording Movement and appraise the relative merits of the cows available only in terms of per cow productions. Very clearly, we need to take into account the fact that the relative efficiency with which the available cows will convert grass to butterfat will depend a great deal not only upon their particular production levels, but also upon how much they each consume: and this latter will, of course, largely be governed by the weights of the cows concerned. Let us, however, acknowledge that this Jersey cow, which weighs 850lb. and which produces 400lb. of butterfat in a 305 day lactation, with milk of 5.5% test, is an animal of high dairy merit and suitable for the purpose in hand. That other, which yields 450lb., certainly looks attractive, but she has averaged 1200lb. liveweight throughout her lactation and, I am afraid, just doesn't quite reach the same dairy merit class.

Studies conducted at Ruakura would suggest that, if the whole of the 14,000lb. of D.M. grown were actually fully consumed by milking cows of the quality selected, we could reasonably expect to obtain from them approximately 850 gallons of milk, or about 520lb. of butterfat per acre.

(In making these calculations it has been assumed that 90% of the pasture D.M. consisted of organic matter, and that this organic matter had an average digestibility of 75%).

On this basis nearly 14% of the energy contained in the pasture would be recovered in the form of the whole milk and about 8% would appear as butterfat. These percentage figures may seem disappointingly small. We have previously noted, however, that losses in the form of dung and urine are high, and it must not be forgotten that even cows of the high quality selected use more than half their annual intake of nutrients for maintenance and growth purposes. The figures given in fact represent maximum efficiencies unlikely to be achieved on commercial dairy farms.

All are no doubt well aware that during the growth of the dairy industry in New Zealand attention was focussed mainly upon the production of butterfat. Over the years, cattle of the Jersey breed have come vastly to outnumber other cattle, and from the point of view of the biological efficiency of butterfat production this must be approved as a sound and logical development. The Jersey breed is characterised by milk of high butterfat test, and other things being equal the feed energy required to produce a pound of butterfat is less when this is derived from high than from low testing milk. Personally, however, I very much doubt whether the future development of the dairy industry in this country lies in the production of butterfat. Margarine of very high quality and palatability is already being sold on the world's markets at but a fraction of the cost of butter, and to me it seems that those who contend that butter will always continue to command a much higher price than margarine live in a fool's paradise. In my experience, it is possible to develop, given time, a palate sufficiently delicate to discern the difference between the best types of butters and margarines, in much the same

way that the practised drinker can distinguish between various brands of whisky. But I vividly remember how, while living in England during rationing, an old lady was eager to exchange her weekly ration of butter for an equivalent quantity of my margarine. I simply cannot see how, in a world short of protein foodstuffs of animal origin, we can hope to maintain our dairy industry mainly on the basis of butterfat, more particularly when a product, equally palatable, equally nutritious and a great deal cheaper—when, in fact, the same product—can readily be produced by the processing of vegetable oils. Indeed, to me the widespread changeover from butterfat and pig production to processed milk production, which is already occurring throughout the country, is an entirely natural development and one to be applauded. That problems and temporary setbacks will confront the fast-growing new industry from time to time is to be expected, but I sincerely hope that we are witnessing the end of the era in which the pig has been used in New Zealand as an “animated drain pipe” for the disposal and destruction of some of the highest quality protein in the world.

This being so, there seems every reason to expect that the “solids not fat” fraction of milk will in the future assume an increased importance. In certain circles there is a widely held belief that higher butterfat production could more easily be achieved by concentrating attention not on level of milk yield but by exercising vigorous selection for high testing animals. The wisdom of plunging for such a programme at the present stage of developments in the dairy industry seems particularly questionable. Perhaps it would be foolhardy to suggest at this stage that we should turn away from the Jersey breed, which has served our ends so well in the past, but it might be well to attempt to promote lower testing strains within the breed. Certainly a plea may reasonably be made that the time has arrived for a changed emphasis in our general attitude and mode of thinking. We must acknowledge that shortly we are likely to be concerned more and more with milk as a whole and to a lessened extent with its butterfat fraction. Under these circumstances might not a start be made by measuring our production achievements in terms not of butterfat but of gallonages of milk per cow and per acre?

Recent research and farmer experience have both shown that dairy calves can be reared successfully on quite limited quantities of milk and weaned when about eight weeks of age. This growing practice is one which must be approved, for it effects a basic improvement in the efficiency of animal production. It reduces toward a minimum that expensive period in the growth of the calf characterised by a double food conversion process. Further advances in this field may well take the form of the development of rearing systems in which feedstuffs of plant origin will be largely substituted for the milk now used during the early growth stages.

While talking of calves on dairy farms, it is perhaps appropriate to raise the whole question of the rearing of replacement stock. It seems to me that our dairy industry leaders, in their enthusiastic and entirely praiseworthy efforts to effect a real improvement in the genetic quality and health status of our herds, have perhaps gone a little far in encouraging as many dairy farmers as possible to breed and rear their own replacements. While readily admitting that many valid and telling arguments may be advanced in support of a home rearing policy, I think most definitely that this is one of those two-sided questions. The amount of land suited to dairying purposes is not of limitless extent, and if such land is to be used partly for rearing replacement stock, then, inevitably, the number of milking cows which may be carried upon it must be substantially less than might otherwise have been the case. Should not store stock, wherever possible, be reared and grazed upon store country, and should not land suited for dairying be reserved for dairy purposes? I would suggest that

first class dairy land is a national asset and one that we should not needlessly squander.

I sincerely hope that I have been mistaken in thinking that there is an unfortunate attitude of mind developing encouraging us to believe that there is something faintly unsavoury about the dairyman who does not rear his own replacements; and that when such a man achieves noteworthy output performances there is often a lurking thought which insinuates that he has somehow cheated.

Let me now direct your attention towards a consideration of the basic efficiency of the beef industry. It should already be clear that any general system of animal production is not characterised by some one fixed and inflexible value, and in the beef industry efficiency values will, in fact, very much depend upon which stage of the production process is being considered. However, the industry as a whole is a relatively inefficient one because by the time it is born the calf has already incurred a very heavy feed mortgage. This it gradually pays off during the course of its growth. As the weight to which calves are carried before slaughter is raised, the overall efficiency of the industry improves, for the fixed overhead costs of cow maintenance are then spread more lightly over an increased amount of product.

The amount of the initial mortgage would, of course, be very much less than at present if beef cows habitually produced twins. It is, in the face of this, indeed, somewhat surprising that improvers of beef cattle should not have developed a strain of cattle prone to twinning, for this would do much to improve the basic efficiency of beef production. The reason for their failure to do so is probably related to the occurrence in cattle of the "freemartin" condition. As is well known, in about 90% of the pregnancies which give rise to mixed sets of twins, the foetal circulations fuse and it is thought that the hormones of the bull foetus circulating in the heifer inhibit the development of the female organs, so causing permanent sterility. But it is of interest to note that in about 10% of heifers born twin to a bull, this fusion does not occur, and that, in consequence, these heifers will breed. I would suggest to our geneticists that it might be well worth while to attempt to develop a strain of beef cattle prone to twinning, but free of the fused circulation condition. Admittedly the task would be difficult—indeed, perhaps impossible—but the issues at stake are enormous.

A condition which must be fulfilled if beef production is to be basically efficient is that, once the fattening process has been initiated, it should be allowed to proceed at a rapid and uninterrupted rate. The process certainly should not be allowed to go into reverse. In other words, store periods must, wherever possible, be avoided with fattening animals. At the breeding stage this aspect is of much lesser importance. At certain seasons, breeding animals may be subject to quite low nutritional levels without deleteriously affecting their reproductive performance. These facts are simple, but their implications are of importance. They are, in fact, the basic considerations which should govern any stratification within the beef industry. If breeding and fattening stages are to be separated, this separation should be effected on the basis of breeding in the poorer, less well controllable environment, and fattening in the environment which provides a better and more uniformly available level of nutrition.

As one deeply concerned that we should use our material resources as thriftily as possible, it has always pained me to realise that we maintain in this country nearly a million beef cows with the one major purpose of their giving birth each year to calves which may be kept for rearing purposes; while at the same time we have presented to us, each year, more than a million calves, a by-product of the dairy industry, which we immediately proceed to slaughter at

birth. If the world food problem became really pressing, could not some means be found for taking advantage of this provoking situation? Surely some system could be evolved whereby we could expand beef production and yet cunningly dodge the high costs normally associated with the maintenance of additional breeding animals. I believe that possible ways and means should be investigated now, for it is my conviction that sooner or later something will in any case have to be done to effect some degree of dovetailing between our dairy and beef industries. In Britain, the intensive agricultural system practised already precludes large scale beef ranching and the position there is that the demand for beef stores cannot be met unless they come principally from dairy cows.

A certain measure of boldness is required in approaching the problem. Perhaps dual-purpose animals may yet find a place in the dairy industry of New Zealand. Alternatively, a system more on the British pattern might be developed, whereby under A.I. superior dairy merit bulls would be reserved for use only in the better quality dairy herds, and these herds would then have the special function of breeding all the replacements needed by the industry. In herds of lower quality, bulls of one or other of the beef breeds, preferably perhaps the Hereford, could be used and all the progeny reared for beef production purposes. Alternatively again, dairy bulls might be used upon only those cows from which replacement heifers were required, and a beef bull used on the remainder of the herd.

Many of you will, no doubt, object that dairying land should not be used for such an inefficient process as beef production, and with this I fully agree. Logically, these calves would be reared on the early weaning system and soon transferred away. In this connection, it would be of much interest to know how calves from Jersey cows, sired by beef bulls, would thrive when shifted to fat lamb farms in, say, early October, when the spring flush is usually beginning to become a problem upon such lands.

Attention has already been drawn to the fact that the fat lamb industry is, as compared with the dairy industry, a relatively inefficient system of converting plant products to fats and proteins edible by man. Probably few people quite realise, however, that during the flush of her lactation a reasonably good dairy cow secretes in her milk during the course of two or three days a quantity of nutrients equivalent to those contained in the edible parts of a 36 lb. carcass of Down Cross lamb.

The fat lamb system is inefficient for the same reasons that the beef system is inefficient; because against the small amount of product represented by each fat lamb must be charged not only the grass consumption of the lamb itself, but also that of the ewe during the whole season. Clearly, the only way in which the overall efficiency of the process may be improved is by increasing the amount of the product relative to the feed costs involved. Let us examine the possibilities.

In the first place, it is obvious that we could cut overhead feed costs by persuading our flocks to produce more than one crop of lambs each year. But this, I fear, would provide no practical solution: the resulting system of production would be one most ill-suited to the seasonal pattern of our pasture growth. Secondly, we could aim to increase the fertility status of our sheep so that the annual fixed overheads in the form of ewe maintenance should be spread over a substantially increased number of lambs. This is a sound approach and one which should be prosecuted with vigour and resource. We must learn to feed and manage our flocks so as to obtain maximum fertility from them; we must breed sheep of inherently higher fertility

than we use to-day and in the meantime there may be a case for obtaining increased fertility in sheep by artificial means, as by the injection of gonadotrophic hormones.

It has always somewhat saddened me that one of the most remarkable features of the fat lamb industry in New Zealand should be the very low fertility status of the main breed upon which it is based. In New Zealand we have traditionally looked to our stud breeders to provide us with superior strains of animals. Our breeders of dairy stock may perhaps be criticised on the ground that they have been unduly concerned to provide us with animals of aesthetically pleasing appearance, but one feels that they have at least been aware that their animals were being used by commercial farmers to produce butterfat. In the case of Romney breeders, everyone will concede that an excellent job has been done in respect to fleece improvement, but one does wonder how many of them have ever even attempted to improve the fertility status of the breed. It may safely be said that this character has certainly not in the past received that degree of attention its economic importance warrants.

A further obvious method of improving the material economy of lamb production is to carry our lambs to heavier weights, and I believe that this line of approach offers tremendous opportunities of increasing production. As I see it, there are three main aspects involved. In the first place, it is logical that we should use to sire our fat lambs, rams of the heavier breeds. The principle of keeping ewes of a small breed, and of mating them to rams of a larger breed, is biologically sound. It cuts ewe overheads and ensures that the lambs born possess the growth potential which enables them to convert large quantities of grass directly into flesh and to be carried to heavy weights without becoming overfat. In Britain during the war, when the amount of meat produced was a matter of some importance, farmers were discouraged from killing lambs until nine months or more of age and larger sires, such as Suffolks, Hampshires and Oxfords, were greatly preferred. Southdown flocks were reduced to nucleus proportions. In re-raising this question of the desirability of an extended use of the heavier down breeds in New Zealand, I have no particular wish to enter into what has now become quite an old controversy. It is merely that, in approaching the whole problem of the efficiency of animal production from the viewpoint I have chosen to adopt, their widespread use must be encouraged and expected as a sound and logical future development and not, as some would have it, regarded as a dangerous and irresponsible departure from long-established practice.

In attempting to carry our lambs to heavier weights, my second point is that we must be prepared to wean our lambs a great deal sooner than the majority of us have been in the habit of doing. We must, in fact, duplicate the early weaning development in the dairy industry, thereby reducing to a minimum that period of inefficient double conversion through the ewe, and save as much feed as possible for direct conversion by the lamb. In doing so, we may comfort ourselves by remembering that by the end of November ewes are far advanced in lactation and that lambs then derive but a small proportion of their total nutrient intake in the form of milk.

The third point I wish to stress is that, in adopting this early weaning-heavy weight policy, we should take full advantage of what the Grasslands Division has to offer by way of improved strains of pasture plants, for under the set up envisaged we shall need to carry forward from November and December into January, February and March large quantities of highly palatable and nutritious fattening feeds.

I believe that the scheme outlined has many practical advantages. It simplifies farm management. The early weaned lambs may perhaps be shorn and drenched at that time, while the ewes may be shorn more or less at leisure and without the tension introduced through their having lambs at foot. The flock may be mouthed and those ewes culled may with luck be disposed of before the main lamb killing season begins. Ewes retained for breeding may have their feet attended to and be dipped in good time. They may be brought into that hard store condition generally thought conducive to subsequent sound breeding performance and in the process they may be prevented from consuming vast quantities of feed they do not require and which should logically be kept for the further growth of lambs and the fattening of cattle.

It seems to me, however, that quite apart from the aspects just mentioned, we may look in the future toward an appreciable expansion of our fat lamb industry. The advent of aerial topdressing may well convert large areas of what is at present store sheep country into fattening country, while steadily increasing production should come from the further development of what were until recently our marginal and problem lands—our gum, ironstone, peat and pumice lands. One of the most notable features of New Zealand farming is that land of reasonable contour, no matter how naturally infertile, has now a real value, for improved techniques of land development and the advent of modern machinery have together made it possible to convert much previously barren and useless land into potential fat lamb country. Indeed, the whole long term trend seems to be toward an expanded area of fat lamb country and a shrunken acreage of store sheep country.

And as the balance changes, new problems arise. In the past, the cheap cast-for-age 5-yr.-old ewe off hill country has always formed the basis of the fat lamb industry. To-day I believe the time has arrived when the 5-yr.-old ewe is no longer cheap. Under such circumstances, farmers are likely to be less ready to overlook the fact that in one respect at least, namely its low fertility status, the Romney ewe is singularly unsuited to the requirements of the fat lamb producer. Some fat lamb farmers are at present attempting to meet the shortage of ewes off store country by putting a proportion of their flocks to rams of the Romney breed. Other possibilities need to be examined. There may well be a case for some further stratification of our sheep industry, such that country marginal between genuine store country on the one hand and genuine fat lamb country on the other, is used for the production of some type of crossbreed ewes characterised by inherently high fertility and the ability to breed early in the season. Or there may be a case for the use on fat lamb farms of rams of breeds which would leave wether lambs capable of being successfully fattened, and ewe lambs which might usefully be kept for breeding purposes—and perhaps bred from at the lamb stage.

There is one characteristic common to animal production systems in New Zealand to which I would direct your attention, for it has a particular relevance to the theme of my address. It is that here in New Zealand feed production and feed utilisation do not form separate and discrete parts of the process of animal production, as they do in overseas countries, where stock are wintered indoors and where stall feeding is commonly practised. Under our grassland system, they instead form sensitively interacting phases that must be brought into delicately integrated adjustment if maximum overall efficiency of feed conversion is to be secured. We must at all times graze and manage our stock to ensure that their present requirements are adequately provided, so that we may look to obtain from them continued high levels of production in the future. We must at the same time see—and

this I stress as of the utmost importance—that as high a proportion as possible of the feedstuffs grown is actually utilised and that wastage is reduced to a minimum. We must see also that our grazing management is such that neither the extent nor the quality of our future pasture production is detrimentally affected. And we must endeavour to carry that number of stock and provide that level of feeding which will result in the best return from the group as a whole. In order to do these things it is obvious that we shall need, to aid us, all the techniques of grassland management at our disposal.

It is also obvious that compromises will have to be effected. Thus, in fat lamb production, we may have to sacrifice average fleece and lamb weights in order to secure high carrying capacity, while in dairying we may have to sacrifice production per cow in order to secure really efficient utilisation and maximum production per acre. The agronomist delights in high producing pastures, the animal husbandman in high producing animals; but the farmer must on occasion be prepared to abuse both these in the interest of overall economy in food production.

In concluding this address, I would just like to say that I am well aware that the exponents of improved agricultural policies are numerous and vocal, and that often conspicuous among them are those poorly qualified to speak. I am well aware that, traditionally, the scientist is expected to be reticent in matters of speculation. He is supposed to devote his time to securing adequate data, and should emerge from the seclusion of his laboratory only to demonstrate conclusions proved and established. But it has always seemed to me that, in a presidential address, there is granted a special licence. Speculative thinking is encouraged and, with great discretion, evidence for the views propounded not even expected.

Reflecting, then, on the course of recent history, it seems to me that with the advent of the industrial revolution, man, armed with the machines which his rapidly expanded knowledge of the physical science enabled him to build, began to mine the accumulated resources of hundreds and thousands of years of photo-synthetic action. This development was paralleled by a tremendous increase in world population, much of which spilled over into vast regions previously empty. The agricultural resources of these new territories, and the increased productivity of agriculture in general, which resulted mainly from its mechanisation, have together enabled the increased demand for food to be met. World population is still increasing, but there are no longer vast empty territories and it is now being suggested that accumulated photosynthetic resources are being exhausted at a rate such that, before long, we shall have to provide a greater proportion of our industrial raw materials from current photosynthetic action.

There are, I think, good reasons for believing that, some time, there will exist a real need for this country to increase the amount and efficiency of her animal production. I would hope that, when that time arrives, producers will have more reason than they have yet had for believing that a real need for increased production exists, and that calls for increased production will be unaccompanied by Meat Board Schedules which penalise the production of heavier lambs and discourage production of beef.

I would hope that, then, there will exist in this country a flourishing dairy industry so organised that all our first-class dairying land is used for dairying purposes and not for the rearing of store stock; so organised that some of the most nutritionally valuable products of the industry are no longer guzzled by pigs but processed for human consumption; so organised that the million-odd surplus calves annually produced are used to augment the world's meat supply; and, indeed, so organised that the general management and breeding

policies will be thoughtfully directed toward utilising with ever-increasing efficiency the greater quantities of better quality pastures our grassland workers will by then have shown us how to grow.

I would hope that there will then exist a much expanded beef industry, encouraged by price incentives at least equivalent to those offering in the basically less efficient fat lamb industry, and that the industry will be stratified, with breeding stock confined entirely to the less favoured broken country and the fattening cattle situated on better-class lands which, as a result of more intensified farming methods, will have been made to provide the improved environment needed for the uninterrupted growth of cattle and for the efficient production of high quality beef.

I would hope, too, that there will then still remain in this country a fat lamb industry, but one so bent upon the production of more lambs that the much augmented demand for a ewe of inherently high fertility will have led to further stratification within the industry; and so bent upon the production of heavier lambs that the Southdown will have become a discarded breed.

Above all, I would hope that, when the real need for increased animal production exists, there will also exist that which seems entirely lacking to-day; I would hope that there will be a definite and agreed policy as to how the increased production should be attained. And I would hope that, in the formulation of that policy, real attention will be paid to some of the considerations I have mentioned, considerations, which, I believe, govern the basic efficiency of animal production.

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