PASTURES AND SOIL FERTILITY

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The papers that follow in this symposium will present, details of soil and pasture improvement in several nearby regions. The part given to me is to offer a general, background to our pasture improvement philosophy and to compare this with other countries,.

Even the most casual study of our economy will show how great has been the contribution of pasture to our high living standards. I think, too, that no one here will deny that improved pastures and animal and crop husbandry will continue to be our best basic national aim. Indeed if continued and extended widely enough, good farming in New Zealand may even be strong enough to carry the great weight of protected secondary industry and our other social services.

In spite of present export trading difficulties, the general picture for the future cannot be anything but bright. There are many advantages of working visits to other countries by our agricultural technicians, but for me the greatest of these has been to see the obvious present and future great need for the products we as a country are so well suited to produce. A precis of this is seen in (a) the difference between diets of high and low living standards, (b) the general rise in world living standards by various means, (c) the increasing world population, and (d) our great national economic advantages for products of animal origin.

In a recent publication it was reported that an American reaching the age of 70 has consumed during his lifetime: 150 cattle, 225 lambs, 26 sheep, 310 pigs, 2,400 chickens, 26 acres of grain, and 50 acres of fruit and vegetables. If we add milk, cheese, and butter to this, and make adjustments between chicken and lamb, and also, of course, add an appropriate acreage for barley to cover essential beverages, we would undoubtedly get a similar 'set of figures for New Zealand or any other country enjoying high living standards. Compare this with the low acreages of rice, wheat, or millet, and the fish diets of people on low living standards, and we can readily see the gap available for filling by New Zealand produce. Consider also in this respect the steady increase in demand for wool by Eastern countries.

On the production side it is necessary to consider our costs and potentials against those not only of competing exporters, but also of food importing regions. In this we should think of climatic limitations to pasture and crop growth, and to feed conservation and stock housing needs; also we should think of topography, access and soil fertility, and of transport and technical, industrial, and financial facilities available for overcoming deficiencies in each country. New Zealand at present compares more than favourably in all these matters, except in the financial sphere, against those countries openly boosting food production for sociological or defence purposes.

From the climatic angle, there is no question of our great advantage for continued good pasture production, and for all-the-year grazing with its several benefits. A corollary is that such good pasture production will also give high soil fertility, so that where required, heavy crops of direct food or forage crops can readily be secured. High soil fertility will itself also aid in levelling out some of the weather vagaries. But a poor pasture in New Zealand is little, if any, better, than a poor pasture anywhere else, and I don't think there will be much argument here that we still have a long way to go to bring our pasture areas up to full potential. This is not only on the obvious undrained or scrub areas, but also on much of our developed land, For these latter areas I believe a basic weakness in 'this country is that we all tend to take too much notice of the eulogies from overseas visitors about the overall greenness of our countryside. To me it is much more constructive to make comparisons within each district against the best that is being done on farms or demonstrated as possible on research areas. I believe too that such comparisons should not be unduly fogged up with individuals' personal or economic matters, but the potentials should be kept firmly in mind.

Another equally valuable picture of our growth potentials can be gained from calculations of evapotranspiration made directly from climate and soil data such as are under way in New Zealand geography faculties and also from similar estimates made from pasture species performances in controlled environments as carried out by Mitchell at Grasslands. Such estimates underline not only our overall suitability for continued growth, but also highlight our major climatic difficulties. For example, although most of us realise our winter temperature limitations, not many appreciate the shortage of light at such times and also that we do have definite summer and autumn soil moisture deficits over most of the country. Such limitations apply of course mainly for high production, and we can use such data to focus our attention on problems of irrigation and drainage, pasture mixtures, the breeding of more suitable strains, fertiliser and management practices for light and shade, for soil moisture, and for out of season grass; and for seed conservation and seed production.

Such estimates also attract our attention to local problems of soil fertility. Examples will later be given of increased production on foothill and local high country. Once the soil deficiencies are corrected better species can thrive and growth increases markedly towards the climatic limitation. Often such responses are very surprising to those who believe that poor yields were directly resultant from poor climate rather than poor soil nutrition. One could readily quote similar examples from the high plateau of the North Island pumice country.

A similar climatic approach offers a valuable comparison with other countries. For example, growth potential over most of Japan is obviously very great for spring, summer, and autumn, due to high temperature, low wind and evaporation, and ample soil moisture; but winter cold is severe with an almost complete limitation to growth and outdoor feeding. Their problems are not only of poor soil and the great need for imports of mineral fertilisers, but also large needs for winter feed supplies and stock housing, plus complications of haymaking and seed production weather troubles. By contrast, Argentina has a good all-year temperature regime, but restricted soil moisture and large induced soil deficiencies, difficult to correct without a great expansion of transport and fertiliser facilities as well as a major change in their outlook. This, coupled with their large population increase and their own internal economic policies, has made it fairly obvious to me that there will be a lot of slack in meat export available for us to take up if we so desire.

By contrast again, Europe has not only a very difficult and expansive winter, but also a variable moisture and temperature regime in the growing season-about midway between Japan and Argentina. Thus although Europe has an obvious potential' for agricultural expansion, it will be relatively expensive to attain, particularly with increased costs of imported feedstuffs and rising labour costs in Europe itself. An interesting local situation is seen in Holland where due to high waler-tables and restriction on carly grazing, a mat of *Poa trivialis* and ryegrass develops against the white clover. Large amounts of artificial nitrogen are therefore required, which, although having some advantages, are also very expensive.

These few examples not only show the need for careful study by us of other people's approaches and their reasons, but also illustrate how well off we are in a general international grassland production comparison. But quite a lot of effort is needed for us to continue to turn our climatic advantages into the reality of good pastures and crops. This work is in the form of beating back the 'natural vegetation and the weeds and scrub, the correction of soil, water, and mineral difficulties, the provision and use of better and more reliable pasture strains, and the control of the grazing animal. Essentially the aim is to establish and maintain a mixture of grass and clover; with animal defoliation for correct balance of leaf, and thus of light 'and shade, for both sets of plants; with animal treading for adequate but not too much consolidation or hoof damage, and with animal dung and urine and earthworms to maintain the soil nutrients and-structure.

All this 'sounds very simple, but as all of us know, it is an extremely tricky business, especially on marginal areas between clear-cut pasture and fertiliser practices and also where soil fertility 'is to be built 'up from raw parent material. It is tricky also to cope with animal feeding problems such as bloat, facial eczema, ill-thrift, or unpalatability, and also to fit in requirements of silage, hay, or seed production.

Grasslands Division over the years has contributed pasture strains with improved persistency, productivity, palatability, and disease resistance, while on the agronomic side we have obtained background data on the production cycle. Our continuing aim is of course to combine these strains and knowledge into better farm production programmes.

Details of the many strains and the various experiments have been given to previous conferences, and there is no need for me to repeat them. Brief mention of some current work may, however, be of interest here. In one series of trials at Palmerston North we are measuring the time taken to build up soil fertility by good pasture and also how long this fertility lasts. Previous trials indicated that at Palmerston North five years of good pasture produced soil fertility with top yielding forage crops. The present series has several pasture and fertiliser combinations and all start from raw subsoil. Grass without clover or nitrogen produces only about 2,000 lb. D.M. per acre, even with adequate phosphate, potash, etc. White clover alone produces some 9,000 lb. D.M., but the grass and clover combinations produce 1 1,000-14,000 lb. D.M. Without the return of the animal manure there is clover dominance with only a slow increase of grass, but with the return it rapidly goes to grass dominance and with a greater total yield and seasonal spread. An interesting and important point is that the response to mineral fertiliser is first in the form of extra clover and then later, when the soil nitrogen has been increased through the clover, an added response to the fertiliser is obtained in extra grass growth. This is particularly so with ryegrass and cocksfoot, compared with browntop, which does not appear to have such high demands or response to such phosphate or sulphur additions.

Such extra and cyclic responses are quite logical when considered against the greater mineral content of grass over clover except in calcium, but the fact is not always appreciated by farmers worried about too much clover in early pasture stages. Instead of cutting for silage or hay and reducing fertility on such paddocks, there is an obvious strong case for continued grazing, even with stock difficulties, and for more fertiliser. The use of a whiff of spray to set the clover back a little, as carried out by some Waikato farmers, and thus urge forward the grass, appeals as another possibility for extreme cases.

In the Palmerston North trial there is also pure grass with artificial nitrogen (urea) applied just sufficient to keep the grass up to full growth. The amount needed so far has, however, been greater than the equivalent of 1 ton of sulphate of ammonia per acre per year. This gives another check on the large nitrogen input by a robust white clover. It is also a useful point for us to focus on when considering seed production on pure grass-quite a difference from the handful of artificial nitrogen applied to most cocksfoot seed production areas in this part of the country.

The trial series has not been going long enough to give a full measure of the soil fertility increase. However, rape crops after the best pasture combinations on this poor soil show yields relative to crops on first-class soil as follows: raw soil at commencement of trial 15 per cent, after 1 year 30 per cent, and after 2 years 50 per cent. A similar sort of situation applies in the earthworm populations and also in the general appearance and structure of the soil itself.

In the exhaustion series the outstanding feature has been the rapid fall in yield under the particular soil and climate at Palmerston North. First crops on land built up by years of good pasture have yields of some 50-60 tons of kale or green maize, 30-40 tons of turnips or rape, or over 25 tons of potatoes; all these without any fertiliser to the crops. Second crops, however, show a dramatic drop to less than half these yields, and with a continuing but slower fall in subsequent years, down to the typical stunted and yellowish crops of low fertility soil., Such declines in yield are, however, not surprising when considered against chemical composition. For example, in a 50-ton crop of kale there is the equivalent of over ½ ton S/A, 5 cwt. KC 1, and 2 cwt. of superphosphate; in a similarly heavy maize crop there is even more potash.

Other checks within this trial series and also in other trials show that nitrogen is our primary nutrient loss at Palmerston

North, undoubtedly from the rapid breakdown of our fairly unstable organic matter. For example, on one area, after taking one crop of kale, nitrogen treatments were applied to the succeeding turnip crop. Turnip yields were: no nitrogen 10 tons, 2 cwt. urea 20 tons, 4 cwt. urea 30 tons, 6 cwt. urea 40 tons. The 40-ton yield was the same as that obtained directly after good pasture. The 10-ton yield was also the same as that after poor pasture at Palmerston North. The trials will obviously need to be run for much longer and on other major soil and climatic types, but even allowing for quite a variation and also for luxury consumption by crops, there is an obvious need for very careful thought about growing crops and also about crop utilisation to avoid fertility losses by stock or by carting the crop off the paddock.

There is undoubtedly plenty of justification for pioneer cropping, even with poor yields and weeds, or with the use of expensive artificial nitrogen. However, my attitude is that it is better and cheaper to grow a small area of good crop than a large area of poor yield. And for this purpose my aim is to use pasture as the pioneer and to build up this pasture continually by early and full correction of soil deficiencies, by eradication of grass grub and other pests, and where necessary by oversowing. Thus I aim to have finally a really good pasture on uniform land, to plough for a crop, which area I know will automatically give me a good crop without any fancy treatment for the crop itself.

You will all appreciate, but not perhaps agree with, the difference between this, and the attitude of those who locally use a pioneer turnip crop and pour on nitrogen and other fertiliser, either directly or by brought-in dung and urine, and call this a soil improving crop. My attitude is also very different from those who grow a crop only after ploughing a run-out pasture, without any concern as to why the pasture ran out and no corrective treatment for the crop itself.

Following in general this policy of full and early correction of soil deficiencies and careful pasture establishment and management of good clover, stock, and grass, we have obtained at Grasslands, very heavy production on our several areas through the country. At Palmerston North on a small intensive self-contained unit we have for some years carried 10 ewes and their fat lambs per acre plus very heavy crops of potatoes in a lo-year rotation. On a similar self-contained dairy unit run in collaboration with Massey College we have produced over 360 lb. of butterfat per acre. An essential practice in these two units has been to use the area to be cropped as the winter feeding and holding paddock—the "sacrifice" paddock system so distressing to many of my friends with advanced aesthetic views.

At Te Awa on very steep, wet hill country we are now carrying over 5 ewes per acre with their lambs up to weaning and some cattle. The big points on this area have been adequate phosphate, oversowing with clover, gully protection, and full utilisation of the herbage by separate grazing, on a continuous basis, of sunny and shady faces, and thus holding a tight, productive, and palatable pasture.

At Kaikohe this year we have established new pastures on raw clay gumland. With heavy phosphate and potash and good inoculation, these new pastures have swung straight into vigorous clover which, with the necessary heavy sheep grazing, are now rapidly settling to a strong grass and clover sward. By contrast, the areas with only light initial phosphate are still weak and open and still quite a weed hazard from manuka and rushes apart from poor return for all the other development costs. Similar results have been obtained in Taranaki, except that there our emphasis is on extra potash and D.D.T. against the high grass-grub populations. For all these difficult situations a quick, good start gives a good backbone for future good pasture.

I quote these results not so much for their own sake, as I know there are plenty of farms and research areas doing equally well. I quote them mainly as examples of yield potentials possible and relatively easy to reach over much of the country.

DISCUSSION

Q. (J. Adams): I have been interested in Dr Sears' comments concerning nematodes in clovers. Can Dr Sears give information concerning the areas affected and possible methods of control?

A. I am no entomologist but the problem appears widespread in North Auckland, and Entomology Division now has an officer investigating the problem. From experience to date, we are puzzled why it is not widespread throughout the country. There are large nematode infections in Europe, U.S.A. and Argentina, and they are breeding for resistance. At our Kaikohe station the trouble appears to be on the alluvial areas. We are trying chemical control but this is expensive.

Q. (R. H. Bevin): I would like to comment on a few points in the paper. If we want good crops we do not plough up poor pastures; this, is a feature of Dr Sears' experiments. We now have difficulties in marketing the lamb crop brought about by increasing ewe numbers. We must also now consider using and growing more cattle. However one of our difficulties is the ability of turf to support the stock load at heavy stocking rates. Would Dr Sears comment on this problem?

A. As you increase productivity the load bearing capacity of grassland falls off but earthworm activity, and roots give rapid soil reconstitution after pugging. It is a major difficulty to balance up extra stock carrying capacity with soil capacity. Whether you have sheep or cattle doesn't much matter as the load bearing capacity decreases with increase of productivity. The load on a sheep's hoof may be 30 lb per sq. inch and with cattle 45 lb per sq. inch. It might be a good idea to hand the problem to the animal people to breed stock with larger hooves, but in the meantime we should consider management adjustments such as the sacrifice paddock system I have been using, on wet land as well as of course better drainage.

Q. (Dr A. Troughton): I was interested in Dr Sears' comment that it takes five years to build up fertility under a ley. This agrees with results from extensive trials in the United Kingdom. There, about four years were needed to rebuild structure and restore organic matter from arable to, almost the standard ,of permanent pasture. Were there differences between leys of different botanical composition and under different systems of management, in their effect on soil fertility?

A. I havk not included different grass comparisons at Palmerston North but Dr Watkin is doing some such comparisons at our station at Lincoln. The five-year term appears to be tied up not only with plants, but also with soil structure and earthworm activity, and I rather think that worms are the most important point in structure rather than roots and plant productivity. The time cycle in Palmerston North, where the climate is fairly uniform, could be expected to be similar to the time cycle in the U.K., but in Canterbury where there are good and bad years, it would vary. To my mind these trials should be repeated on major soil and climatic types.

Regarding botanical composition and different species-it must also be remembered that we have to use the pastures for production, and as such soil and pasture measurements must be appropriate for the carrying of stock. Tall fescue, for example, may be good for the build up of fertility, but not so good for production. We must be careful about this.

D. A. Campbell: 1 was interested to hear the comments concerning the destruction of the raft of grass under heavy stocking. Pasture furrows and contour banks have shown that this problem can be partly overcome. We can also get extra grass through drainage and adequate water conservation.

A. Yes. I think we have to keep all these factors in phase and it is important to keep the conservation of moisture in view.

Q. (W. Faithful): I wish to ask two questions. If there is a heavy concentration of ewes and lambs on high production pasture, what is the effect on the thrift of the lambs ? How about long-rotation ryegrass if and when it becomes available?

A. At Grasslands I am this year carrying 10 ewes and 15 lambs to the acre in a small block. The lambs averaged 11.7 lbs weight when' born and have steadily gained ½ lb per day. Normally we get our lambs fat but certainly they are not the best lambs in the country. Actually 10 ewes per acre isn't so very much-at least on good pasture.

Comment: It's a lot in the winter.

A. Perhaps in three to five years long-rotation ryegrass may be in commercial production. We've already made a preliminary nucleus and even this is very good-outstandingly good. Even with competition in the field and under heavy grazing it is standing up very well. H.1 can be tricky and perennial ryegrass has its limitations from palatability point of view, It's all very well to talk about spelling pastures and other management practices but for really high production pastures we must have flexibility and this new ryegrass should give us more of this. We've tried it in single plants and small plots from Kaikohe to Gore but we are not quite ready yet. It should be available in, say, another five years.

Q. (C. E. tversen): High stock carrying and unthrifty stock are said to go together. Perhaps if we accept the commonly held view we will run into trouble, because of increases in parasites. etc. Perhaps it's not necessarily so and your experiment appears to confirm this. If it is a question of the mineral nutrition of animals, your soil is good in this respect. Have you any views on the matter?

A. I'm out of my depth on such matters and wilt pass this on to Dr Filmer.

Dr J. F. Filmer: This subject is too large to deal with in a few minutes. From various experiments at Ruakura it seems that, within reasonable limits, as rate of stocking goes up the weight of the individual animal goes down but the weight per acre goes up. It's just a case of deciding what you want. Big lambs mean fewer per acre and big yield per acre means more and smaller lambs.

Re minerals: I know of no case where overstocking has accentuated mineral deficiency, e.g. iodine.