

LINCOLN COLLEGE

(Canterbury Agricultural College)

UNIVERSITY OF NEW ZEALAND



The Proceedings
of the
10th Lincoln College
Farmer's Conference
1960



LINCOLN COLLEGE

(Canterbury Agricultural College)
UNIVERSITY OF NEW ZEALAND



The Proceedings
of the
10th Lincoln College
Farmer's Conference
1960

Frontispiece: *Cattle in Yards at Tarnedale, Molesworth.*

LINCOLN COLLEGE FARMERS' CONFERENCE

1960

Committee

Mr C. Baird, Wendon, No. 3 R.D., Gore (Otago-Southland Y.F.C.)

Mr S. C. Bowmar, Bowden Fields, No. 4 R.D., Gore.

Dr M. M. Burns, Director, Lincoln College.

Mr L. P. Chapman, Inverary, Mt. Somers (Chairman).

Mr J. L. C. Chaytor, Marshlands, Spring, Creek, Marlborough.

Mr A. Henderson, Nethershiel, No. 3 R.D., Winton.

Mr J. Hunt, Fork Farm, Private Bag, Cromwell.

Mr J. A. Hurst, "Braeside," No. 7 R.D., Waimate.

Mr J. R. Little, Hui Hui, Hawarden.

Mr T. A. McKellar, Knockindale, Pigeon Bay, Banks Peninsula.

Mr N. Maxwell, "Mt. Sandford," Cheviot R.D.

Mr C. A. B. Pilbrow, Coldstream, R.D. 3, Ashburton.

Mr A. J. Rushton, Anama, No. 8 R.D., Ashburton (Canty. Y.F.C.).

Mr G. J. Slater, Hilton, Geraldine.

Mr S. M. Wallace, Haupiri, Nelson Creek, Westland.

Hon. Secretary,

L. W. McCaskill,

Lincoln College.

PROGRAMME

1960

Page

NEW ZEALAND FARMING: SOME RECOLLECTIONS AND SOME REFLECTIONS Mr A. P. O'Shea, Wellington	8
SELF-FEEDING OF SILAGE IN BRITAIN Mr T. G. Tyrer, N.Z. Dairy Exporter, Wellington	16
VARIATIONS IN SOLIDS-NOT-FAT CONTENT OF THE MILK OF DAIRY COWS Mr M. G. Hollard, Lincoln College	21
BRUCELLOSIS IN DAIRY HERDS Dr C. S. M. Hopkirk, Lincoln College	26
RECENT ADVANCES IN SELENIUM AND ANIMAL HEALTH Mr W. J. Hartley, Wallaceville Animal Research Station	29
PROGRESS REPORT ON ILL-THRIFT Mr Graham G. Thomson, Lincoln College	33
THE FUTURE OF PEDIGREE BREEDING Dr C. P. McMeekan, Ruakura Animal Research Station	42
THE VIEWPOINT OF THE PEDIGREE BREEDER Mr A. W. Montgomerie, Mangere, Auckland	51
CONSTITUTIONAL VIGOUR IN DOMESTIC LIVESTOCK Mr J. R. Little, Hawarden	57
THE IMPROVEMENT OF FRONT HILL-COUNTRY IN CANTERBURY Mr H. C. A. Sidey, Hawarden	68
THE MANAGEMENT OF HIGH COUNTRY Mr Geo. Burdon, Mt. Burke, Central Otago	76
SOME ASPECTS OF THE BOTANY OF TUSSOCK GRASSLANDS Mr H. E. Connor, D.S.I.R., Lincoln	78
PRODUCTION IN THE MOUNTAINS Dr K. F. O'Connor, D.S.I.R., Lincoln	82

	Page
THE PRODUCTION AND MANAGEMENT OF BEEF CATTLE ON MOLESWORTH FOR THE STORE MARKET .	
Mr M. M. Chisholm, Department of Lands, Moles- worth	95
INCREASING THE ANNUAL CALF CROP	
Mr E. D. Fielden, Ruakura Animal Research Station	103
WOOL: RESULTS OF RECENT RESEARCH AND ITS APPLICATION ON THE FARM	
Dr A. E. Henderson, Lincoln College	110
THE MANAGEMENT OF HIGH-FERTILITY FARMS	
Mr W. Faithful, Department of Agriculture, Inver- cargill	116
NUTRITIONAL ASPECTS OF FODDER CONSERVATION	
Dr I. E. Coop, Lincoln College	127
A SURVEY OF MACHINERY AND METHODS FOR FODDER CONSERVATION	
Mr G. G. Lindsay, Lincoln College	132
BUDGETING FOR THE FARMER	
Associate Professor A. H. Flay, Lincoln College . .	154
SOME THOUGHTS ON PROVIDING TAXATION AND DUTIES TO ENSURE CONTINUITY OF FARMING	
Mr N. B. Fippard, Hastings	158

OPENING

The Chairman, Mr L. P. Chapman:

It is my privilege to welcome you all to this conference—the tenth to have been held here at Lincoln College.

During this conference we will hear much of the word “research.” Perhaps it has struck you, as it often has me, that much scientific research is but a painstaking way of proving what the observant farmer already knows. Though this may often be true—particularly in the field of stock management—it does not nullify the value of such work, which gives us the whys and hows of what underlies our observations. It is this team-work, of detailed study on the one hand, and of keen observation and readiness to adopt new ideas on the other, which makes for the happy relations existing between the agricultural scientist and the farmer.

Another expression of which we all hear much is that of “maximum production”—particularly in relation to overseas exchange. Now, though we are all aware of the desirability of earning the greatest possible amount of overseas exchange, I feel that we, as farmers, should look somewhat critically at what use is being made of this increased exchange that we are urged to produce.

Our fundamental aim in farming, it seems to me, must always be to grow healthy stock or produce of the highest quality, at a cost that our world markets can afford, and to show the greatest net profit at the same time as we maintain or improve our land. When these basic conditions of optimum production are fulfilled, let us then produce to the maximum that individual incentive and national improvidence will allow.

It is with this aim of more efficient farming that we gather year by year to attend this conference.

Mr W. H. Gillespie, M.P., Chairman of the Board of Governors:

The Board of Governors, staff and members of the College generally, cordially welcome you to your tenth annual conference and it is again, of course, my privilege to extend that welcome to you. . . .

I noted several days ago, and felt very concerned, that registrations for this conference were a little over 200. I was glad to learn this morning when I arrived that a rush of registrations came in at the last minute and there are now well over 300 present and I want to offer you my warm congratulations that so many of you see fit to come to this very, very important conference and take part in the general discussions that take place.

I thought it might be pertinent because of what was told to me a few days ago to make some reference to the fact that latterly the Department of Agriculture has organised a similar conference lasting three days at Invermay, and Federated Farmers this year organised a smaller conference at Blenheim lasting two days. I felt when I learned there were only 200 registrations that perhaps these conferences had had some effect on this one and I felt if it was going to be the pattern in the future that we were to have similar types of conferences held in different places then the time will come, and I hope it does not, there will be no necessity for this type of conference here at Lincoln. I thought you might want to give some consideration to it, and I put forward the idea for your consideration: that is, whether it is not better to have a conference of this type where so many gather together with people from wide areas coming together and pooling their ideas rather than having a series of smaller conferences dotted around the country. If it was decided to have the smaller

type of conference then, in my opinion, we could not expect the outstanding people who work in research fields in various parts of New Zealand to travel long distances to put in the time of preparing papers and that kind of thing for this type of conference. . . .

If we are not able to attract into agriculture more capital and labour, how can we expect to adequately service our manufacturing industries which have made such considerable expansion in the last eight or ten years? I suggest to you that the future is not going to be very bright for these industries or the people to whom they give full employment if we in the farming industry are not able to increase and expand our production and, on top of all that, I believe it is going to need all the ingenuity of those who work in research fields pertaining to agriculture.

With all the work that is done in research fields I believe the main problem is to get the ideas over to those people who are on the practical end of agriculture—the fellows who work in the field—and it will be their job to put these practices into operation if we are going to make the progress which I hope we will make in New Zealand in the years that lie ahead. That is, I suggest to you, the objective of this conference and I take the opportunity of wishing you all well in your deliberations, and I now declare this conference officially open.

NEW ZEALAND FARMING:

Some Recollections and Some Reflections

A. P. O'Shea, General Secretary, Federated Farmers of N.Z. (Inc.)

Kipling, who knew human nature as few people do, once said:
"Try as he will no man breaks wholly loose
From his first love no matter who she be.
Oh was there ever sailor free to choose
That didn't settle somewhere near the sea?"

With a break of seven years during which I was acquiring a degree, I have now been connected with farming over a period of more than 40 years. For 33 years I have worked for farmers or for farming. This, in spite of the fact that some people will tell you that the farming community are not good people to work for. Perhaps I might not have lasted for 30 years with other types of employer.

Farming is still my first love.

Let me apologise now, for the first part of my remarks will contain much of the first person singular. But I want to trace the course of farming as I have seen it, and to make some observations on its development and on some things that may possibly influence its future. Hence the title I have chosen—"New Zealand Farming—Some Recollections and Some Reflections." That makes it necessary to refer to my history.

THE RECOLLECTIONS

My first recollection of farming business must be of an incident about 1908 or 1909 in North Otago. The owner of the place came in in high spirits and told his wife that he had got the highest price in the district for his lambs—12/-. As a boy I spent many holidays on farms. With misguided zeal I learnt to milk. In the 1916-17 and 1917-18 holidays, I did some harvesting near Geraldine. In 1919 I went to Ruakura for a year as a cadet. It was here that I first saw A. H. Cockayne with Bruce Levy, his assistant, carrying a mason jar to collect some specimen or other. At a farm school I can remember A. H. saying, "The South Island farmers say that the North Island farmer doesn't farm, he only grows grass. The South Island farmers will learn how profitable this practice of grass growing is, and they will be pleased to copy it." How right he was. I also remember his reply—"Feed the land"—to a question "How do you get rid of weeds in pasture?" From Ruakura I went to South Otago, and for two and a half years I drove a team—six horses in the paddock and seven on the road. Our big activity in the district was oat growing, and I can still see from half way down the hill the wagons loaded with oats converging from the side roads on to the main road. In those days Otago supplied, in the form of the oat, a large proportion of the motive power of the Dominion. The oat was a most important part of our economy. I was reminded by Mr Percy Smallfield that when Ruakura was started, one of the big jobs it faced was the production of a rust-resistant oat. This was tackled by A. W. Green, and the Ruakura oat was bred and selected. Some of us have seen and driven binders which created a huge wave of red dust, and have come home at night looking like the popular picture of Mephistopheles. Usually such crops looked like the thatch of a red-haired man who had been in a fight with bottles—they were lying in all directions. Oat growing was not altogether a simple or easy

activity. But it was a very necessary one. It was actually when I was in South Otago in 1922 or 1923 that the big move towards the adoption of motor lorries in place of horse-drawn vehicles took place, and the oat-growing industry lost its importance. Here I would like to make an observation. Had we endeavoured to stick to horse-drawn vehicles and the oat industry, we would have been doing, in principle, what our Governments have been trying to do for a considerable period, i.e., to keep New Zealand as self-contained as possible. The difference is only in degree. We are told from time to time by our Industries and Commerce Department, "You cannot import that plant or that implement—a similar article that is made in New Zealand can do the job." The first time I encountered this, I may say, was in 1939 when imports of manila plough-line were prohibited. I pointed out then to the Department that the person responsible for the decision had obviously never tried to drive a six-horse team on a wet day. Apparently no one was aware of the painful effect of wet flax rope on the hands. The idea, of course, was to help local industry, and to save overseas exchange. But we could have helped local industry and saved much more foreign exchange if we had prohibited the importation of motor trucks and stuck to horses. And we would have provided a great deal of employment. At the same time, of course, we would not have achieved the efficiency in primary production we have achieved, nor would we have had the expansion. I suggest the analogy is worth reflecting on.

On the farm I was on we had to put the plough over the whole farm once in every five years. The reason was: that was the life of the pasture; in fact you were lucky if it lasted five years. A few years ago I was back in the district, and was told that the then owner of the place did not own a plough! Such has been the effect of topdressing and certified seeds.

In 1921, 17,100 tons of phosphate rock were imported into New Zealand although, of course, three or four times that amount of basic slag was brought in. By 1929-30 approximately 300,000 tons of phosphatic fertiliser were being used. That period marked the big swing towards intensive grass production and management. Today we are using an amount approaching 1,000,000 tons. It always seems to me that the contribution of A. H. Cockayne to New Zealand's farming has never been properly recognised. After all, he was really the "father" of grassland farming in New Zealand, but, as happens in so many cases, his time was well before that of the people who recognised the result.

There is a consequence of the advent of the motor truck which, though small, is sometimes forgotten. It made possible the use of concrete on the farm to a much greater extent than was previously the case. When it took a two-day trip with a horse waggon to obtain a load of gravel, concrete was used very sparingly. The motor lorry changed the two days to two hours. It was a big thing for many farmers.

From South Otago I went to Glenorchy at the head of Lake Wakatipu to shepherd on the high country. In those days the Merino was regarded as essential. Today the move is towards half-breds. The older men in the area had a distrust of half-breds because they said, "A really 'old-man' snow will mow down half-breds like a binder mows down oats." We have not had an "old-man" snow for a long time, so we are unable to judge whether or not their distrust was justified. I suppose that rising costs have made it necessary to get a return from the carcass as well as from the wool. Only time will tell whether the change has been worth while.

From the Wakatipu I went to Gisborne where I was for nearly five years on reasonably-easy hill country. I was amazed by the fact that pasture was virtually permanent. The ryegrass on the road

verges in Hawkes Bay and Poverty Bay was a change from the brown top in South Otago. It was a first impression that remained with me. That was permanent grass; later we were going to approach it by way of certification. The only other place I had ever seen ryegrass verges like this was in Central Otago. On the verges in the more fertile areas in the South Island, cocksfoot, of course, was the dominant grass. Those were the days of relatively-new bush-burn country on the East Coast north of Gisborne. The Coast sheep at that time were strong, big-boned sheep. A few years ago when I was on a visit to Gisborne, I went to a sale at Matawhero. I was most surprised to see the Coast sheep then. It was a lesson to me about what happens when fertility is drained from the land and nothing put back. The people of this country will have to realise that they have a vital interest in this business of fertility. Heavy taxation may be able to be borne by the better land, or land that has been brought up to a reasonably-high state of fertility and maintained at it. But high costs make the task of the man on the more-distant poor land an almost impossible one.

Poverty Bay saw my introduction to pedigree Romney sheep. The station on which I was employed had a Romney and a Southdown stud. There were three stud rams—one from Matthews, one from Short, and one, I think, a Perry. They were three entirely different sheep, both in wool and in conformation. Some twelve years later when I attended the stud ram fairs at Feilding and Masterton for the first time, there had been a tremendous change. On a superficial examination it seemed that the animals had all come from the same flock. In the intervening period, the Romney breeders had worked hard at their standards. It was a real surprise to me. When I visited the home of the Romney in Kent in 1947, I found what to me seemed very considerable variations in type in their sheep. I realised, however, that it merely high-lighted the success in achieving uniformity that had attended the efforts of New Zealand's Romney breeders.

But the Romney breeders have achieved a great deal more than uniformity. They have evolved the most profitable dual-purpose sheep in the world. New Zealand is the only sheep farming country with predominantly meat sheep where the sheep industry does not have to be supported by public funds. Over the last ten years, with one exception, our receipts from exports of wool have come to over 50 per cent. more than the value of all our meat exports combined. The credit for this must go to the Romney sheep and its breeders. It has been a great effort.

Since I left Gisborne over 30 years ago, there have been far-reaching developments in farming. The first was the introduction of the chilled beef trade to New Zealand. At one time it was considered it would change our pattern of beef production very considerably, but its impact on the industry has not been as great as was anticipated. Then we have had the electric fence. The breeding of plants and grasses has steadily progressed. One result has been the shift of the cocksfoot seed growing from Akaroa. But the development of certification has had tremendous influence. It has enabled farmers to be sure that their pastures would hold productivity, persistence and palatability. I would like to refer to the work of the Crop Research Division and of Grasslands. The successes of the Division in solving farmers' problems are perhaps the least publicised activities of any agency helping the farmer in New Zealand, but I can recall that they had spectacular success with club root and with improving strains of wheat. Shaking is one instance that comes to mind. Grasslands has given us better grasses and clovers and ones that will persist. But apart from any dramatic discoveries such as trace-element deficiencies and those I have mentioned, there has been a steady advance in techniques which have been largely fostered by

the good work of the Departments of Agriculture and Scientific and Industrial Research. All these things are cumulative. Then, of course, we have had the founding of Massey and the transfer to University status of Lincoln College.

Over the 40 years there has been a steady increase in production per acre per annum and per labour unit, which reflect also the progressiveness of the New Zealand farmer. When aerial topdressing was first mooted, I must confess I was sceptical that it could ever be an economic proposition. I was proved wrong—very much so. But without the favourable prices from 1950 onwards, I doubt whether we would have had real development of this practice. In 1951, 45,000 tons of fertiliser were spread; this doubled in 1952, and the rate steadily increased until 1956 when it was over 400,000 tone. The effect of lower prices has been seen in 1958—not only of lower prices, but also of heavier taxation. The initial stimulus of 1951-52, however, has helped to establish the practice.

In my day in Gisborne, we had little in the way of disease problems. But intensification of stocking has apparently vastly increased them. The only drenching we used to do was for worms in lambs in occasional years. Today the sheep farmer seems to be engaged in a perpetual round of ramming things down sheep's necks or poking them into their carcasses with a hypodermic needle.

The other great development in farming has been in mechanisation. This is a much later development than is generally realised. It was the war that stimulated mechanisation in the first place, and the general scramble for labour, particularly off the farm, that intensified farmers' efforts to mechanise. In 1927 there were 2,500 tractors on farms, in 1937, 6,500, in 1947, 21,000 while in 1957 there were over 71,000. And we have seen over the years continuing improvements in mechanical aids for hay and silage making, crop planting and harvesting.

The big development, however, that influenced farming was one that took place off the farm, and to which I referred earlier—the adoption of the motor truck as a means of transport. It made possible the metalling of roads, and it very soon ousted the drover. It would never have been possible to have metalled roads economically without the motor truck. The whole process in turn stimulated liming and fertilising, and New Zealand became the most efficient producer of animal products in the world.

I have made little reference to dairying, but the big revolution in dairying—the change to machine milking—had largely been effected when my association with farming began. Since then, of course, we have had big developments. Dried milk is one. It was just getting started in 1919 and the Glaxo factory at Matangi was a source of keen interest to dairy farmers. Casein, of course, has come, so has A.B. and also tanker collection.

Summed up, then, I would give the developments I have seen in farming in the last 40 years as follows:

1. The swing away from arable farming, and the acceptance of grassland farming as a nation-wide policy.
2. The advent of the motor truck that helped to make this possible.
3. The development of seed certification that gave us permanence in our pasture.
4. The development of the best dual-purpose sheep in the world.
5. The general establishment of mechanisation, including aerial farming.

Now, I hope that no one is going to get up and say you have missed out such things as herd testing, stoopless milking and other modifications of milking shed design and the electric fence. These are important, but they were evolutionary not revolutionary. They were coincident with the five major revolutionary developments I have enumerated.

REFLECTIONS

My first reflection is that after 40 years, and with all the talk about secondary industry, New Zealand is even more dependent on prosperous farming than it was 40 years ago. The reason is that if farming cannot bring in the raw materials for the factories, in addition to our being short of goods, a great number of people would be short of jobs. Before the days of the bulldozers and carry-all, public works could provide jobs. This is not the case today. This is a change that some of those in authority might ponder.

We have evolved the most efficient forms of sheep and dairy farming in the world. Some people will tell you that this is because of our climate. Those of us who have seen the north-west of America know that this is not the whole story. It is always a puzzle to me why more people in this country are not prepared to ponder the fact that we have streamlined our sheep and dairy industries to make them the most profitable undertakings of their kind in the world. Some people, of course, do realise this, but they think that farming is so efficient that it can carry any weight of costs at all. I would suggest that these people think again. If ever farming is forced on to the public funds of this country, it will never come off them. That has been the experience in all countries where that has happened. The result will then be a poor standard of living for all of us. But the only thing that can force farming on to the public funds is if it is asked to bear too heavy a load. There are signs that that is happening already with our poor land. New Zealand is no longer a low-cost country. In fact Australia, Sweden, U.S.A. and New Zealand are, I should imagine, the four highest-cost countries in the world.

When I realise the difficulty of getting major questions examined dispassionately, I sometimes become afraid. We are a practical people, and our general practice is never to tackle a problem until there is no escape from doing so. Empiricism is a main principle with us. We are seldom prepared to look at the principle behind anything. It was quite obvious to us on the Facial Eczema Fact-Finding Committee that the problem of facial eczema had never really been subjected to general discussion. It is a great weakness with us New Zealanders that we are neither fond of, nor good at, general discussion. We talk at people better than we talk with them. I think it is because we don't practice the art of discussion enough. We are very good at the type of thing we are having here today, but that is not the best way of solving problems. Don't let it be thought that I decry such gatherings as this. They perform a most valuable function. I believe, however, that we would get much greater value from them if they were supplemented by discussions among smaller groups.

Walter Bagehot in his "Physics and Politics" said of discussion: "Once effectually submit a subject to that ordeal, and you can never withdraw it again; and you can never clothe it with mystery, or fence it by consecration; it remains for ever open to free choice and exposed to profane deliberation."

A man who had occupied high Cabinet rank in this country once said to me, "The hardest thing in the world is to get a subject discussed critically, exhaustively and dispassionately."

Let me take five matters that I believe could profitably be the matter of intensive discussion. They are:

1. The best policy of economic development for New Zealand.
2. The size of optimum farm unit on various types of country.
3. The advisability of trying to make the Romney breed more fertile.
4. The possibility and advisability of expanding our beef-cattle population.
5. The steps necessary to expand our markets for primary produce.

1. The Best Policy of Economic Development for New Zealand:

From time to time we hear *ex cathedra* statements that we must have more secondary industry to provide jobs for an expanding population. Now it is quite obvious that the people who make these definite statements have never really critically examined the situation. I would doubt very much whether or not one person I have listened to on this subject has ever set down all the facts on paper, and then endeavoured to draw conclusions from them. There are certain questions connected with this problem that really require an answer, but which I am quite sure have never been considered. The first is, "At what level of costs will the operation of our export industries become difficult?" Then it should be asked, "Can we continue to operate a policy that keeps the railways short of staff, that makes it difficult to operate our hospitals, that means we are always short of teachers, and that makes it impossible to staff our prisons?" These things are surely matters of vital importance for everyone in the community. Then there is the matter that I have stressed on numerous occasions. Would it not pay us to have a look at the return we would get by providing all-weather round-the-clock loading of ships as compared with the return from setting up industries that require heavy or complete protection to keep them in operation? Are these not admirable matters where frank discussion would be profitable?

2. The Size of Optimum Farm Unit in Various Classes of Country:

Over the years as long as I can remember, we have had a policy of cutting up properties to settle more people on the land. But no one can tell accurately whether this policy has been a sound one. In certain cases we know it has not been. The settling of the foothill country of this province after the 1914-18 war is a case in point. We know, of course, that conditions change as the years go by. Surely, our object should be to encourage farms of a size that will produce most efficiently, i.e., that will produce the greatest amount of produce with the smallest amount of labour. When I was a boy in South Otago the 500-acre farm was regarded as the optimum size in that particular area. The reason was that it kept a six-horse team comfortably utilised. So you grew in multiples of 500. On the country referred to, a four-horse team could not quite handle the going. The 500 acres was a rough and ready standard. Today there is a belief that the optimum size of unit for a dairy farm is between 70 and 120 cows, that the minimum size of unit for a sheep farm is 1,000 ewes, and we know that the optimum size increases as the distance from markets increases and/or the fertility decreases. But if we are to have sound land settlement and taxing policies, should we not know the facts? They would not be really difficult to ascertain. And what do we really know about the ratio of income and expenditure to capital invested? One other thought I would leave with you—land settlement has been most successful, and there have been few failures, when Governments have acquired land voluntarily.

I put it to you that these are matters for dispassionate examination and discussion.

3. The Advisability of Trying to Make the Romney Breed More Fertile

Of recent years we have had regular exhortations from different people on the need to make the Romney more prolific. Now as far as I know, the Romney is the same breed throughout New Zealand. In Southland they have high lambing percentages as good as, if not better than, they have in the home of the breed in Kent where they claim 125 per cent. as normal. Now it would appear to me that no one has taken the trouble to sit down and plot all the facts so that

they could be examined and discussed. But I do know this. Over a good deal of the hill country of New Zealand, particularly on the East Coast, a high lambing percentage is a very mixed blessing for two reasons. The first is that twins or triplets call for a much higher standard of shepherding. The second is that because of the dry weather that usually sets in by mid-January, it is advisable on this country to get your wether lambs away fat by that time. This calls for an early lambing with the hazard of losses. It also calls for putting out rams early, again with the risk of not achieving the greatest efficiency. But suppose there were a general successful drive to achieve higher percentages, what would happen? In many cases there would have to be more intensive shepherding, and, in addition, it would probably be necessary to grow feed on many places where it is not attempted today. These things cost money. It would be possible that the extra return would not cover the increased outlay. We are inclined to forget that our whole prosperity is founded on our high output per labour unit on our farms. Then again, I have seen some of the very prolific breeds in Britain and U.S.A. As a wool-producing proposition, they cannot hold a candle to the Romney which has proved itself the best dual-purpose sheep in the world—easily the most profitable. It seems to me that here again is a valuable subject for detached examination and discussion. I would hate to see any action taken to interfere with one characteristic which could have the result of altering other characteristics for the worse. That is not to say that we should not always be trying to improve everything but surely it would be wise to examine all possibilities before trying to interfere in a radical way? I always remember an incident in a Ford garage in 1923. A man brought in his Model T which was making a noise like a dog being sick. He explained to one of the joint proprietors, "She was running like a sewing machine until I took the cylinder off and decarbonised her." The proprietor said, "Haven't you got enough sense not to interfere with a car when it is going well?"

4. The Possibility and Advisability of Expanding Our Beef Cattle Population

We hear also from time to time unconnected, loose, general statements to the effect that we should increase our population of beef cattle. Let me say that I agree wholeheartedly that if this can be done economically it would be an excellent move. But there are one or two snags in it. For one thing the return per acre from beef cattle is nothing like the return from sheep. The author of the earliest book on English farming, Anthony Fitzherbert, said: "Shepe in mine opinion are the most profitablest cattle that any man can have." We have discovered this for ourselves. Also we are apt to overlook the fact that if a farmer decides to increase his herd, he has to stand out of a return of income for a considerable period. On the East Coast the big problem is water. I was there in the 1926 drought. Most of the easy collection areas for dams have now been utilised, and there is no need to point out the huge cost, if not even the impossibility, of putting dams in gullies on broken country. They had 11 inches of rain in three days at Gisborne last month. Then in the South Island there is the cost of the better fencing required. We are inclined to forget that 80 per cent. of New Zealand is hilly or mountainous. Farmers usually carry as many cattle as they can provide for by saving pasture or by providing winter keep. As our pastures improve, and as more winter keep can be provided economically, we can expect a corresponding rise in our cattle numbers. I would observe, however, that New Zealand farmers are usually quick to perceive profitable practice. However, it may be that in the aggregate, the position would be in favour of greater beef production.

I don't know. I merely suggest again that this is a subject eminently suited to a close examination and to discussion by well-informed and competent people. It would also pay to examine and estimate the aggregate increased national cost of such a policy as compared with the cost of a policy of really getting to work to sell our lamb. In my own mind, I have little doubt as to what the result of such an examination would be, but should we not have the facts established?

5. The Steps Necessary to Expand Our Markets For Primary Produce

From time to time we hear very definite statements about how we should tackle the problem of expanding our markets for primary produce. But I will make this statement with confidence. There are few people who are aware of all the facts as applying to any one particular market let alone to all of them. Surely this is an example *par excellence* of where careful examination, plotting of facts, and well-informed detached discussion, would pay dividends. I do not claim to know anything of countries other than U.S.A. Here I do claim to know one thing, and that is that the whole matter is exceedingly complex, and that the solution cannot be found in any one single course of action. But I do know this—you can take it that where we have a problem in selling our produce, it is always, in the first place, a political one. Again, to quote Bagehot, "Discussion, too, has incentives to progress peculiar to itself. It gives a premium to intelligence. To set out the arguments required to determine political action with such force and effect that they should really determine it, is a high and great exertion of intellect." That is really what we need more than anything else in determining what we should do if we are going to expand our markets. The job is a huge one. I suggest that no exercise we could indulge in would be more fruitful, than discussion on this matter. If we are to succeed—and goodness knows we are urgently in need of success in the matter—we shall need team work between all parties concerned. Yet we have never really had this. I suggest it would be well worth while to discuss the question.

Now I have set out five matters in which I consider that careful examination and intensive dispassionate discussion would pay profitable dividends in the national sense. They are only a few of the things that, on reflection, I have come to the view it would pay us farming folk to examine and discuss. They are not matters that initially could be profitably discussed in a large conference, but examination and discussion by a small group would pave the way for such an activity. By achieving this, I believe we could perform a service of real value, not only to the farming community, but to all the people of New Zealand.

Now I would like to thank the committee responsible for inviting me to be present, and to deliver this address. I consider it to be a very great honour. In the second portion of it, I have said some things that will be regarded as controversial. I usually do. But if I have said anything that will lead to closer examination and real discussion of these and other major matters affecting this country, I shall be very well rewarded. After all, I am now getting to the stage where I consider I can, with some justification, be entitled to regard the farming community as a very close relative, and you do like to see your relatives flourish. Is that not why we are all here?

SELF-FEEDING OF SILAGE IN BRITAIN

T. G. Tyrer, N.Z. Dairy Exporter, Wellington.

Self-feeding of silage is basically only an extension of the grazing principle into another field of farming practice. Professor M. M. Cooper, the distinguished New Zealander who is Dean of Agriculture at Durham University, recently found a new name for self-feeding and it's a good one. He calls it "vertical grazing."

This buffet bar, or cafeteria system of feeding silage has the big advantage that you bring the cows to the feed, rather than the feed to the cows. It saves a lot of hard work by eliminating the heavy and frequently messy work of feeding out silage in the paddock. My early farming experience was on a hill-country sheep run and so I have never fed out silage on a wet, cold winter's day. But in the past 28 years as an agricultural journalist, I've been on a great many dairyfarms when they were doing this job and have seen and heard enough to realise why it's a most unpopular chore with most farmers and farm workers.

That is why I've been particularly interested in self-feeding since I first heard of it being practised in Britain. There are obvious advantages in a system where the cows help themselves to the silage at the point where you have made it. When they are self-feeding, your contribution is confined to cleaning up the relatively small amount of slurry which collects on the feeding platform over 24 hours and doing a proportion of their manure spreading for them. British experience has shown that when properly organised, this is a relatively light job and takes very little time. As one British dairyfarmer put it to me: "Compared with cutting silage at the face, carting it and feeding it to the stock, it's a cake-walk."

Over the past three winters in Britain, self-feeding has gained more support every year amongst milk producers. Last winter, it was used to provide the bulk ration for winter milk production on about ten per cent. of British dairyfarms which run herds—or on about 16,000 farms.

I arrived Home ahead of the snowdrops last year so that I could see something of self-feeding in operation. I would have seen much more had the winter not been such a mild one and the spring so early. Many of the herds were out to grass some weeks ahead of normal time, but I visited eight farms where the cattle were still feeding at the silage face and later I talked with many more farmers who practise self-feeding and saw their organisation.

Because I went mainly on to farms which were in the higher production bracket, it could be suggested that what I learned about self-feeding over there came from a selected sample. Be that as it may, the fact remains that I did not meet a single farmer who was self-feeding and who was not enthusiastic about it. They have proved that it's a most efficient way of providing cattle with their winter bulk ration. It frees labour for winter maintenance jobs, reduces waste to a minimum, cuts costs, and once adequate facilities have been provided, it's very simple to operate.

I feel that I should say something here about the question of self-feeding and mud. I do this because apparently there are still some dairyfarmers in this country, who when you mention self-feeding have a vision of a silage clamp sitting up like Kapiti Island in a sea of mud, dotted with cows' heads. The answer to that one is that if you set out to self-feed on land where mud is a problem in the winter, without providing a weatherproof surface for your feeding platform and approaches, you are obviously going to have a sticky mess on your hands. Self-feeding in the paddock is only suited

to really free-draining soils. On all other soil types, you need to provide a firm, hard surface for your clamp and its approaches. Thousands of British farmers and a few New Zealanders, too, have proved that if you do that, mud is no problem.

The majority of British dairymen who are practising self-feeding were previously stall-feeding silage to their herds, which were housed in byres during the winter.

There are two main types of self-feeding installations in use in Britain. The most popular method is the concrete yard, with a single or double-ended wall clamp built on a concrete base. The side walls are built either of solid concrete, or concrete slabs, or railway sleepers. These silos can be either roofed or in the open, but roofing is favoured because it is easier to make good silage under cover and a roof provides more comfortable conditions for the cows at the face. British farmers get a subsidy towards the cost of building their silos and this no doubt has a bearing on the number of roofed silos constructed.

Adjoining the silo in most of these arrangements is a covered yard with a concrete floor on which straw or sawdust is spread as bedding for the cattle. As this becomes trampled and fouled, it is built up with fresh material and by the end of the winter it has attained quite a considerable depth. The usual practice is to clean out the mixture of dung and straw when self-feeding is completed and cart it out as dressing on land to be cropped.

The silo and covered yard are usually handy either to a milking parlour, or to a moveable cow bail, which is brought into the concrete yard for the winter self-feeding period.

24-Hour Access

The great majority of self-fed cows in Britain are given free access to the silage face over the 24 hours, apart from milking times. All the farms that I visited were operating this system. The cows come and go at will between the covered yard and the silage face. With this system, a study made by workers at the West of Scotland Agricultural College showed that the average cow spent between four and four and a half hours feeding in each 24.

Amounts Eaten

Estimates of the amount of silage eaten per cow per day on the farms that I visited varied from 80 to 90 lb. In a self-feeding survey carried out by the Milk Marketing Board, however, they found that because of the variations in density of silage from farm to farm, it was not practicable to assess consumption by weight and their figures are quoted in cubic feet. The average daily intake of silage per cow was a little over two cubic feet, although this included a proportion of dry cows. On practically all British farms where they are self-feeding silage for milk production, they are also feeding some concentrates.

The milkers covered in the M.M.B. survey were fed an average of 3.2 lb. of concentrate per gallon of milk produced.

While the amount of concentrate fed varies quite considerably from farm to farm, it is generally accepted that, on average, around 3½ lb. of concentrate is fed for every gallon of milk produced over the year on British dairyfarms.

Paddock Self-Feeding

The alternative to self-feeding on concrete and loose housing under British conditions is the Rex Paterson method of paddock self-feeding, where the cattle are out-of-doors all through the winter. This is suitable only for free-draining soils. He has been using it successfully for three winters on his Hampshire farms with a chalk subsoil and also more recently on his Welsh properties, where the subsoil is stony.

With this system, the mud-forming surface soil down to the chalk is scraped with a tractor blade from an area large enough to accommodate the clamp and a standing area to the front. For each of his herds of 65 cows, Rex Paterson provides a clamp 40 feet square and about six feet high when the silage has settled. The surface soil scraped off with the blade is used to build a ramp at the back of the clamp, and two side walls which are lined with railway sleepers.

He feeds kale plus some straw and concentrate for the first half of the winter and then, in early February, the cows commence unrestricted self-feeding of silage for a period of about eight weeks until early April.

When not feeding at the face, the cows lie out on an adjacent area of four to six acres on which straw is spread for bedding and to keep down the mud. Tracks are scraped from this lying-out area to the feeding face and a single electric wire is used to enclose the whole arrangement. Over this period, apart from silage, the cows get a small ration of concentrate at the rate of three pounds per cow per day. Rex Paterson never feeds more than this daily quantity and his concentrate feeding is restricted to seven and a half months of the year. His herds are averaging around 600 gallons per cow, which is 150 gallons below the national average, but these are low-cost gallons and he is interested in net returns rather than high production at high cost.

Top Feeding

The alternative to the two methods of self-feeding described above is top-feeding in the paddock. With this method, a double-ended wedge is built on a flat surface of grass and the cattle climb on top and eat their way down through the silage. In general, however, top-feeding is regarded in Britain as suitable only for the wintering of dry stock and it requires a very free-draining soil, otherwise the build-up of mud in wet weather at both ends of the clamp will cause trouble.

From what I saw of it in Britain, I believe that self-feeding at the face is the most suitable and efficient method for general adoption in New Zealand.

Further Self-Feeding Points

There are a few further points about self-feeding in Britain that should be mentioned.

With 24-hour access, the generally accepted allowance for width of face per cow in Britain is nine inches, although on the farms that I visited the allowance varied from 7½ to 11 inches.

The height of feeding face aimed at is six feet of settled silage, but Friesians and Ayrshires predominate in British dairy herds and I should imagine that five feet would be adequate for Jersey cows. If the face is too high, the cows cannot reach the top layer and you get an overhang which has to be cleaned off with a silage knife. If too low, there is the risk of them clambering on top of the clamp.

On all the farms that I visited, they used some method of restraining the cows from delving too deeply into the face. A single electric wire stretched across the front of the face about halfway between the top and the bottom, and about a foot out from the face, is quite effective for this purpose.

Quality and stage of maturity of the material in a clamp for self-feeding should be as even as possible. If it is not, a layering effect is produced and some of the cows tend to leave the more-mature material uneaten.

The Slurry Problem

Whether face-feeding is practised in concrete yards or on a scraped surface, the general practice is to clean off daily any slurry

that has accumulated on the feeding platform to the front of the face. The amount of this material that accumulates in 24 hours is relatively small and it is a matter of only a few minutes to scrape it off the surface of the platform with a blade, or a bale of hay or straw impaled sideways across the tines of a buckrake.

Many farmers allow this material to accumulate in a heap for some weeks and then cart it out and spread it on the ground to be cropped in the spring. The most efficient method of slurry disposal that I saw in Britain was on the Wiltshire farm of Mr J. S. Morrey who has a concrete ramp at the end of each of his feeding platforms. After cleaning each day, the slurry is pushed up this and dropped into a low-slung rubber-tyred cart, with a tipping mechanism which can be operated by the tractor driver. It is then carted out daily and spread on pastures which have been closed up for spring grass. With the tractor moving at slow speed, the material is spread on the pasture without the driver leaving his seat. The body of this cart or tumbrel, was made from half a circular water tank, cut down the centre from top to bottom. With this equipment, the job of spreading slurry takes only a short time, involves no hard work, and the tractor and tumbrel with their light load do not damage the pasture.

Place in New Zealand

I am confident that we will see a big increase in self-feeding of silage on our dairyfarms in the next few years. As I see it, self-feeding can be used in three ways under our dairyfarming conditions:

1. For the wintering of in-calf cows on factory-supply dairyfarms.
2. For the provision of the bulk ration for winter milk production on town-supply farms.
3. For the feeding of milking cows in the last few weeks of their lactation on factory-supply dairyfarms in those North Island districts where climatic conditions make it possible to adopt the "Wallace technique" and winter the in-calf cows mainly on spelled grass.

As to whether free access over the 24 hours, or restricted feeding is practised will depend entirely on the circumstances on the individual farm. If restricted feeding is practised, the width per cow allowed at the face will, of course, require to be substantially increased.

Meeting Our Needs

There is, of course, a great deal of difference between the conditions under which the British winter-milk producer operates and our dairyfarming conditions in New Zealand. I am not suggesting that British systems for self-feeding are suitable in their entirety for adoption here. I think that we will have to work out our own destiny so far as self-feeding is concerned and produce modified systems to suit our conditions. And what may suit the pumiceland dairyfarm of the North Island certainly would not be suitable on the heavy soils of the Taieri Plain in the south.

A number of progressives have already made a start with self-feeding and with the resource and initiative available amongst our farmers and research workers, there is no doubt that either the British systems will be tailored to fit our conditions, or new systems will be evolved.

I believe that the Rex Paterson system, or something very similar, for self-feeding in the paddock might well have a place on some of our really free-draining soils in the North Island, more particularly in some of the pumice areas.

Other than on really free-draining soils, however, some form of weatherproof surface for the feeding platform, with weatherproof access from the face to a lying-out area will be essential. The most

satisfactory base for self-feeding is undoubtedly concrete, but solid concrete has the disadvantage that your self-feeding site is permanently anchored in one spot, and that may not suit the book of every dairyman.

If a weatherproof surface for a feeding platform can be evolved which can be picked up and removed to another site if required, this would be the ideal. Dr McMeekan and his team at Ruakura are already "on the ball" in this direction. This winter at Ruakura they will be testing out self-feeding on a base constructed of concrete slabs. The dimensions of these are about five feet by two feet and a ring bolt is set in the centre so that the slab can be lifted with a front-end loader or a buckrake. As an alternative to this, they are also planning to test out restricted feeding on each side of a clamp, dropping the timber side-walls and using the inside surface as a feeding platform.

If either of these methods proves successful, we will have taken a big step along the road towards fitting self-feeding to the wide range of conditions found in our dairyfarming districts from one end of New Zealand to the other. There are numbers of farmers at the present time who see the advantages of self-feeding, but are waiting before making a start in the hopes that a satisfactory feeding surface that can be shifted from site to site as required, will be found.

The ideal location for a self-feeding stand would appear to be alongside the central metalled or concrete race on a dairyfarm, as Mr Hector McIntosh, Dairy Board Consulting Officer in Canterbury, Otago and Southland has been advocating for at least three years. As a run-off or lying-out area, a "sacrifice" paddock, to be worked up in the following spring and either re-grassed or cropped, would be quite suitable.

In a few cases, South Island town-milk producers have taken a leaf from the British book and built roofed silos on a permanent site with concrete floors and access. One or two have even provided roofed lying-in accommodation also.

The type of organisation and the amount of money that is spent on it, must, however, be determined by the individual farmer in the light of his conditions, needs and circumstances. I certainly would not advocate any farmer embarking on any major expenditure for self-feeding unless he was completely satisfied that it was a sound investment, and the most suitable installation for his conditions, and that the site was the best available on the farm in terms of easy working.

Additional Advantages

Self-feeding of silage can have advantages under New Zealand conditions, additional to those which I have mentioned with the system in Britain. One of these is the elimination of the waste of material that occurs when silage is fed out in the paddock under wet conditions and a proportion—sometimes quite a large proportion—is trampled into the ground by the cattle. The amount of silage that is wasted during self-feeding is very small indeed.

Winter pugging of pastures will also be either largely eliminated, or at least reduced very materially and confined to a small area of the farm. The benefits of this will be seen in increased pasture production in the following season.

VARIATIONS IN THE SOLIDS - NOT - FAT CONTENT OF THE MILK OF DAIRY COWS

M. G. Hollard, Lincoln College.

In New Zealand, according to legal definition, "Milk shall be the normal secretion obtained by emptying the udder of the cow, properly fed and kept, excluding that got four days immediately following parturition. It shall contain not less than 8.50 per cent of milk solids other than milk fat . . ."

Now, there is specific evidence to indicate that in Canterbury, and in many other parts of the world too, the compositional quality of market milk in regard to non-fatty solids, has been deteriorating over the past 30 years. In many cases, at critical times of the year, a high proportion of the market milk supplied has contained less than the presumptive limit of 8.5 per cent. solids-not-fat.

I do not propose to do more than comment here on the adequacy of the presumptive limit, and to suggest that there does seem to be considerable doubt as to whether the presumptive limit of exactly 8.5 per cent. solids-not-fat in market milk can be justified on human nutritional or other grounds. Nevertheless, the only reason for the existence of the town-milk industry is the fact that cow's milk is a valuable human foodstuff. Therefore, anything causing a decrease in its nutritional value is of major importance to consumers and producers alike.

A commendable awareness of this situation has led to an intensification of investigational work in many parts of the world on the subject of factors affecting the solids-not-fat content of cow's milk. As a result of this and earlier work, a great deal of information is now available on the subject.

Briefly, the major factors affecting the S.N.F. percentage are as follows:

GENETIC EFFECTS

Breed Averages

The best estimates available for New Zealand are:

Jerseys	9.3%
Ayrshires and Shorthorns	8.9%
Friesians	8.6%

Most cows could be expected to fall within 0.3 per cent. of the appropriate breed average and nearly all cows within 0.5 per cent. of it.

Heritability of Lactational Averages for S.N.F. Percentage.

This heritability is the proportion of the total variation in a character such as S.N.F. percentage of milk which is determined by genetic factors. Values obtained for heritability of lactational averages for S.N.F. percentage are high enough to suggest that some progress could be made in improving the S.N.F. content of the milk of a herd by selecting the parents of replacement stock on the basis of their S.N.F. percentage. However, because of low culling rates and the fairly small variation between cows within a breed in S.N.F. percentage, the actual rate of progress made with such a breeding policy will be very slow. Genetic improvement in S.N.F. percentage could be more rapid, however, if a crossbreeding policy was adopted.

Repeatability of Lactational Averages for S.N.F. Percentage

The lactational average S.N.F. percentage of individual cows is very consistent from one lactation to the next, particularly if age is taken into account. If the necessary figures were available, cows could be fairly accurately selected on the basis of their first lactations.

Relationship of Fat Percentage to S.N.F. Percentage

Examination of lactational averages shows that, in general, cows with higher fat-percentages also have higher S.N.F. percentages in their milk. The various studies made indicate an average rise of 0.2 per cent. to 0.6 per cent. S.N.F. for every 1.0 per cent. rise in fat.

Town-supply dairyfarmers are interested primarily in milk yield. While it is true that there is a small negative correlation between milk yield and S.N.F. per centage, selection of breeding stock for yield alone would not be likely to cause any great decline in S.N.F. content of the milk. Anyway, any potential decline in S.N.F. percentage could probably be held in check by paying some attention to fat content as well as yield in the selection of breeding stock.

ENVIRONMENTAL EFFECTS

Age of Animal

All studies made indicate a fall of between 0.1 per cent. and 0.3 per cent. from first lactation to maturity.

Stage of Lactation

The most accurate study made of stage of lactation effects showed that, during the first seven weeks of lactation, there is a rapid fall in S.N.F. percentage of the milk. This is followed by a rise in S.N.F. during the remainder of the lactation, slowly at first, and then more rapidly as the end of lactation approached.

Season

Highest values for S.N.F. percentage are invariably found in the late-spring period and the lowest values towards the end of winter and in hot, dry summers.

Pregnancy

The characteristic rise in S.N.F. percentage towards the end of lactation does not occur in empty cows. Hence it is likely that this rise is the effect of advancing pregnancy.

Disease

The effects of disease on S.N.F. percentage may be direct or indirect, and are variable. Severe mastitis infection may lower S.N.F. percentage by a direct effect on the udder, while ketosis, severe bloat and digestive upsets may depress S.N.F. percentage as a result of depressing food intake.

Feeding

Investigational work has shown that underfeeding of cows may lower S.N.F. percentage by up to 0.4 per cent., and that this effect is most marked in the earlier part of lactation. It is equally clear that not only bulk of feed but also quality of feed is involved. The evidence indicates that the major limiting nutritional factor is energy. In a number of experiments the S.N.F. has fallen by as much as 0.4 per cent. when the energy part of the ration is reduced to about 75 per cent. of the normal requirements for maintenance and milk production. If the reduction in energy is corrected within a few weeks, the S.N.F. percentage will probably recover to a normal level, but after more prolonged underfeeding, the low S.N.F. may not recover in that lactation. In overseas projects, very energy-rich foods such as flaked maize have been useful for raising low S.N.F. values, but protein-rich foods have been without any special effect.

From recent work on the digestion of food in the rumen, it seems likely that the enhancing effect of energy-rich feeds on S.N.F. percentage lies in the proportions of the various fatty acids produced in the rumen as a result of the digestion of the feed by the microflora of the rumen. It may mean that the range of rations considered suitable for milking cows is really not quite as wide as was thought if energy-

rich feeds are indispensable in producing the necessary proportions of fatty acids required for high S.N.F. in milk. However, no doubt cows will still manage to produce satisfactory milk from a fantastic variety of feeds.

Local Studies on the S.N.F. Problem

Much of the information outlined above has been derived from the statistical examination of production records or from experiments carried out at research stations in various parts of the world. It became of interest, therefore, to make a study of dairy-husbandry practices on Christchurch town-milk-supply farms in relation to the solids-not-fat content of the bulk milk produced on these farms. The object was to ascertain whether known factors could account for the variation expected to be found in the milk produced.

Under the auspices of the New Zealand Milk Board, and in co-operation with Mr M. Hunter of Canterbury Dairyfarmers Limited, I made such a study in the winters of 1958 and 1959.

Nine herds were studied in the first year and 20 herds in the second. A close check was kept on the dairy-husbandry practices which were likely to influence the solids-not-fat content of the milk produced, and over the periods concerned the bulk milk produced on these farms was sampled and tested for butterfat and solids-not-fat content on two consecutive days weekly.

A summary of the main features which have been revealed by examination of the data collected is as follows:

Variation in S.N.F. Content

The average S.N.F. content percentage of the bulk milk from all the herds studied showed the expected decline from a value of 8.70 in March to a value of 8.37 in July. This fall was followed by a slow but steady improvement to a peak value of 8.82 in October. This general pattern was common to all herds studied.

Individual herds differed widely in general level of S.N.F. percentage. The highest herd at no time dropped below 8.75 per cent., and the lowest herd exceeded 8.5 per cent. on only three occasions between March and October.

Breed of Cattle

Included in the survey were herds containing Jerseys, Friesians, Ayrshires and animals of mixed breeding. The general level of solids-not-fat in the bulk milk of the respective herds was in accord with that expected from knowledge of the milk-composition characteristics of dairy breeds.

In the herd with the lowest content of S.N.F. in the bulk milk, over half of the cows in the herd are by the one sire; it is possible that in this case genetic factors are of some significance in determining the low level of S.N.F. observed.

Calving Pattern and Effects of Stage of Lactation

In common with all other town milk producers, the farmers concerned calved down the majority of their cows in the autumn in order to maintain the highest possible level of milk production from their herds during the winter period in the face of adverse climatic and feeding conditions.

The average situation for the herds studied is that in the months of June, July and August, when the average S.N.F. percentage of the bulk milk was at its lowest ebb, 57 per cent., 72 per cent. and 56 per cent. respectively of the cows in milk were at their lowest ebb in regard to S.N.F. percentage on account of stage of lactation effects.

Age of Cow

The composition of the herds studied was examined according to age of cow in case an abnormal age-balance had affected the overall

level of S.N.F. content in the bulk milk produced. However, it is clear from the data that this factor was of no importance in causing either high or low levels of solids-not-fat.

Disease

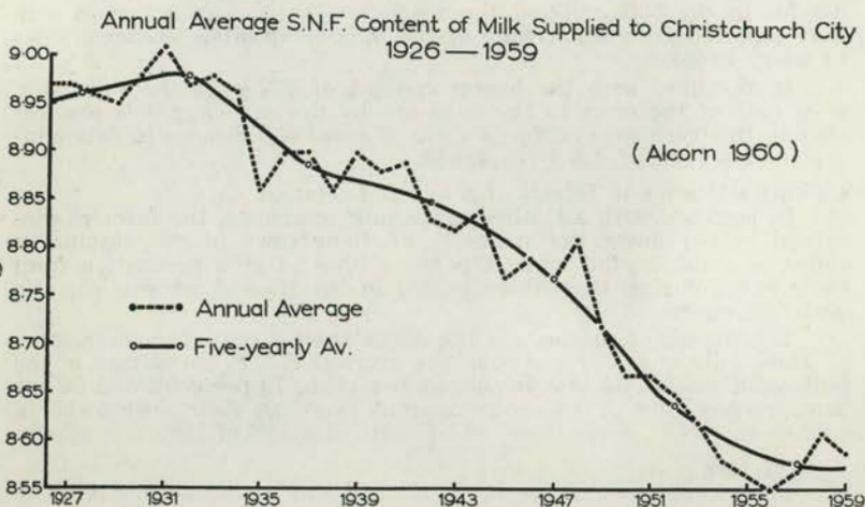
The incidence of disease in the herds studied was remarkably low and in no case could disease infection have contributed to the low levels of S.N.F. observed in the bulk milk produced.

Feeding

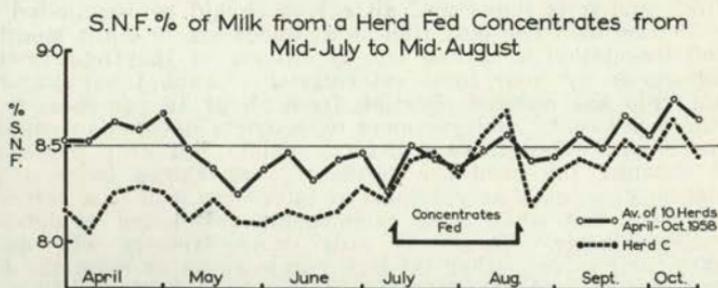
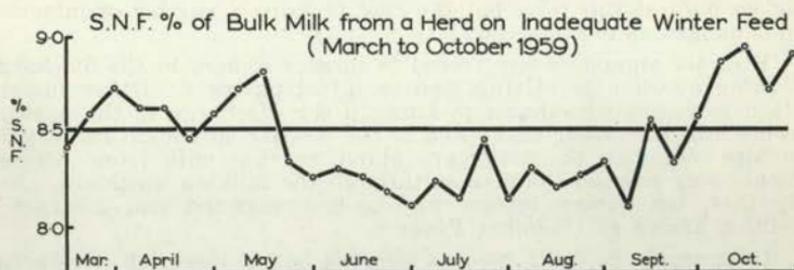
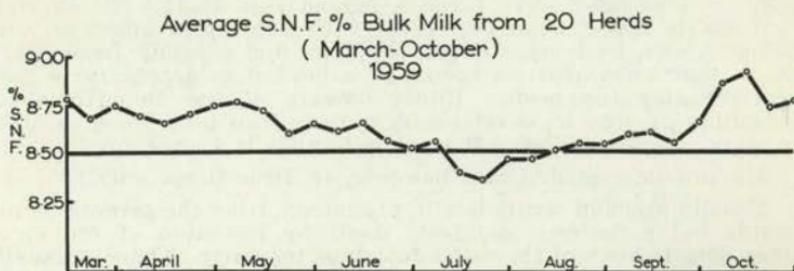
A wide variety of supplementary feeding stuffs used at a wide variety of levels was encountered. The quality of the hay and silage used in most herds was poorer than the farmers believed and the quantities of feeds supplied daily were generally much lower than would be recommended. Moreover, it was clear that as the winter progressed the intake of supplementary feed by the cows markedly declined. It is fairly certain that poor-quality feeds, inadequate rations and declining appetite with the passing of the winter months are all important factors leading directly or indirectly to underfeeding of the herds concerned.

In two herds, extremes in feeding caused gross variations in the S.N.F. percentage of the bulk milk produced. In one of these herds, in the May-June period, reliance on limited quantities of poor-quality lucerne hay supplemented by pasture pickings only, resulted in a fall of 0.4 per cent. in the S.N.F. percentage of the bulk milk produced. In the other herd the supplementing of a basic ration of farm grown feed with barley meal over the July-August period resulted in an increase of 0.3 per cent. in the S.N.F. percentage of the bulk milk produced.

Results of feeding trials at various research stations are confirmed by observations made during this survey. Of most interest are the facts that good, leafy pasture will support a level of S.N.F. above that of the commonly used winter rations; that hay and silage of average quality, no matter in what quantity, will not support what are normal levels of S.N.F. for the cows concerned; and that the addition of reasonable amounts of energy-rich concentrates to high roughage, or roughage plus root rations, will give some improvement in S.N.F. in most cases.



The possible economic implications of the findings outlined above are beyond the scope of this paper. The main point which should be made clear at this stage is that it is possible, in the present state of knowledge, to account for the greater part of the variation which is encountered in the solids-not-fat content of milk supplied for liquid consumption.



BRUCELLOSIS IN DAIRY HERDS

C. S. M. Hopkirk, Lincoln College.

Contagious abortion due to *Brucella abortus bovis* was very well known some years ago but has been markedly reduced since the introduction of a Strain 19 vaccination programme. There is, however, still a percentage of abortion in the Dominion dairy herd which could be reduced by attention to hygiene and calf vaccination, and could finally be eradicated were farmers behind this ideal. All abortion is not due to *Brucella* but may occur with *Leptospira* infection, with Trichomoniasis, from macrocarpa clippings and possibly from Vibriosis, so that when abortion occurs in a herd it is necessary to have a correct diagnosis made. Either officers of the Department of Agriculture or your local veterinary surgeon can take blood or other necessary samples and send them to a diagnostic station for a report.

We are interested today, however, in Brucellosis only.

Usually abortion occurs late in pregnancy from the seventh month onwards but sometimes manifests itself by retention of the membranes due to birth of the calf a few days too early. There is usually some discharge from the uterus arising from infection of the dead membranes. The brucella organism causes necrosis of the cotyledons, thus preventing the necessary food supply to the foetus from the blood stream of the mother, and causing death of the foetus from starvation. If the cotyledons are not too badly damaged, the calf may be born at full term but the cow remains a carrier of infection and is dangerous to other cows.

Brucella organisms are voided in large numbers in the discharge following abortion or calving, and so infect pastures. Other susceptible non-vaccinated animals picking up the discharge in the pasture become infected rather easily and so the disease spreads. The organism also lodges in the mammary gland, so that milk from infected animals may pass on the disease through the milking machines. Not only that, but human beings may become infected and contract a condition known as Undulant Fever.

Only rarely do bulls become infected but if infection does occur they may show a cold abscess affecting the scrotum and one or both testes.

There are several methods of attack to prevent the disease in a dairy herd.

First, and it is important, all calves should be vaccinated with Strain 19 vaccine. The best time is at about six to eight months of age and inoculation is carried out by officers of the Department of Agriculture or by your local veterinarian. Annual vaccination of the calf crop has reduced abortion from about 16 per cent. to less than three per cent. Dairyfarmers in districts devoted to supply of milk to towns, where there will be a double calf crop per annum, should consider the need for vaccination of calves twice a year. Vaccination of animals as yearlings or later may lead to a permanent positive blood test when blood samples are taken and so defeat an eradication scheme. There are still many farmers who do not vaccinate their calves either through carelessness or from the belief that vaccination leads to delayed conception in heifers. This is a mistaken belief because millions of calves have now been vaccinated without any suggestion that sterility may occur. In any scheme for eradication or control, the first procedure then is to have the calves vaccinated.

Secondly, if Brucellosis is thought to be present, blood samples

from all cows sent to a laboratory will show by agglutination test which cows are affected, and such cows should be isolated and finally sent to the meat works and not to the local sale yards as dairy-herd replacements. Sometimes abortion will break out in adult herds even after years of vaccination of calves. This is usually due to some newly-bought-in cow or in-calf heifer voiding large numbers of virulent organisms which may, by ingestion, break down the immunity of some members of the herd, so provoking a storm. It is a moot point whether it is better to let this storm run out or to try re-vaccination of the adult herd. I think, in the present state of our knowledge, re-vaccination would be the better course of action provided the herd is not in an area where an eradication scheme is in force. However, it would be wiser to have the bought-in animals tested at once before adding to the herd or else to buy only tested animals to safeguard against reintroducing infection.

Thirdly, in all the Christchurch metropolitan area the composite-herd-milk Ring test has been very successful in showing which herds contain infected animals. The test as applied to bulk milk is very sensitive. Following a positive Ring test, a composite milk sample from each cow is put through the agglutination test to find which cows are responsible. Cows which give a positive reaction are sent to the abattoirs. Tests have shown a number of disease-free herds and in infected herds the percentage of infected animals has been small, so that a pilot scheme for identification and eradication of Brucellosis in dairy herds may be eminently successful in this area. It should be realised that abortion does not necessarily occur because there is a positive agglutination test, but a positive test generally means that there is a voiding of disease organisms in the milk from the positive cow. The Ring test will require to be carried out twice a year so as to catch winter and summer milkers. Such a scheme could be applied to milk supplies of other cities and doubtless will be in the future.

Fourthly, hygiene is necessary. When an abortion occurs the cow must at once be isolated and milked apart from the herd. All cleanings and discharges should be destroyed and concrete in the shed disinfected. Cows do not void the *Brucella* for long periods, probably 14 to 21 days, but remember that milk may remain infective. Animals once infected with *Brucella* often get secondary bacterial infections of the uterus. This makes the cow difficult to get in calf. It is noticeable that vaccination will often help prevent sterility where a storm has arisen in an adult herd.

Great care is taken in production laboratories to see that Strain 19 vaccine is kept up to a high standard. The strain is an American one found to produce immunity but not to cause abortion in cattle. The vaccine is thus a live attenuated one, which may cause a slight temperature reaction in adult animals but does not seem to affect young animals to any extent. In adult animals a permanent swelling has also been known to occur after vaccination but in calves this does not happen. The vaccine has one disadvantage that it produces undulant fever in the human being if infection is accidentally introduced into the body, as many veterinary surgeons know to their discomfort. Other vaccines are known and used overseas but they have the disadvantage that, when the animal becomes adult, the agglutination positive reaction in the blood persists so that an eradication scheme could not then be practised. The agglutination reaction from Strain 19 disappears in almost all animals before the heifer is put to the bull.

To summarise

To control Brucellosis:

1. See that all calves are vaccinated from four to eight months of age. This is a "must" for all dairy farmers.
2. Isolate aborting animals for at least three weeks and destroy all cleanings and the aborted foetus.
3. If eradication is desirable, carry out the blood agglutination test or the milk Ring and whey agglutination tests.
4. As far as possible retain a self-contained herd until such time as Brucella-negative replacement stock is readily available.

RECENT ADVANCES IN SELENIUM AND ANIMAL HEALTH

W. J. Hartley, A. B. Grant and C. Drake, Wallaceville Animal Research Station.

At the last Lincoln Conference we were able to give you an interim report of our investigations with selenium. Today we can give you additional information on this subject.

We have been able to demonstrate under carefully-controlled conditions that selenium administration can prevent

1. Congenital white-muscle disease.
2. Delayed white-muscle disease.
3. A barren ewe problem associated with 1 and,
4. Some forms of pre- and post-weaning unthriftiness in lambs.

I shall now give you a brief description of our more recent investigations.

Congenital White-Muscle Disease and Associated Barren Ewe Problem

At the last conference mention was made of the very low conception rates on some properties in West Otago experiencing outbreaks of congenital white-muscle disease. We investigated the lambing area for the 1958 season on 37 properties in Canterbury and Otago all of which had experienced white-muscle disease the previous year. In 1958, 21 of the properties experienced mild to severe outbreaks of congenital white-muscle disease. Table 1 depicts the incidence of barren ewes on these farms. It is seen that there is a close relationship between the presence of congenital white-muscle disease and the incidence of barren ewes. On some of these properties, lambing percentages were normal in ewes that were bought in just prior to mating.

TABLE 1.

Empty Ewe Incidence and Congenital White Muscle Disease

Congenital White-Muscle Disease	Total No. of Properties	Empty Ewe Incidence		
		10%	10-30%	Over 30%
Present	21	3	8	10
Absent	16	12	4	0

During the 1959 season we carried out detailed trials with ewes on 11 properties in Otago and on three in the Rotorua-Taupo area, all of which had had low lambing percentages and white-muscle disease the previous season. In the North Island trials, all the ewes on the property were divided up into age groups, half of each age group was given selenium, the other half served as controls. In the South Island trials, mobs of ewes from 100 to 500 were given selenium and a similar number were kept as controls. All trial ewes on each property were run together from prior to mating until just before lambing, when the two groups were separated, the selenium-dosed ewes lambing separately from the controls. The selenium-dosed ewes received 5 mg. of selenium at monthly intervals from one month prior to tupping until just prior to lambing; half the rams were also given selenium at monthly intervals prior to and during tupping. All lambs born dead or dying in these trials were subjected to a detailed post-mortem examination with particular reference to the presence of white-muscle disease.

TABLE 2
Lambing Data, Rotorua Taupo Trials

Property	Lambing percentage		Barren Ewe Percentage		W.M.D. incidence	
	Control	Selenium	Control	Selenium	Control	Selenium
C	60.6	94.9	31.1	7.5	37.5	0
D	55.0	86.0	24.3	11.5	22.2	0
E	70.5	93.6	26.1	6.4	12.0	0

Table 2 shows the results of the three trials carried out in the Rotorua-Taupo area. On all properties the selenium-dosed ewes had a considerably higher lambing percentage and far fewer barren ewes than did the controls. Further, there were no cases of congenital white-muscle disease in any lamb born from selenium-dosed ewes.

TABLE 3
Lambing Data, Otago Trials

District	Lambing %		Empty Ewe %		W.M.D. %	
	Control	Se	Control	Se	Control	Se
Moa Flat	104.9	106.0	5.0	2.5	0	0
Dumbarton	108.0	120.0	5.1	3.7	0	0
Hakataramea	90.8	89.8	N.A.	N.A.	1.6	0
Arrowtown	110.0	117.0	9.0	5.0	70.5	0
Crown Terrace	85.1	97.2	5.0	3.0	10.5	0
Cromwell (M)	119.0	121.0	3.0	1.0	0	0
Cromwell (L)	42.0	86.0	27.0	12.5	5.0	0
Cromwell (H)	82.0	103.0	N.A.	N.A.	0	0

Table 3 depicts the lambing data from eight farms in Otago (the other three were unable to complete the trials). On four of the farms there is a markedly increased lambing percentage in the selenium-dosed ewes. Once again selenium prevented the development of congenital white-muscle disease.

The initial trials clearly indicate that selenium administration can have a markedly beneficial effect in some cases of ewe infertility. It is most important to realise that an increased fertility can be expected only where there is a past history of congenital, and possibly also the delayed form of white-muscle disease, and a concomitant high incidence of barren ewes. It seems most unlikely that selenium will raise the lambing percentage of those flocks where it is regularly 100 per cent. or more.

The monthly administration of selenium, as carried out in our initial trials, is impracticable under New Zealand farming conditions. We are at present carrying out detailed ewe trials on the pumice soils in the Rotorua-Taupo area to ascertain more practicable methods of selenium administration.

Some interesting data resulted from uncontrolled farmer trials in the Wairakei area during the 1959 lambing season. On one recently settled Lands and Survey block, six of the 15 settlers gave one dose of 5 mg. of selenium to their ewes prior to tupping, one farmer gave all his ewes 2½ mg. and seven gave no selenium. Table 4 gives the lambing percentages for these properties and includes the data for our trial property. These figures strongly suggest that one dose of selenium given prior to tupping may control the barren ewe problem; however, it may not prevent congenital white-muscle disease.

TABLE 4
Lambing Percentages on Oruanui Block, Wairakei.
 Average Lambing Percentage 1959-60 (15 properties)

Number of Properties	Pre-tupping ewe treatment		
	No Se	$\frac{1}{2}$ Se	All Se
7	52.2% (35.0-74.0)		
6		72.4% (61.5-77.0)	
1			85.7%
Trial farm	55.0%		86.0%

Unthriftiness in Lambs

Last year we were able to show you the dramatic effect selenium had in controlling lamb unthriftiness and mortality on the pumice soils in the centre of the North Island. Other speakers told of their experiences with selenium and increased growth rate in lambs in Canterbury.

During the 1958-59 season we carried out 30 trials with selenium on unthrifty weaned lambs in the North Island and in 22 of these there was a statistically-significant growth response to selenium.

This year officers of the Department of Agriculture are carrying out a Dominion-wide survey to investigate the effect of selenium and cobalt, separately and combined, on increasing the growth rate of both thrifty and unthrifty lambs. No results are yet available from these trials.

The dose rate of selenium employed in our 1958-59 trials was 5 mg. of selenium given by mouth at monthly intervals. During the past season we have carried out detailed dose-rate trials in unweaned and weaned lambs on two problem properties in the North Island. One of these is at Bulls and is on sand country, the other is on pumice at Taupo. We gave lambs varying dose-levels of selenium both by mouth and by subcutaneous injection at varying intervals of time.

Our preliminary results for this season, a season in which unthriftiness has not been such a serious problem, suggest that dose levels considerably below those previously used and given at longer intervals of time will produce a satisfactory growth response in unthrifty lambs. Higher dose-levels and more frequent dosage did however give a slightly better response. There was no appreciable difference in the response to selenium when given by mouth or by injection.

Suggestions for Selenium Administration to Sheep

The following oral dose levels for selenium are suggestions based on trials we have carried out on North Island sand and pumice soils. They are not general recommendations either for all soil types or for all seasons.

1. **Barren Ewe Problem and Associated Congenital White-Muscle Disease.**

Ewes. 5 mg. selenium one month prior to tupping, repeated two months later and again one month prior to commencement of lambing.

Rams. 5 mg. selenium one month prior to tupping.

2. **Congenital and/or Delayed White-Muscle Disease.**

Ewes. 5 mg. selenium one month prior to commencement of lambing.

Lambs. 1 mg. selenium at docking.

3. Unthriftiness in Lambs.

Unthriftiness responsive to selenium has been encountered mainly on the lighter soil-types namely pumice, sand, silt or shingle. If any of you therefore farm on any of these soil types and you experience either pre-weaning or post-weaning unthriftiness, particularly in seasons of lush, summer pasture-growth, we advise a selenium trial. The suggested dose is 1 mg. selenium at weaning (or before, if unthriftiness appears before weaning) followed by 1 mg. at two or three monthly intervals or as soon as lambs appear to be slipping. We must emphasise that selenium is **not** the answer to all forms of unthriftiness in lambs. It does not appear to have any beneficial effect on the autumn-flush ill-thrift which is so common.

Other Methods of Selenium Administration.

As such minute amounts of selenium are required by the animal, individual dosing appears to be the most logical, and, at the moment, the only recommended method of selenium administration.

In our opinion selenium should **not** be incorporated into artificial fertilizers, feed stuffs or "licks" at this stage. Such methods of selenium administration would undoubtedly supply more selenium than the animal needs. It is our opinion that, if selenium is to be widely used in this country for the prevention, control and treatment of white-muscle disease and unthriftiness in lambs, it is imperative that only the minimal selenium requirements for the animal be given. We must take all possible precautions to avoid the contentious problem of selenium residues in our export lamb carcasses.

Q.: During the trials that were carried out, the selenium-dosed ewes and the control ewes were run together. In view of the fact that the selenium is supposed to be excreted on to the paddock, would this interfere with the results?

Mr Hartley: It could have confused our results but we had a very good difference. If that small amount of selenium had not been excreted on to the paddocks the difference might have been even greater still.

Q.: Concerning the possibility of selenium residues being present in the meat, particularly in our export lambs following the administration of selenium, what effect may this have on our export trade? Can that selenium have any toxic effect?

A.: Selenium in the dose levels we employ could not possibly have any toxic affects on humans. Recently there has been a suggestion from America that selenium is another of those compounds that are likely to cause cancer but it has not been proved. At the moment in America they are not allowing selenium to be included for the general treatment of stock diseases but only for experiments.

In our trials we have been trying to find the maximum level of selenium which will produce a satisfactory growth response in animals. The reason is to try and minimise the amount of selenium these animals may be accumulating in their bodies. We just do not know how much is accumulating following the small doses given. We have no method of estimating these small amounts of selenium; that is why I am suggesting we use these small doses until we are able to analyse the organs to see if there is a residue of selenium present and how much.

PROGRESS REPORT ON ILL-THRIFT

Graham G. Thomson, Lincoln College.

Ill-thrift has been with us for many years and from time to time it has exercised the minds of both farmers and research workers. Numerous attempts have been made to study it. In spite of this, very little is known about what exactly it is or what causes it. Unlike most other diseases it cannot yet be defined accurately. At the moment we know it as an inability of young sheep to thrive under conditions of apparent plenty. This only indicates the type of sheep affected and gives a rough idea of the conditions under which it is known to occur.

When an affected lamb is examined it is not yet possible to say which part is affected and is failing to function. No one has yet been able to show a specific change which is common to all sheep having the disease. Usually several abnormalities can be seen. These vary from the mild simple failure to grow, to the severe signs such as a marked loss of condition, scouring, dehydration and death. It is not known why the animals die. Post mortems reveal a variety of changes. Some lambs are emaciated and some may have fatty livers. The heart may be flabby. In others the intestines are watery and contain variable numbers of parasites. The mineral status also varies. Progress to date has failed to show any specific pathological change common to all cases of ill-thrift. It is possible that what we see, may actually be more than one disease. It seems to me therefore that a detailed study of the disease by a team of experts is what is needed to determine the exact effect of ill-thrift on our sheep. A clearer understanding of the disease would also help in the development of preventive measures.

With regard to the conditions which produce the disease, a little progress has been made and our knowledge increased. The disease occurs in the North Island in weaned lambs under certain characteristic conditions. It usually appears between March and June and develops when young sheep are feeding on short, green, growing pasture. This dangerous grass appears to follow autumn rain.

The disease may also appear sporadically over the whole of New Zealand. It varies from season to season, from district to district, and often from paddock to paddock. We know comparatively little about the pasture conditions which produce it, but some useful information has come to light. Still more requires to be done. I think that a special investigating team is needed in this direction also, to solve the many unknowns associated with the production of ill-thrift.

It is true to say that several conditions can produce signs similar to those seen in ill-thrift. For example, a deficiency of cobalt in lambs will do this. If the trouble is due to a lack of cobalt it can be cured by making it available, but cobalt will neither cure nor prevent ill-thrift, as most of you know. Bone fragility is seen in both ill-thrift and in copper deficiency. Copper will strengthen the bones where there has been a deficiency, but it will not cure ill-thrift. Some of you may have had ill-thrift on pastures which have been dressed with copper and cobalt so that it does not appear that deficiencies of these two substances can be blamed.

Regarding the part played by internal parasites, a good deal of confusion still exists. There is little doubt that worms can cause disease in lambs with symptoms like ill-thrift.

It is generally agreed that parasites in lambs can become harmful if the lambs are weakened in some way. Lambs are often subjected to several kinds of stresses such as mineral deficiencies, nutritional upsets, and poor sheep management. Any of these can predispose the lambs to an attack by worms. It could well be that ill-thrift is another of these stresses on lambs which lowers their resistance and so allows the worms to take charge.

It seems most likely that ill-thrift comes first and the worms second, for studies on autumn ill-thrift at Ruakura have shown that worms are not a basic cause of the disease. There it has been shown that ill-thrift can occur in lambs which have no parasites at all. They have also shown that lambs can be heavily parasitized, but when grazed on certain types of mature pasture they come to no harm. Other features which suggest to me that worms are not of prime importance are these.

In some outbreaks only a few parasites are to be found in affected lambs. In other instances no amount of worm drenching appears to have much effect on the prevention or cure of the condition. In one of our trials, on a farm badly affected with ill-thrift, anthelmintics given fortnightly to lambs from three weeks of age onwards, failed to make the lambs grow as fast as normal lambs. There are, however, many recorded instances when worm drenching has led to increased weight gains and one would not deny the soundness of using drenches when worms are present or are thought likely to occur.

Several workers have discovered the presence of abnormal quantities of certain substances in pasture plants. Dr Butler of Plant Chemistry Division of the Department of Scientific and Industrial Research has shown that the young, rapidly-growing "toxic pasture" which causes "autumn ill-thrift" frequently has a higher-than-normal nitrate content. Sheep eating this kind of pasture suffer either a check in growth or a loss in weight. Workers at Ruakura do not think it is the nitrate which causes the trouble but some other associated substance. Efforts are now being made to study other components such as amines which may be present in toxic grasses. Unpalatability of pastures is another abnormality which is also being looked at.

Probably the most publicised aspect of ill-thrift has been the effect of selenium on animals. Minute amounts of it have been found to have beneficial results under a variety of conditions. How selenium works we do not yet know. When given to ewes it has, on occasion, increased their fertility, decreased the number of dry ewes and made them produce more wool. It also prevents the appearance of white-muscle disease in their lambs. Minute amounts of selenium given to lambs have produced increases in their rates of growth. Where ill-thrift has occurred, it has markedly reduced the death rate.

It would be wrong to assume that by using it all farmers could obtain these results. Beneficial responses do not always follow the use of selenium. At this stage I would like to mention some of the results we have had in this part of Canterbury.

1. The Effect of Selenium When Given to Ewes

On four farms, several thousand sheep were divided into groups. Some were given 5 mg. selenium before tupping, some after tupping. All treated groups were given 5 mg. at monthly intervals during pregnancy. After lambing we could show no beneficial effects on lambing percentages, birth weights or on the dry ewe problem. But on one farm the selenium dosed ewes produced lambs which, at eight weeks of age, weighed about four pounds heavier than lambs from the control ewes.

On one farm, selenium clearly prevented white-muscle disease in the lambs from treated ewes while on the other three farms there was not enough evidence to show whether it did or not. On all farms the administration of selenium reduced the serum transaminase levels in both ewes and their lambs and we interpret this finding to mean that it was beneficial to them. The untreated sheep had higher transaminase levels which suggested that they actually suffered a slight attack of white-muscle but had no visible signs of disease.

2. The Effect of Selenium When Given to Lambs

Selenium given to lambs affected with white-muscle led to good clinical improvements and at the same time markedly reduced the transaminase levels from about 2,300 units to a few hundred thus indicating recovery of damaged muscle.

Our growth responses to selenium were variable. In 1959 we got no responses on farms which had responded in 1958. Our graded dose trials failed to respond also and we were unable to find an optimum dose level. Work by Hartley and others indicates that only very small amounts are needed. About 1 mg. to a lamb at docking, repeated at monthly intervals, is all that is required.

We had variable responses within farms. Sheep in one paddock responded while others elsewhere on the farm did not. Your own trials may also suffer from this variation.

If growth responses occur, they often do so within a few days after selenium has been given. In one of our trials the differences did not appear until the trial had been running for over two months when the control lambs began to lag behind. It is difficult to account for this. It is possible that the differences resulted from the control lambs exhausting their supply of selenium at this time or that the selenium content of the pasture was reduced or perhaps an antagonist to selenium then appeared in the pasture. These aspects will have to be studied. We at the College are attempting to play our part by preparing a project to study various relationships. We have been given a generous research grant for this by the Department of Agriculture. We plan to study the relationship between different pasture species, pasture production, its mineral composition, and the thrift of young sheep.

As far as white-muscle disease is concerned, there is some evidence to suggest that it is not caused by a simple deficiency of selenium. American workers have found that diets producing white-muscle have just about the same selenium content as diets which do not produce white-muscle.

When we used selenium as a top dressing on lucerne and grass pastures at two ounces of selenium to the acre, we failed to observe any beneficial effects. Other people using four ounces to the acre have caused deaths in lambs. So, at the moment, I would not advise farmers to top dress with selenium. It may be dangerous, and we still have to study the selenium uptake rates of our cereals and grasses.

To find the toxic levels of selenium we injected groups of lambs with graded amounts at weekly intervals for a year. Some lambs took a total amount of 750 mg. without apparent harm. It is known, however, that one dose of 10 mg. can kill some lambs. Selenium therefore should not be used carelessly.

3. The Effect of Selenium on Ill-thrift

Selenium appears to control some types of ill-thrift. When used in the North Island it has helped to stop deaths in some outbreaks and it has also led to some gains in weight. It is reported from

Ruakura that selenium did not prevent losses of weight in lambs affected with the North Island "autumn ill-thrift." In order to judge the efficiency of selenium on "Canterbury ill-thrift" we will just have to wait for a few bad outbreaks to occur and see how it works then. It may be the answer, in which case everyone will be happy. It may be a failure and the research will have to continue. There are reports that selenium was of little use in sudden outbreaks of the disease in Canterbury.

We have, however, been able to study unthriftiness on a local farm which has had ill-thrift regularly for the last ten years. Since 1954 this farm which carries 900 ewes has produced only 65 fat lambs per year and most of these have been seconds. The rest either died or were sold as stores in late autumn. On this farm the trouble usually appears when the lambs are about five weeks of age. This year we commenced our trials with them when they were three weeks old. All the groups made reasonable progress until at the age of nine weeks, in early December, ill-thrift began its attack. In most groups, growth slowed down, and many of the lambs lost condition, scoured badly and died. One group receiving selenium continued to make near normal gains while its control group made no gains at all—only 0.20 lb. in four weeks. After three months the result of this trial was:

Treated	(20)	3 deaths	1148 lb. live weight.
Untreated	(20)	10 deaths	504 lb. live weight.

In this instance selenium exerted a most beneficial effect, but a disturbing feature on this farm has been that in the 1959 and 1960 trials the responses to selenium have decreased during the autumn months.

When the change was observed on this farm in December, we placed 20 healthy College lambs on the farm. Four of these soon died and the remainder grew only half as fast as their controls which stayed at the College. Untreated lambs from this farm taken to the College soon picked up and made excellent gains. They made very much better gains on the College pastures without selenium than did those getting selenium back at their home farm. This again suggests that selenium is not the only requirement for normal growth under ill-thrift conditions. There was obviously something wrong with the pasture. There was plenty of it and it looked attractive. During February and March lamb growths on this pasture improved, but showed a marked decline following the rain in April. What went wrong with the pasture we just do not know. In addition to using selenium on this farm we tried many other minerals, but found none of them helped the lambs to grow.

To sum up: Progress towards the solution of ill-thrift is slow. Firstly, because we have not been able to define accurately the disease in the animal; and secondly, because we have found out relatively little about the pasture conditions which produce it. The problem seems to be beyond the scope of the general investigator. At the present time most people interested in ill-thrift have other work to do as well and it is my own considered opinion that until a team of experts can devote the whole of their time to the problem as is being done with facial eczema, then ill-thrift will continue to baffle us and kill our sheep.

TABLE 1

		Selenium injections began	No. of ewes	Lambs born	Lambs tailed	Dry ewes	Lambing % (on lambs born)	Lambing % (on lambs tailed)
Border Repl. Control	Se	Before	303	366	336	12	121	111
		tup.	322	398	350	12	123	109
Corriedale Repl. Control	Se	After	217	307	282	8	141	130
		tup.	445	603	535	5	135	120
Swannanoa Control	Se	After	193	223	198	15	115	103
		tup.	230	279	233	18	121	101
Kirwee Control	Se	Before	290	307	269	15	106	93
		tup.	290	293	255	26	101	88
West Melton Control	Se	After	250	271	250	28	108	100
		tup.	262	250	234	36	95	89

TABLE 2

	No. Ewes	No. White Muscle Lambs*	Average Serum trans- aminase level		Results
			Ewes	Lambs	
A.D. Corriedale					
Se	217	Unknown			83
Control	445				
Border Repl.					Inconclusive
Se	303	Nil			
Control	322	Nil			54
Swannanoa					White muscle disease pre- vented
Se	193	Nil	160	65	
Control	230	11	208	120	150†
Kirwee					Inconclusive due to low incidence of the disease
Se	290	Nil	69		
Control	290	2	118		135
A.D. Fat Lamb					Inconclusive due to low incidence of the disease
Se	588	Nil	93		
Control	562	Nil	104		117‡
West Melton					Inconclusive due to low incidence of the disease
Se	250	Nil	65		
Control	262	Nil	49		75

*Over 500 lambs submitted for post mortem examination.

†Highly significant.

‡Significant.

TABLE 3

Growth Responses to Selenium

(a) The Effect of Selenium given to Ewes on Lamb Growth
—a dose of 5 mg. selenium given once a month during pregnancy.

Farm	Average weight lambs from Se ewes		Average weight lambs from Control ewes		Difference in lb.	Remarks				
	Twin Male	Female	Single Male	Female						
1. Swannanoa	55.93		52.54		3.39	Highly significant Differences obscure as two mobs were run separately after lambing				
2. Kirwee	43.91		43.62		0.24					
	Twin Male	Female	Single Male	Female	Twin Male	Female	Single Male	Female		
3. Border Repl. Flock A.D. Mean birth weight lb. Average daily growth (70-80 days)	9.15	8.83	10.97	10.34	9.44	9.15	11.14	10.56	0	No difference
	0.643	0.578	0.658	0.622	0.554	0.568	0.673	0.623		
4. Corriedale Repl. Mob A.D. Mean birth weight Average daily growth (70-80 days)	8.89	8.15	9.56	9.90	8.40	8.13	10.28	9.55	0	No difference
	0.606	0.493	0.611	0.539	0.576	0.479	0.578	0.537		

TABLE 4
Mean Transaminase Levels in Ewes and Lambs

Locality	Ewes given Se	Ewes in W.M. affected flock	Ewes in W.M.-free flock	Lambs clinically affected with W. M.	Apparently normal lambs in W.M.-affected flock	Lambs from Se ewes	Normal lambs in unaffected flock
Swannanoa							
24.7.59	160	208					
1.9.59						120	65
7.9.59						155	
12.9.59						130	40
17.9.59						150	85
Ashley Dene							
24.7.59	93		104			67	54
22.9.59						83	117
24.9.59						83	110
25.9.59							
Kirwee							
30.7.59	69		118				
2.10.59						90	135
Springston							
29.7.59			30				
12.9.59							75
West Melton							
30.7.59	65		49				
21.9.59						89	75
Waiau							
8.10.59				2750			
14.10.59		135			400		

Many of these differences are statistically significant.

TABLE 5
Selenium Toxicity Trial
(Trial Proceeding)

Group	Initial weight 20.3.59	Final weight 29.2.60	Gain lb. 49 weeks	Total selenium to date
15 mg. Se/week (Selenate)	54 52	111 95	57 } 43 }	735 mg.
7.5 mg. Se/week (Selenate)	60 48	104 83	44 } 35 }	
10.0 mg. Se/week (Selenite)	51 67	103 115	52 } 48 }	490 mg.
Control	58 45	84 61	26 16	

TABLE 6

No. 1

Group	Initial weight 7.10.59	Weight Gains				Total gain in 21 wks.	Deaths
		7.10-59- 6.11.59	6.11.59- 17.12.59	17.12.59- 12.1.60	12.1.60- 16.2.60		
Minerals I	20.9	14.8	14.9	4.1	0.08	38.9	5
Minerals II	20.8	14.5	15.5	3.4	4.62	44.16	2
Minerals III	20.9	12.0	11.9	5.2	4.20	41.5	6
Se + Co IV	21.2	13.8	16.0	8.7	5.94	55.4	3
Fe, Cu, Co + Pheno V	22.4	12.6	12.9	6.5	6.35	48.1	1
Control VI	20.6	14.7	15.3	4.8	2.10	44.37	3

No. 2

Group	Initial weight 1.12.59	Weight Gains			Total gain in 110 days	Deaths
		1.12.59- 17.12.59	17.12.59- 12.1.60	12.1.60- 16.2.60		
Zinc	38.4	1.2	0.5	6.37	14.4	6
Manganese	38.4	2.0	3.1	0.25	9.7	3
Vit. E + Selenium	38.4	4.4	6.9	9.0	31.1	3
Control	37.4	0.9	1.1	0.21	8.6	10

No. 3

Group	Initial weight 1.12.59	Weight Gains			Total gain in 77 days	Deaths
		1.12.59- 17.12.59	17.12.59- 12.1.60	12.1.60- 16.2.60		
College lambs at College	50.9	13.3	16.5	14.3	44.1	0
College lambs on farm	50.8	11.0	2.3	5.56	18.86	4
Farm lambs at College	37.7	3.3	11.5	15.06	29.86	2
Farm lambs at farm	37.5	0.9	1.1	0.21	2.21	10

Q.: What is the normal cost of dosing stock with selenium to keep ewes and lambs in normal condition?

Mr Thomson: You might dose for a half-penny a sheep for the material which is itself very cheap; to that you must add the cost of mustering and dosing.

Q.: Could you tell us if one dose of 1 mg. selenium, given to lambs on properties where the ill-thrift shows up or lambs go back just prior to drafting, will keep that lamb healthy until 12 weeks old without drenching again?

A.: It depends largely on the amount you gave at each drenching and if you were going to sell these lambs to the Works for export. The chances are that if you give nine-weeks-old lambs 2 mg. you would probably cover the problem sufficiently.

Mr Hartley: One mg. should be given to the lambs at docking, and again at weaning if they go back before that time. With regard to trials in Rotorua-Taupo, $\frac{1}{2}$ mg. is almost as good as 5 mg.; this will reduce the cost to a degree. Small doses are recommended in case there is any selenium stored in the body. It is not advisable to give lambs selenium just a few days before sending them away fat.

Mr Lindsay Morris, Wanaka: You will remember last year I offered a ray of hope for the use of selenium for the treatment of barren ewes and ill-thrift. I am pleased to say that the hope has been justified. Last year we used 5 mg. of selenium each month on the ewes from before tupping up till lambing. The ewes produced 115 per cent of lambs which were very thrifty. We did not use selenium again and we got away two-thirds of them fat-off-their-mothers approximately the first week in January with quite good weights—from memory, 33-35 lb. In my case, the ewes were all running together. The treated mob and the untreated were confined to a small space—two mobs of 100 run on something like 30 acres and fed on one corner of that with hay and I am quite sure that the ewes which were receiving 5 mg. of selenium each month must have secreted selenium which was taken up by the controls. There was practically no difference in the lambing percentages or wool weights, and there was no sign of white muscle in any of the lambs; whereas a neighbour who had his running on a more open area had something over 20 per cent dry ewes in his control mob. He had only one case of white muscle showing up in the lambs. Prior to shearing you would have seen no difference just looking at the sheep but it was obvious later on when they came out of the shed. The ones which had had selenium were more robust and were better sheep. The wool weights showed a difference of 10 per cent better with selenium. I might say that it has been particularly dry this year in Otago and my lambs did not have selenium. I put the wether lambs, after the first week of weaning, on to wet pasture; they did quite well for a while but by the end of February or beginning of March they began to pack up. It took me over a week before noticing it. Then I got selenium to them and they soon showed improvement. Out of 100 lambs there were nine deaths; from past experience there would have been 50 deaths if I had not treated them.

One fact I did not mention last year was teeth troubles. For years I used to have a wastage of anything up to 30 or 40 ewes a year. At culling I found those ewes had a lump on the jaw—a horrible mass of pus. They would waste away and die. This year I cannot find one example of this trouble.

THE FUTURE OF PEDIGREE BREEDING

C. P. McMeekan, Ruakura Animal Research Station,
Hamilton

I understand that the invitation to address you today upon this subject, arose from my indiscretion in delivering a similar paper to the N.Z. Jersey Breeders' Conference last winter. The indiscretion is even greater on this occasion since, in addition to causing annoyance to dairy breeders, the need to cover the beef cattle and sheep may get me into the black books of all sections of the farming aristocracy of New Zealand.

In mitigation I would like to stress that I do not intend to annoy. My views have been formed after a lifetime of interest in and study of the many problems involved both in New Zealand and in other countries, and are advanced only after careful consideration of the implications to breeders, to commercial stockmen and to our national welfare.

Speaking first to all breeders, it is only just over 100 years ago since the first British Breed Societies were formed. They came into existence following the private publication of the early Herd and Flock Books and because of a growing belief in the power of pedigree to influence animal production of the future. It is worthwhile at this point to remind ourselves very briefly of the process of breed formation used by the early promoters of pure breeds. Only a matter of 200 years or 40 cattle or sheep generations ago—the number and diversity of recognisable types of cattle or sheep in a breeding sense in Britain was prodigious. Most counties and, in some places, even most villages, had their own type of stock. The first problem in forming a breed lay in recognising the most useful type of animal for local conditions. A mild form of in-breeding in the chosen group was then undertaken to produce a greater degree of uniformity in distinguishing characters such as colour, size and shape, which are so easily and rapidly selected for. When this fixing of general type was successful, expansion of numbers to replace nondescript types followed, the breed became a recognised entity, a herd or flock book of family pedigree was evolved, and finally a Breed Society formed.

The function of the Breed Society in those days was much as it is today. The Society was responsible for managing the Herd Book and for conducting the necessary promotion campaigns for the particular breed involved with necessary emphasis on the economic welfare of the breeders concerned. Concentration was always on the production of bulls or rams for sale as the key means of grading up and thereby improving nondescript stock. The economic facts of life soon indicated that a breed's success or failure was determined largely by the ability of the animals of that breed to make more money for the commercial farmers than animals of alternative breeds. So strong has this factor become, it follows that a Breed Society can be assured of a future only so long as it makes available more productive animals to the commercial farmer than he can economically obtain from any other source. This statement is, in fact, a specific if general answer to the question implied by the title of this paper, "Is there a future for the Breed Society?"

Speaking now to the breeder of dairy cattle, the real question, of course, goes far deeper than this. I would suggest that it is, "Can the pedigree breeder of dairy cattle continue to breed more efficient animals than are obtainable at comparable cost in some other way?" The first step in considering this question is to examine the organisation of the pedigree breeding structure as it exists in New Zealand.

As you are all aware, there is much movement of pedigree cattle from farm to farm and from breeder to breeder. It is easy to trace the pattern of this movement. Even a cursory analysis shows that New Zealand dairy cattle fit into a neat social pyramid. At the top of the pyramid are a small group of dominant breeders—about 100 or less in number—who buy bulls only from each other or who pursue a policy of severely limiting the purchase of breeding stock so that their herds are relatively closed in a breeding sense. These dominant breeders sell bulls to the second tier of the pyramid. They sell to a much larger group of breeders who, in fact, simply multiply this stock and who, in turn, sell bulls to a still larger number of smaller and would-be pedigree breeders. It is this last group at the base of the pyramid, together with most of those in the second tier, who breed primarily to sell bulls to the commercial dairyman. Within the pyramid, as a whole, the closed Herd Book prevents the addition of new genetic material.

The consequences of this social system are easy to visualise. It is easy to see that genetic differences—the true differences in inherent dairy merit—that may exist at any time between the different tiers, are continually being ironed out by the interchange of breeding stock. Any culling in the lower herds produces no long term improvement, because its effects are constantly being diluted by the genetic material from the next bull bought in from the group above. It follows that it is upon the operation of the elite group of herds at the top of the pyramid and of its success in breeding better cattle, that the immediate future of the multiplying breeders in the middle and at the base, and the long term future of the pedigree cattle actually depends.

The alternative policy to buying pedigree bulls that the commercial farmer can adopt today is obvious to all. He can use artificial breeding. At present about 400,000 cows in New Zealand are mated artificially. Soon this number will be over half a million, or 25 per cent. of the total number of dairy cattle. In a few years the proportion will be 50 per cent. The consequences of this programme at this present stage of development are threefold:—

1. Already about 12,000 bulls from the 70,000 odd bulls in use prior to the development of A.B. are no longer required.
2. The daughters of A.B. matings are substantially higher producers than their contemporaries bred to pedigree sires.
3. Many commercial farmers have begun to keep non-pedigree bulls sired by the best A.B. sires from their own selected top grade cows, rather than continuing to buy pedigree bulls.

Expansion of this practice could result in fresh pressure being brought to bear upon those responsible for artificial breeding to include outstanding non-pedigree bulls in the A.B. bull teams with still further harm to the orthodox pedigree breeding industry.

So far the growth of artificial breeding in New Zealand has not been as phenomenal as in other countries, for reasons peculiar to the New Zealand farming scene. These reasons have now been overcome. It is not dangerous to forecast that the bulk of the commercial stock will ultimately be bred this way. It seems only yesterday, although actually 20 years ago, since, along with Dr. Joseph Edwards, now Director of herd improvement of the British Milk Marketing Board, I assisted with the first semen collections from bulls in Devonshire, a step that soon led to the Dartington Hall A.I. Group, one of the first commercial groups established in the United Kingdom. Last year artificial breeding in England celebrated the birth of its ten millionth calf—and this after only 13 years of commercial operations in the most conservative of all conservative cattle-breeding countries and the home of the pedigree concept. England now proposes to breed continuously 2,000,000 head

of cattle to 200 bulls each year. The U.S.A. breeds 6,500,000 head. France 3,500,000, Germany 2,000,000, Denmark 1,500,000.

The usefulness of artificial breeding to the commercial farmer is demonstrated by the picture presented by a herd which has been under my personal control at the No. 2 Dairy at Ruakura since 1944, since which time it has been bred solely along advocated artificial breeding lines. Although half the cattle in the herd of 160 cows are relatively poorly fed, because they are involved in an experiment which imposes poor feeding upon them, the whole herd milked on 147 acres, averaged 400 lb. of butterfat per cow and 435 lb. per acre over the last two years. Two, three and four generations of artificial breeding, based upon selection for production and production alone, are represented in this herd. The two-year old heifers from the two well-fed groups over the past two years, 50 strong, produced 400 lb. of fat uncorrected for age as two-year-olds and 450 lb. of fat as three-year-olds. This performance does not prove that artificial breeding is the only way to develop a high-producing herd of cattle. The figures do indicate, however, that sound economic animals, capable of high output per animal and per acre, can come from this simple and foolproof method of breeding. For various reasons I believe that this herd is probably 60 to 80 lb. fat better in inherent dairy merit than the average herd of the industry. This superiority arises because of the way it has been bred. As a matter of passing interest I am not ashamed of the appearance of the cattle concerned. I am proud of their freedoms from disease, their ease of milking and their longevity. If only I could be the recipient of the income they bring in I also would not be ashamed of the taxes I would pay.

Some of you will be aware of the five-year feeding/breeding experiment recently concluded at Ruakura. We have measured the extent to which groups of high and low producing herds of the industry differ in the inheritance of the cattle contained in them. Very briefly the results indicate that all of the large difference in milk yield between these high and low groups of herds is due to feeding and management factors; that half the difference in test is due to feeding and management and half to genetic factors; that because of this genetic difference in test, only about 10 per cent. of the difference in butter-fat yield is genetic, the other 90 per cent. being due simply to better feeding and management in the high group of herds. Remembering that the high group is representative of the production performance of those herds of the Dominion which are producing about 400 lb. of butter-fat per cow and that the low group is representative of the poorest segment of the cattle industry averaging close to 240 lb. of butter-fat, these results are extremely important to the question under discussion. They suggest strongly that the elite group of pedigree herds at the top of the pyramid have little margin of safety in terms of genetic merit for milk and fat yield of their cattle. In other words, they suggest that the true genetic difference in milk and fat production between their cattle and those operating at a much lower level of efficiency is far too small to allow any degree of complacency or smugness on the part of the pedigree breeder or Breed Society.

The expansion or decline of A.B. and the use of well-bred but non-pedigree bulls is likely to be closely dependent upon the relative cost and profitability of the two systems to dairy farmers. The competition offering from artificial breeding is extremely strong and quite capable of overwhelming the breed societies as we know them today. The grade farmer is sufficient of a realist to know that he must obtain the most efficient cattle as cheaply as he can if he is to survive in this increasingly competitive world. I believe that unless pedigree breeders supply farmers with animals capable

of measuring up to their specifications, the days of pedigree dairy breeding as we know it are numbered. The process will take a long time. In any British community, tradition dies hard, and the cult of the pedigree is one which has been so woven into our farming fabric that the disentanglement of its unimportant frills is and must be a tedious process.

Apart from eliminating many rather obvious defects from the present attitude and methods of pedigree breeding, are there any more positive steps that Breed Societies might take to improve their chance of survival? I believe there are three.

The first concerns the Breed Societies as a whole. I believe that they must "open" the Herd Books. I believe that they must do this to legitimise the use of outstanding sires now classed as grades which have been and will be bred to an increasing extent by A.B. sires. The attitude of regarding these animals as social outcasts—as illegitimates—is dangerous. By absorbing the best of them, Breed Societies and breeders would be in a position to make use of any worth while genetic material that such animals can contribute to breed welfare, and especially strengthen the chances of preserving the high traditional status of pedigree cattle. This suggestion was advanced five years ago by one of the most respected and successful members of the Jersey Breed Society. In doing so this gentleman pointed out that with the exception of one, every Breed Society Herd Book in Great Britain—the home of pedigree cattle—was an "open" book.

The second suggestion concerns the multiplying breeder who breeds in order to sell bulls to the commercial farmer and who will be the first to suffer as the market retracts. To this large group I suggest that artificial breeding should be used to breed a large proportion of the bulls it is hoped to sell. By doing so two purposes would be achieved. In the first place we know that the sons of outstanding A.B. sires are first-class breeding bets, so that multiplying breeders using the technique will be selling better than average bulls to buyers, thereby retaining their confidence. Secondly, by providing the pedigree animal bred by A.B. as a reasonably priced alternative to the grade bull which the commercial farmer might otherwise be tempted to keep, the suggestion may slow down the trend of using grade bulls by A.B. sires.

The third suggestion offered concerns the nucleus breeders. To those of that group who have large herds of pedigree cattle, and by "large" I mean 100 cows or so, I suggest that they consider the virtual closing of their herds and the pursuit of a line breeding policy to outstanding sires turned up by progeny testing. Under these circumstances, such breeders must cull their poor producing animals most ruthlessly and must introduce new bulls, but gradually, so that if they turn out badly the damage is minimised. They must remember that famous progeny and not famous ancestors are important. With a large herd, with ruthless selection, and with resourcefulness of purpose, continued gradual improvement is feasible. By operating along these lines this elite group will stand a chance of safeguarding, on a long term basis, the genetic material present and developed in such herds. By so doing, they would be contributing in a worthwhile, and perhaps even vital, way to dairy cattle improvement. They could provide a continuing source of new and beneficial blood to the A.B. movement. They could, thereby, assist in minimising the potential danger in A.B. where concentration on too few key animals could result in too close breeding of the national herd with inevitable deterioration. In making such a contribution the elite breeders would be doing so with both profit and honour to themselves, and could justify their claims to be the "master breeders" of the game.

Without such changes in policy—and changes they would be for most—even these elite breeders could go under. They, together with all pedigree breeders, must remember that artificial breeding in itself offers tremendous scope for progeny testing and selecting superior cattle. This fact confers a tremendous advantage to any organisations interested in breeding cattle by A.B.—an advantage which cannot be enjoyed by those to whom artificial breeding is denied. Whatever is done it is sure that for certain survival, intelligent and understanding leadership, indeed what one might term "Pedigree Statesmanship", of a very high order is required. In this statesmanship I firmly believe that co-operation with all concerned, not isolationism, must be the guiding principle. Without such leadership, the future of the Breed Society and the pedigree breeder will be short lived.

Now a few words to the breeder of pedigree beef cattle. At the present time he is not faced with anything like the problem confronting his counterpart on the dairying side. A.B. is not a practicable technique for the breeding of commercial beef animals. Our national beef breeding herd is run under conditions where the females are not sufficiently docile to be bred artificially. Even when run on low land country in small mobs, so that they do become accustomed to being handled, and in consequence are reasonably quiet most of the time, they forget their manners once they have a calf at foot.

Successful artificial breeding involves not only the capacity to handle the female easily, but the keeping of accurate records of oestrus periods. These can seldom be done in a beef herd. I can well remember our experience in attempting to combine artificial breeding with artificial twin production in a herd of Aberdeen Angus cows some 15 years ago at Ruakura. The task of cutting out "Mum" from the herd and of temporarily getting rid of the complication of her calf, resulted in a daily rodeo of Texan dimensions. It seems likely, therefore, that the breeder of pedigree beef cattle is unlikely to have to face the new and disconcerting challenge of A.B., but can expect to continue as a major supplier of sires for the commercial beef producer.

By and large, too, the beef cattle breeder is in a more fortunate position, in that selection for continuing improvement in beef qualities is somewhat easier than is selection for higher milk and butter-fat production in dairy cattle. The major objective of improved conformation is more readily attained, since the conformation characters sought after can be seen and thus, to some degree assessed and evaluated, by the eye of the experienced stockman. Because they can be measured in both sire and dam, progress is at least twice as rapid.

At the same time the beef cattle breeder will also have to face up to new demands in this rapidly-changing world. In doing so he may have to throw overboard some of his long-cherished ideals. I refer here in particular to the growing importance of pre-cut and pre-packaged meats. All modern countries—and this is now beginning to apply with increasing emphasis even to Britain, the most conservative of them all—are showing an ever increasing interest in meats of this type, and are developing special selling techniques in handling. The new trade has much to commend it, especially where long distance transport is involved. Only edible material has to be shipped or carried. Space requirements are substantially less than needed for carcass meat. Cheaper cuts for manufacturing purposes in particular involve substantially lower distribution costs. Pre-packaged meat lends itself admirably to modern deep freezing, with consequent advantages in storage from the viewpoint of both

distributor and consumer. From the consumer viewpoint waste is minimised, since mainly edible meat is purchased.

All this back-lashes upon the type of animal produced. It does not require much imagination to appreciate that if the only form in which distributor and consumer view the finished product is in the form of cellophane packed cuts, the original shape or conformation of the cattle beast is of little consequence. All those characteristics involved in eye appeal in the past in our carcass-meat trade disappear in these circumstances. They are replaced by the basic need for animals which will yield a high percentage of edible meat of adequate tenderness and flavour. To illustrate the point, few breeders of Aberdeen Angus, Hereford or Shorthorn cattle, bred along traditional British lines and characterised by the low set, blocky, conformation of the so-called improved beef type, can look with favour upon the French Charollais, the American Santa Gertrudis or the Zebu or Brahman type cattle. Humped, goose-rumped and indubitably ugly by every British standard, these curious members of the cattle tribe, however, do possess grand fleshing and cutting qualities.

While I do not suggest that there is any need for, or likelihood of introducing Asiatic breeds to this country, the strong probability emerges that our breeders must pay far more attention in future to rapid growth in beef cattle than to conformation. Much scientific investigation has demonstrated quite conclusively that not only do British beef cattle vary tremendously in their growth-rate performance, but also that the character of rapid growth is strongly inherited. Ruakura studies with Aberdeen Angus breed in a large number of North Island studs show that there is much scope for improvement in growth rate in our New Zealand cattle. Soon we hope to have evidence to show that advantage can be taken of this situation by selecting future cattle primarily on a basis of growth rate. The particular study in progress at present is one which should be carefully watched by all beef-cattle men. We are regularly performance testing young bulls in a large number of North Island studs. A fast and a slow growing bull from the same stud are selected each year and, along with five other such pairs, are being mated to a herd of 300 Aberdeen Angus cows. Half of the herd goes annually to fast-growing bulls and half to slow-growing bulls. The growth rate and the carcass characteristics of the progeny are being closely followed. It is interesting to note that the fastest growing bulls on test tend to be large, relatively raw-boned beasts and the slower growing ones much more in accord with normal concepts of good pedigree type. The final test of the two systems will be the quantity and value of saleable meat produced. Already the indications are that selection on a basis of growth rate as the main factor will be well worthwhile. Progeny of bulls selected for fast growth are themselves faster growers. In my opinion, progressive beef breeders looking to the future will embrace performance testing and growth rate as a new weapon and new approach in their work.

Now for the sheep man. A good deal of that which has been said about the position of the dairy-cattle breeding industry applies also to sheep breeding, and needs no retelling. Mr P. G. Stevens, of this College, has gone to some trouble to analyse the social structure of our two main breeds of sheep, the Romney Marsh and the South-down. He has made it quite clear that the same kind of breeding pyramid exists, but to a much more exaggerated degree than in the case of dairy cattle. Instead of there being 100 or so elite breeders on the top of the pyramid, the majority of both Romneys and South-downs go back to but one key stud in each case. All major studs contributing rams to the multiplying breeders who, in general, supply most of the rams to the commercial farmer, rely upon these two

main studs for their improvement stock. While they interchange animals between themselves, the genetic base is obviously very restricted.

As in the case of dairy cattle, it is obvious that genetic differences that may exist at any time between different tiers of the pyramids are continually being ironed out. It is equally obvious that any long term change in the genetic make up of the breeds is controlled by the operations of the dominant breeders at or near the top of the pyramid. Since, by and large, breeding methods of stud masters can only be described as straight-selection techniques and very limited in their rate of progress, it is therefore, understandable that there has been virtually no basic improvement in the weight of national wool clip in New Zealand over the last 30 or 40 years. The increase that has occurred has been due to expanding sheep numbers and to improved feeding and management conditions, and not to an inherent change in the capacity of our sheep to produce. Straight selection under conditions of expanding numbers is, of course, far less efficient than it can be when numbers are static, since the advantages of culling cannot be taken into account.

The more rapid rate of improvement in production qualities of dairy cattle under the A.B. system is derived not only because the influence of any one sire is multiplied up about 700 times, but also because the sires so used have been selected not upon appearance but upon their breeding performance, and are in consequence real herd improvers. Progeny testing methods can be and have been developed for sheep, while artificial breeding can also be used with these species. In practice, however, these two approaches have been associated with much disappointment. With no organised recording service such as that available to the dairyman through his herd-recording movement, progeny testing has had to be the individual responsibility of the breeder. The technical difficulties associated with recording and analyses of data, and, with the maintenance of large numbers of small sire-groups, particularly with a breed as infertile as the Romney, have militated against any effective application of progeny testing. Artificial insemination, too, has also not been easy to organise, since any large flock provides sufficient work to keep one man fully engaged because ewes come into oestrus continuously over the mating period. The dairyman's system of a travelling artificial breeding technician capable of handling a herd 40 or 50 cows is not practicable. For these reasons advocacy of the two methods has declined of recent years, and sheep breeding has continued along traditional lines.

Modern developments, however, seem likely to change this situation. Methods are now becoming available whereby it is possible to bring the majority, or any selected proportion, of a key flock into season within a couple of days. These days can be nominated. When this technique has been developed to the stage where it can be used under field conditions, it will be possible to employ trained artificial inseminators as is done in the dairy industry. For the top quality breeders this situation would warrant the use of effective progeny testing systems and the consequent extensive use of superior sires by artificial breeding. To the commercial flock owner, particularly on fat-lamb country it could reduce the number of rams used, enabling lambing to be better organised with many advantages on the feeding and management side.

Summing up, the future of the breeder of pedigree dairy cattle is precarious; his beef breeding counterpart also faces new challenges; the sheep man is likely to do so in the not-too-distant future.

Q.: Do you think it is possible that by A.B. you may develop

animals that are so good that the farmer might not be able to look after them up to their capability?

Dr McMeekan: It is an elementary fact of livestock farming that you do not get production out of thin air. Production comes from feed and if you are going to have cattle with a high capacity to produce it is possible that they may be too good for some farmers. While it is true, in my opinion, that the majority of our animals in New Zealand are underfed for a large part of their lives and therefore do not produce to their existing genetic potential, farmers are improving all the time and the chances are that the two levels will move along together quite happily. There will always be some farmers who will not be able to look after their stock to their full genetic capacity.

Q.: Should we not be paying more attention to the efficiency of utilisation of food rather than the rate of growth?

A.: What we want is an animal that will give us the maximum amount of produce per acre of grassland in this country; that is our major economic target in breeding of our stock but it is a question of practical politics coming into the game.

Beef cattle should be measured by rate of growth. The fast grower produces more gain per pound of food than the slow grower.

As far as the dairy cow is concerned, the higher-producing animal by and large does require (and we have measured this under grazing conditions at Ruakura) less feed per pound of butterfat produced than does the lower-producing animal. If you want to convert the high individual producer to an animal which is also producing a maximum per acre then the problem is quite simple—put on more animals. You drop the production per animal but you increase the production per acre.

Q. You suggested that there is very little real difference in genetic merit between the animals at the top of the pyramid in the dairy industry and the average grade Jersey, and you presumed the same situation applies in sheep. Have you any figures or are you presuming?

A.: I have not got any North Island evidence to substantiate that presumption but I remember some work done here at Lincoln by McMahan 30 years ago. He submitted ordinary flock sheep to stud-level feeding. They produced in fleece weights equal to the stud animal. At the moment this presumption is based on experiments overseas, a little in New Zealand, and a lot of theoretical grounds.

Q.: Under your management at Ruakura, can you breed a higher-producing herd than the bulk of the pyramid today?

A.: I do not only think we can, I think we have done it. The herd has, for the last five years at least, run at a rate of a cow to the acre on grass alone with no supplementary feeding. We have had an average of more than 400 lb. butterfat per cow and 450 lb. per acre and it is getting near to being the top dairy herd of the Dominion today. Already we have done 515 lb. of fat this year. If you put a normal amount of concentrates into those cows in addition to their normal feeding on grass, you would get another 100 lb. butterfat per cow.

Q.: Is it not that you are giving the cow the benefit of the good farm management and the wonderful pastures you have at Ruakura?

A.: Those of you who know the No. 2 dairy farm will agree with my description of it as a farm which is on a very poor soil

type (70 per cent peat) carrying a pasture described by Sir Bruce Levy as "extremely poor"—browntop, fog, sweet vernal, flat weeds, ryegrass and white clover. It is nothing like as good as the rest of Ruakura. It is topdressed very little, with no potash, and there is no seeding or pasture renewal and no techniques adopted at any time to improve paddock productivity. Many North Island farmers say the cattle are too good for the farm.

Q.: In the selection of bulls do you take type into consideration at all?

A.: I haven't selected a bull for 18 years. I use bulls selected by the Dairy Board on their sire-survey rating. They are all pedigree bulls. A sample of the daughters of the bulls is looked at to ensure they are free from defects of commercial importance such as bad udders, and a member of the Breed Society helps with this inspection. But in general, type is not taken into account in A.B. today. Type has certainly not been taken into account when culling the No. 2 herd.

THE VIEWPOINT OF THE PEDIGREE BREEDER

A. W. Montgomerie, Mangere, Auckland.

At the outset I want to make it perfectly clear that the views expressed here are my own and not necessarily the views held by any organisation to which I belong. I certainly don't want any of those organisations held responsible for my ideas.

The theme of this paper is a plea for a greater degree of co-operation between the agricultural scientist, the geneticist and the statistician on the one side, and the breeder and breed organisations on the other.

That the breeder has made a large contribution to our national economy cannot be denied. The last figures published show that the average butterfat production for pedigree cows was 23 lb fat greater than for grades. The N.Z. Friesian Association take considerable pride in the fact that the most recent sire survey booklet shows that of all the Friesian bulls surveyed that year more than half reached merit standard. Over the last five years there has been a small tendency for the number of tested cows to drop, yet in spite of this there is a greater percentage of elite merit cows each succeeding year. It would appear that breeders are paying attention to those fundamentals that produce cows that work and wear. Dr Hamilton in his address to the 1954 Animal Production Society Conference said that the output of livestock products has increased fourfold in the last 50 years. Carrying capacity has been doubled, output per stock unit nearly doubled and this with only seven per cent increase in area. This fourfold increase in livestock output has not been uniformly spread over all phases of livestock industry. Dairy production has increased over tenfold. We pedigree breeders suggest that some of this great increase is due to the use of more efficient cows, as well as, of course, to greater use of fertilisers and improved pastures.

It has been said that to breed dairy cows we shall have to balance art with science, reason with imagination, knowledge with experience. The more we have of one, the greater our need of the other. Stock breeding like other creative work demands the exercise of all our faculties. It is not a pure science. With nature two and two do not always make four. It is the gap between practice and science which the intelligent breeder of today is called upon to fill, and which the man with imagination and initiative, and perhaps luck, has succeeded in filling. Unfortunately many breeders, who have the faculty for learning directly with their eyes and ears, do not take readily to the ideas of research workers, and in fact in neglecting these findings, the breeder is in the position of throwing out the baby with the bath water.

Could I take in turn each section connected with dairy-cattle breeding, to see where our differences are, and to suggest remedies, and to start with the agricultural scientist on this vexed question of type? It has been fashionable in certain quarters lately to say that type does not matter, and that as long as a cow milks well we can overlook her structural faults. Unfortunately with certain species, perhaps the dog and the fowl, show-ring type does not go with utility and this fact has been a weapon against the idea of the necessity of type.

However, if in our ideas of correct dairy type, we adhere to essentials and fundamentals that are associated with longevity there

should be no argument. Nobody would expect the draught horse to run six furlongs in 1.12, or conversely expect a race horse to pull a load of turnips. Just as there are large degrees of difference of type in the two horses, so would we expect there to be differences in type between a cow living a long and useful life of high-production and the low producer or the cow that is finished early in life. The self-evident structural fundamentals that should guide us in our ideas of correct type for cows to live a long and useful life in the rough and tumble of commercial milk production, should be an udder of correct texture, good useful legs, a roomy pelvis, large muzzle and jaws, and large heart and lung room. I know it is impossible to tell the efficiency of heart and lungs by the amount of space they occupy, but to my knowledge nobody has yet succeeded in building a five horse-power electric motor to the size of a quarter-horse motor, so space there should be some criterion. Above all we like to see the dairy cow during her lactation in reasonably lean condition with angularity. The scientist sometimes offers the question, does a cow milk efficiently because she has the angularity or conversely because of high milk production does she get angular? However, does it really matter which comes first, as long as experience teaches us that angularity and efficient milk production go hand-in-hand. Is it not reasonable to assume that a cow that does 500 lb. fat and loses considerable flesh is a more efficient producer and requires less food than the cow doing 500 lb. fat and stays in heavy condition?

I freely admit that occasionally experienced judges make mistakes in evaluating a cow on type. For one thing the eye cannot tell the butterfat test, but so too are there mistakes in our testing. When our testing officer tells us that a cow has done a record of 400 lb. fat we know that owing to the idiosyncrasies of the cow on each testing day the record probably falls in the margin between 360 lb. fat and 440 lb. fat. The record tells us only that under a certain environment the cow has done somewhere around 400 lb. fat. It does not allow us to compare that cow with another cow of similar fat record in a completely different set of farming conditions. The wise farmer in evaluating a cow for genetic quality will always take into consideration her type and production record.

I infer from Dr McMeekan's address last year to the Waikato Jersey Breeders' Association that in the 80-cow herd that was well fed over a period of two years, 50 two-year-old heifers were added. This is a much higher replacement rate than is usual in our dairy herds, and I sincerely hope that it is not due to the fact that the A.B. bred cows which had been replaced could not live long and useful lives. As a member of the A.B. Committee I most certainly welcome his assurance.

I am in complete agreement with Dr McMeekan in his advocating that there is a real and definite need for most pedigree breeders to use A.B., especially the top sires through nominated services. To encourage this there is need for still greater liaison between the Herd Improvement Council and Breed organisations. Many years ago the N.Z. Friesian Association asked for, and was freely given by the Dairy Board the power to veto the use of any Friesian bull selected for A.B. for pedigree Friesians. This veto has not yet been exercised for the simple reason that the breed has been expanding rapidly, but it has given the N.Z. Friesian Association the opportunity of sending a responsible officer to inspect the progeny of each naturally-surveyed sire used in A.B.

No bull is perfect, and the N.Z. Friesian Association has on record in its office for the guidance of its members the strength and weakness of each bull. If a breeder wants to strengthen udders he can use bull A or B, or if his herd is weak in legs, he can avoid bulls C and D.

For a few years, the A.B. catalogues showed any weakness of any bull, but for some reason this course was discontinued. We must find some means whereby breeders of all breeds can easily ascertain the virtues of each bull used artificially.

The whole basis of A.B. rests on the accuracy or otherwise of our system of surveying bulls. I suppose the chemical analysis of a bull is the equivalent of about a dozen drums of water, about a hundredweight of lime, several pounds of lead-head nails and a few pounds of minor elements to taste. If such was the case it would be a very simple matter by using a chemical formula to give each bull a rating, but a bull is a living mass, and I expect is a little like us, some days below par, other days above.

Seriously, however, we consider the New Zealand system one of the very best in the dairying world, and breeders should be thankful for the help and guidance of sire surveys. The system practised by the New York Artificial Breeders' is nearly on a par with that of New Zealand, but over there they take into consideration the particular month of the year the cow calved. In New Zealand this doesn't materially alter the figures for our spring calving herds, but here in Canterbury in town supply the month the heifers calve could materially affect the rating.

In New Zealand with our growth of farm advisors there is a school of thought that a sire-survey figure is sacrosanct, but breeders consider the rating as approximate and only as a guidance.

Bulls appearing in the pedigrees in the 1959 A.B. Bull Catalogue are probably a fair random selection of bulls. A quick perusal shows that 18 different bulls have been surveyed naturally in two or more herds. Let me emphasise that I am not referring to the bulls used in A.B. work, but to the sires which appear in those pedigrees. The A.B. Catalogue is the only one in my possession that publishes these relevant facts and also covers many different blood lines. Some striking differences appear, e.g., Plus 59 in one herd, Plus 17 in another; Plus 63 and Plus 22; Plus 38 and Plus 2. Also similarities, Plus 32 and Plus 31. An average of the 18 shows their high rating to be plus 34 and the low rating to average plus 16. As these are all good bulls, nationally it probably doesn't matter, but breeders are interested in and must work with individuals.

The breeders' main criticism of sire selection based on progeny test is that over-emphasis is automatically placed on first lactation records with consequent selection for early maturity. Authorities including Dr Henderson of Cornell University, don't agree with us that this is a bad thing.

If a bull's two-year-old daughters have been exceptionally well done, and come from a fast maturing strain, and at a later date their actual mature production doesn't equal their two-year-old record added with the supposed age correction to give a supposed mature equivalent, this bull is over-rated.

Let me take the case of a large town-supply herd here in Christchurch. Looking ahead, a farmer sees he will be short of calving cows in a vital quota month. He brings in a line of heifers calving about 22 to 23 months of age. Being small and suffering competition for feed from older cows, these heifers cannot do their best but they have definitely fulfilled their purpose of producing milk when needed most. Next year the farmer may bring in heifers from the same bull calving about 28 months of age. Their production will be much higher, and yet both groups are probably the same genetic merit.

The mathematician does his best to tabulate these figures, but the bull who sired the heifers that calve early, or are slow developing and at a later date do more than their supposed mature equivalent,

this bull is definitely under-rated and suffers a stigma from which it is very hard to rise above. This position is further exaggerated by the reluctance of the authorities, probably owing to pressure of increasing number, to carry on the surveys from many years of mature records.

My observations of some extended surveys do show that some bulls' two-year-old daughters are disappointing as aged cows and it would be interesting to see the figures including only their mature records and omitting supposed corrections. An inspection of such bulls' daughters could show fundamental weaknesses, mitigating against longevity.

The probable argument against correcting these figures when the daughters have actual mature records would be that the bull himself would be too old for much use in the industry, but we say it is never too late to right a wrong.

As yet very little work has been done on the effect of hybrid vigour in dairy cattle, and this is probably another factor that has an influence on sire surveys.

However, no system dealing with reproduction analysis can ever be perfect and we must appreciate that the breeder today has much more help than those of 25 years ago.

I expect a simple definition of the aims and objects of a breed society would be to watch over its members' interests, and to promote the increase both in numbers and production of their particular breed, such as are the aims of the directors of any limited company. But a breed society is a service organisation and what is more important is a national organisation, and as such should at all times work to further the national dairy economy. It should be to the interests of any breed society to keep track of, and make use of, as many cattle as possible. Therefore I have long been an advocate of Dr McMeekan's proposal that Breed Societies should open their doors to high-grade cows of superior genetic merit. If initially they don't want to include these cows under strict control in their herd books, I suggest that they can at least keep a separate register with the intention of watching the progress of these cows with a view to full entry at a later date.

Because a man's ancestors came over with William the Conqueror, it doesn't make him any better than his neighbour. Man is judged according to his contribution to the national good: so should it be with cows.

I referred to the fact that the last figures available showed pedigree cows out-producing grades by 23 lb. fat. As we see the good grade herds in our dairying districts, breeders should use every tool available to stay ahead. After all, is it not better for our breed organisations to keep and use the figures of superior grade cows, than for some central Wellington office to do so?

Breed organisations should give serious consideration to changes in classification. As well as the broad classification into which a particular cow is placed, it would be desirable to have break-downs under such headings as mammary system, feet and legs, body capacity and head. Later these findings could be tabulated in the office, and it would be easy to find which bulls were siring certain qualities or defects.

Even with the help of his breed society and the Herd Improvement Council the individual breeder will need all his ingenuity. Naturally at all times he should have his herd under test, but in evaluating cows he must use figures intelligently to differentiate between genetic merit and environment. High herd averages should

be carefully considered until something is known of management and stocking rate, etc.

He should occasionally read simple books on elementary genetics—if there is such a thing. He need not necessarily agree with the authors, but he will at least think for himself even if it is only to give him some understanding of the doggerel which may be not quite correct about “the chap who went to bed with a darkie, the result was one white, one black and two khaki.”

I would here commend to our monthly journals that they publish a short series of articles on breeding.

The breeder must be tolerant of new ideas. In the light of modern genetics, and the greater use of A.B., the Auckland Agricultural and Pastoral Association has been trying to take the emphasis away from the showing of bulls. To this end we substituted the normal group of three cows and one bull with a group of four cows. A small change, but in our view a desirable one. The hue and cry was terrific, even taken to national level!

In any discussion on animal breeding eventually the subject of agricultural shows arise. A show association is also a servicing organisation, an organisation to promote agriculture and to educate farmers and breeders. Unfortunately, on account of expense, most competitions are for individuals instead of group classes. Any breeder knows we should not attach too much emphasis on one single animal. We desire to see the whole group, or at least a fair representative selection. A. and P. Associations should be encouraged to give their bigger prize money for groups. We look to the co-ordinating authority of all A. and P. Associations, the Royal Agricultural Society, to give a lead in this direction. Unfortunately, as I understand it, the Royal Agricultural Society under the Royal Charter through which it operates, has little power, and consequently is not in a position to enforce any progressive ideas. However, it would be advisable if they could give an important lead such as changing their schedule by deleting many bull classes and adding worthwhile progeny classes at their own annual show. By doing so the desirable changes could gradually seep down through the whole A. & P. strata.

What is the solution for this position in the breeding industry where opinions are apt to be so numerous concerning topics in which facts are so few?

A conference should be immediately called with representation from our leading scientists, geneticists, the Herd Improvement Council, the breed organisations, breeders, and the Royal Agricultural Society. Each man must sit with one idea—that which gives us the best policy and plan for our dairy industry.

At each annual meeting of the Dairy Breeds' Federation, representatives are invited from some of our animal research stations. Frankly we have been quite disappointed in what they have offered to our discussions.

Finally it is important that there should be added to the suggested conference a delegate from our national selling agency.

Over the last 50 years, all financial data pertaining to our export trade have been expressed in so much per pound of butterfat. Butterfat has been emphasised at all times, although we know that there are other most important constituents of milk. With the greater increase of tanker collection of whole milk, and the relatively better position of cheese, there is a growing awareness of the value of solids-not-fat or protein of our milk.

Mr Sen, Director General of the United Nations' Food and Agricultural Organisation said in Auckland recently that at present one third of the world's population had an inadequate food supply and

that there was a lot of truth in the statement that a majority of the people in the world might be starving in the future.

I suggest that some day there will be a real need for this relatively cheap source of high protein, and it would be a great pity if we developed a national cow that was not readily adaptable to meet this situation. It would take at least ten years to change the emphasis of our national herd, and a senior member of our selling agency is in the best position to judge the demands of the future.

It must be with the help of all these organisations that the breeder will go forward and play his considerable part in the economic future of New Zealand.

Q.: Why did you get so little help from the research scientist at your Dairy Breeders' meeting each year?

Mr Montgomerie: I do not know. We fought among ourselves for several years about the question of inviting them and when we got them we were disappointed with what the research workers gave us. We hope next time Dr McMeekan will come himself.

Dr McMeekan: There seems to be some misunderstanding on this issue. My organisation has received an annual invitation to be present at the meeting in question but never to my knowledge were we actually asked to make any contribution. All I have done was to see that one member of my staff sat in on this meeting just to tell us what happened. If the Breed Societies or Combined Breeding Organisations really are interested in receiving information from our institution they will have no trouble in getting it. In the past my experience has been that they have been most antagonistic to scientific people who likewise have regarded breeders with a certain amount of suspicion. We must have two-way co-operation.

CONSTITUTIONAL VIGOUR IN DOMESTIC LIVESTOCK

J. R. Little, Hui Hui, Hawarden.

This paper is concerned with the importance of constitutional vigour in domestic livestock. Its intention is to define constitution; to emphasise the importance of constitution; to indicate some of the problems possibly created by its neglect; and to offer some suggestions which may help to avoid such neglect.

The term "constitution" is given many shades of meaning. It may be defined as "life force," "vitality," "viability," or just the ability to stay alive. For its use in relation to animal life in general, this very rough definition is probably that usually implied—the ability to stay alive.

(This is quite apart from the rather cynical definition given by those who claim that it is merely the excuse offered by stud breeders to explain away coarse bone in a cattle beast or rough britch in a ram.)

While this generalisation has been sufficient, when we merely talked of constitution as a rather necessary, but very nebulous characteristic, and one that just happened like "Topsy"—either an animal had a strong constitution or it did not, and there was usually enough of it to go round so it remained something vague, and this general idea was sufficient.

However, I suggest that the time is very rapidly approaching when this old evaluation of constitution as being something that was just floating around anyway, will have gone—if it has not already gone. There just is not enough of it floating around any more.

And I further suggest that of all the characteristics of our domestic animals, whether those controlling the quantity of their production in milk, meat, lamb or wool, or the quality of that production, by far the most important one for the next few years is going to be this completely neglected one of constitution. The essential thing is not going to be the increase or improvement of our animals' production—it is going to be to keep them alive at the production plane we expect, and under the conditions that we are providing for them now.

As it is impossible to discuss any subject as a nebulous abstract, I make no apologies for attempting to clarify the term "constitution"—somebody has to try and at least it will make clearer to me what I am talking about.

I should make it clear that I am not attempting a dictionary definition, but only a definition of the term in this specialised usage of viability.

As this characteristic is the primary essential in all animal life, one must consider wild-life as well as domestic livestock in order to obtain some understanding of its complexities. And particularly so, as constitution in its least-complicated form is found among wild animals in their natural state (before we put them on to improved pastures and the stud breeders got hold of them). In this connection a wonderful field of study in animal constitution and behaviour is becoming increasingly available in the game reserves of Africa, where vast areas are maintained in the natural state and where animals under completely natural conditions have been under close and sympathetic observation for many years. I am referring to the Kruger Park type of thing.

In its broadest sense constitution in this specialised usage means the ability to live in health.

But as this health must be maintained under the wide variety of conditions existing on earth, and as obviously those physical characteristics which make this object possible in Polar regions will not attain it under desert conditions, any general definition must include the factor of environment.

Thus, "constitution," in a slightly narrower sense, becomes, "the ability to live in health under the conditions in which the animal exists."

At this point, part of the reason for the confusion attached to the term becomes apparent—we have one expression covering two quite different abilities. First is the basic physical toughness which enables some individuals in any group of any species to maintain a greater reserve of vitality than the remainder of that group under similar conditions, and not merely because physically they are more suited to those particular conditions, but because they are more vitally suited by reason of a more efficient or stronger "internal economy," set of vital organs: heart, lungs, liver. This is a sort of vital or basic constitution occurring in every species, and any group of any species, and varying in degree of presence with every member of the group.

And secondly, we have the specialised physical characteristics developed in the various species which enable them to maintain this health in their particular environment—a sort of environmental constitution.

So we have "basic constitution," which means that one polar bear has greater reserves of vitality than the rest of the polar bears, and "environmental constitution," which means that all polar bears are better able to maintain health under Arctic conditions than say the very best of camels.

While it is elementary, it is essential to accept the vitally important fact that the production of any attribute of an animal, whether blood, bone, muscle, fat, hair, hide, wool or energy itself, creates a demand on the vital organs, the vitality, or the basic constitution of the animal. The conversion of foodstuff to another form of matter alone requires energy, additional blood, additional oxygen, and this also creates a demand on the environmental constitution by the necessity to carry out this conversion under the conditions of existence.

These demands are greatly increased when production is surplus to the animal's individual requirements, as is the case in reproduction when there must be a surplus, or reserve, of both basic and environmental constitution to develop the foetal growth and feed the progeny at a later stage. The parent must have sufficient constitution to maintain its own health, and a surplus of constitution sufficient to develop and feed its young.

A further important point is that those constitutional reserves occur in all animals in a great variety of degree. These reserves may be inadequate, in which case the animal dies at the first slight additional demand made upon its constitution. Extra demand may come through a slight increase in production demands, or through slightly adverse conditions or by the faintest impact of illness. These reserves may be adequate, and can cope with all normal demands made upon them by their environment. There may be a constitutional reserve greatly in excess of any normal demand. It is from these constitutionally-superior individuals among the original wild stock that our present-day improved, and highly-producing strains have been developed.

I am prepared to hazard a guess that, of the first ten wild cows trapped up a gully by the first cave-dwelling stockman, five of them died. This would not worry our ancestor quite so much as, despite a lack of refrigeration, he probably ate them anyway. But that would be the first step taken in culling for domestic cattle; not how much

milk they produced, or how suitable their carcasses were, but whether they stayed alive in the new conditions.

Among animals in a wild state, Nature makes only one demand—apart from maintaining life and health on the constitutional vigour of the animal—that of increasing the species population. (Nature strives for an increase in population, not merely a maintenance, as she wants a reasonable culling percentage like everyone else.) The production of all physical attributes in the wild animal is kept to the minimum required to fit the animal to its particular environment, to maintain its environmental constitution.

When we come to consider constitution as related to domestic animals the thing becomes even more complex because in these animals we demand production of one or more of their physical attributes, very greatly in excess of their normal environmental requirements, and also in most cases in a form greatly changed from the original.

To take one common example some two or three pounds of mixed short wool and guard-hairs satisfied the environmental needs of sheep in their original wild state as it does today on Tibetan sheep in the extreme cold of Outer Mongolia. The amount of this covering is held in a very delicate balance between their environmental needs (as a covering) and the demand placed on basic constitution required to produce it on the available feed.

Similar examples, of course, occur in all our domestic stock.

So we must add still further to this definition in its final relationship to domestic livestock, and include the production factor, which will give up something like this:

“Constitution is the ability to live in health, and produce the maximum possible of those commodities for which the animal is kept, under the conditions in which it is maintained”—a sort of domestic or commercial constitution.

I have spoken of three separate types of constitution. All three enter into this definition. All three nevertheless remain individual qualities, which interact to produce what we call simply, constitution in our domestic animals.

In these terms constitution becomes a characteristic of infinitely variable degree, with the adequacy of that degree depending on the demands made upon it by the extent of production and by the conditions under which that production is made.

It is like the horse-power rating of a tractor. Whereas an eighteen horse-power wheel tractor may be capable of pulling three furrows on flat, free-working soil, it is not capable of pulling six furrows and it cannot pull any furrows at all on the steepest of stiff-clay hill country.

So the adequacy or usefulness of this horse-power is entirely related to the load imposed on it and the conditions under which it performs.

If we accept this definition with its required three point balance of Basic Constitution, Production Demands, and Conditions for our livestock, and relate it to modern farming practice, we find an increasing tendency to totally ignore one of these essentials, emphasise a second one to the limits of genetic possibility, and change the third essential as rapidly and violently and unsuitably as human ingenuity and mechanical efficiency is capable, and all with an utter disregard for the inter-relationship between any of them.

In this sort of mad gallop into the wild blue yonder, stock farming practice is being dragged on by an exuberantly assured science in front and spurred on by political and economic expediency from behind.

We are encouraged to throw away the concept of basic constitution altogether and replace it with veterinary science, to ever increase the production of the animal irrespective of its ability to produce or sustain that increase of production, and to force the animal to do this under conditions of which "more" is the only criterion and "suitability" never considered.

We have got the six furrows on that little 18 h.p. tractor and we are headed for Mount Cook.

I said earlier that constitution represented the one great overall problem facing our livestock industry, and the statements of a growing body of both farming and scientific people confirm this; that is, if we accept the fact that the significance of constitution lies in the balance held between those three factors—basic constitution, production, and conditions. Basic constitution in itself is of great importance but basic constitution, in its relationship to conditions and demands of production, becomes all important.

I am quite certain that the alarming and ever-increasing ill-health and mortality in the livestock of this country is, in virtually all cases, brought about by the disregard of this essential balance. Tragically it is rather more than disregard; it is by the deliberate creation of this lack of balance. And I am equally certain that in direct ratio to the extent and rapidity with which we continue to develop this situation, so will a decreasing number of individuals be found among our livestock capable of coping with it—and an increasing number will die.

I referred to Nature's demand for a culling percentage. This is necessary because of the continual production in Nature of those variants from the normal or general type of any species which make an evolutionary process possible. Under any change of conditions in which a species exists, Nature has some off-types, superior in one way or another in varying degrees to suit any new conditions. Under normal circumstances these off-types are discarded (the factors which make them superior for new conditions sometimes make them less suited for the old) but under changed conditions the most suitable of these variants becomes the nucleus of the adjustment to the new conditions.

It is very definite that in our livestock we are going through a violent evolutionary period, and that we are in effect in the process of isolating strains within our breeds to suit a violently new set of conditions, and I repeat that the more difficult we make these conditions, then the number of individuals found capable of meeting them will be fewer.

I do not agree with the opinions which have been freely expressed that we should revert to the 200-gallon milk yield or to the three-pound fleece; nor do I agree with the suggestions that we should go back to the native pasture carrying half a ewe to the acre. This is a challenge which can be met. After all, the same evolutionary process has shaped the whole of our farming industry from its very beginning, and our livestock have gradually evolved with the gradual change of conditions. Our present problem is greatly accentuated by the fact that today our technical ability enables us to change those conditions to an undreamed of degree and, what is worse, with undreamed of rapidity.

While we must learn to live with this problem and fully utilise that technical ability, at least let us recognise that it is a problem and use every conceivable means to lessen its impact wherever that is possible.

There is a military dictum in attack, "No exploration without consolidation," meaning that one should make sure first of all that one can hold the positions one has gained before proceeding to take

further positions. And a major problem with insufficiently disciplined or co-ordinated troops is that the enthusiasm engendered by a successful attack may very easily cause them to forget about consolidation.

I suggest that the recent great advances made in livestock farming by the combined efforts of research workers and livestock farmers, including the stock breeder, represent such great steps forward that we have reached a stage where some thought to the matter of consolidation has become essential.

And the next decade, particularly in our livestock farming, must be devoted more to confirming and consolidating the very great advances made, than to blindly continuing to move on from an already precarious position to a possibly even more precarious one.

The increase of spasmodic flare-ups of ill-health and mortality among all classes of livestock, all over this country represents, to my mind, a loud and clear warning that for the next few years at least:

1. We should not continue to concentrate on increasing our animals' production to the brink of danger unless we ensure that they have also the ability to sustain that production, and particularly unless we ensure that our created environment is suitable for the animals at that production level.

2. We should not continue to develop higher-producing pasture, either by plant breeding or by managerial methods, until we ensure that such additional feed production is not merely greater quantities of a less suitable product, but that feed production is related to the animals' complete requirements.

3. And, we should not continue to devise methods whereby we can carry more and more stock on a smaller and smaller quantity of soil until we can ensure that all the minerals, elements and what have you that go to make up that soil are present to a degree that can sustain the full health of the additional animals, as well as sustain their production.

Any such suggested review and consolidation of the constitutional vigour of our livestock, if considered on the basis of this three-point balance, will naturally divide into the three groups comprising that balance: Basic or inherent constitution, production demands, and conditions.

The points raised in the final portion of this paper under these headings, are, I suggest, some which could repay consideration.

I should emphasise that few of the opinions and suggestions contained in this paper are original. They are, rather, a composite of opinions, observations, and ideas of a great number of people—some agricultural scientists, medical people, game wardens, farmers from nearly every area where stock of any variety are raised, and a hard core of several hundred breeders containing many of the most successful and experienced stock men throughout the world.

Basic Constitution

The first essential under this heading is to recognise and accept the existence and necessity of constitution at all.

I once drove some 120 miles on a cold, wet night in order to hear Dr John Hammond—in this hall—contemptuously dismiss the whole idea of constitution, using the example of milking cows to indicate that constitution merely described the ability of an animal to utilise too small a percentage of its feed-intake in milk production, and take too much of that feed intake for its own use. (That is low cunning not constitution.) And, while such animals do exist in all domestic livestock, constitution cannot be dismissed as easily as that. The whole pattern of wild life proves this, even if sick and dying domestic stock did not.

Constitution, as a factor, exists and is, in fact the primary essential.

A second viewpoint is that constitution is not important anyway because you have two vigorous sciences—veterinary and animal nutrition—that can now take the place of constitution. This may be to some degree true in the case of stall-fed stock where the diet is under complete control and the attention is simplified and constant.

But, in the case of animals maintained under conditions and on pastures of varying degrees of suitability, this idea becomes not only an economic impossibility but a highly dangerous fallacy; and, even in the case of the stall-fed animal, the production demanded requires basic constitution plus a safe reserve, particularly when to pay for this type of husbandry in unsubsidised farming, production must be at a very high level.

A further theory which can have a harmful effect on the constitution of our livestock, is one already mentioned. It could be called the "Topsy" theory, which at least admits the existence of constitution but considers it "just something that happens"—a factor automatically present to the full degree required by the production potential of the animal. This theory holds that, if you could develop a ewe with a potential production of three or four lambs, the milk to feed them and an 18 to 20 pound fleece all at once, and could induce her to produce this full potential, the unfortunate animal is somehow automatically supplied with a basic constitution sufficient to do it all with a careless laugh. Certainly those animals capable of higher production frequently have also a better constitution to support this production; but this is very far from being an absolute rule. It may, in fact, be less general than we like to think.

Basic constitution is a separate and individual characteristic and, in breeding, must be regarded as such.

Thus any programme of selective breeding which does not give full weight to this factor and treat it as a separate and primary essential, may well end in permitting the development of constitution which is inadequate. The breeding programme must be kept in balance for all factors.

Another point possibly worth further consideration is the effect on constitution of any violent change in the physical characteristics of an animal type where these characteristics have been moulded by thousands of years of evolution. This process has achieved for the animal an exact balance with its environment. It is perfectly equipped for the business of staying alive. I grant that for our production requirements and our domestic conditions we must alter the original animal type, but we should consider just how greatly, and how rapidly we can make these changes without harm to constitution, and must further consider the changed type in its relationship to these new domestic conditions.

A final point on this group is one that concerns stud practice—not breeding concepts.

I suggest that a grave danger to the future constitutional vigour of our livestock can lie in the over-reliance by stud men on preventative and curative veterinary practice. I repeat, by over-reliance.

This suggestion does not apply to the commercial flocks and herds. These may use every assistance offered by veterinary science to the limit to which this is necessary, and is economically feasible, without greatly affecting the future constitution of our livestock.

In fact, we owe a large debt to that great and long-suffering veterinary science. It has covered up most of our mistakes so far. In the possible chaos which may lie ahead of our livestock farming, this science could become our only hope, just as today it is a major factor in keeping continued production possible.

But the studs are a rather different matter, as this small group of animals carries the grave responsibility of shaping the commercial livestock of the future.

I think that the soundest bit of breeding theory I received from a long family tradition of stock breeders was when I was told, "It's not a bad idea to let the Lord do some of your culling for you. He doesn't make a bad job, you know. He has been at it a bit longer than we have."

I happened to quote this to a visiting Australian during one of Australia's droughts. The Australian smiled rather sadly and remarked that, in that case, the Lord was having a fair lash in Queensland at the moment.

I do not suggest we go to those lengths.

To refrain from using every assistance offered by veterinary science and farming practice, in an emergency, would be absurd, in stud, as well as commercial animals.

It is even essential, in the case of studs, to use some veterinary aids to meet some of the problems created by new conditions or to lessen the impact of others; but, to rely completely on veterinary science to answer these problems among our stud animals, can only prevent any evolutionary process taking place at all, because those blood-lines more constitutionally suited to the new conditions remain hidden among the mass of animals surviving only by reason of increasing veterinary attention. The so-called breeder has discarded "selection" as a tool and replaced it with a hypodermic syringe and a drenching gun.

It may be that this situation is inevitable among livestock maintained under the completely artificial conditions, mentioned earlier, made necessary by decreasing areas of farming land in the face of increasing human population, but the whole system is only made economically possible by the high rewards obtained and retained by the producers through the high local value of their products, their low costs of disposal, and the increasing use of subsidies.

Under pastoral conditions where the only competitive asset we have is comparative cheapness of production, we cannot afford to throw that one asset away. We cannot afford to replace something which Nature supplies free and only requires the application of certain effort and skill to utilise, with an alternative which, while requiring very much greater effort, is by no means free.

Also, we should remember that Nature frequently only produces or retains a characteristic to the degree that the characteristic is required.

Remove the need for a characteristic and Nature may remove that characteristic, and this effect sometimes pyramids. An original lack of natural enemies in New Zealand made the need for flight unnecessary—and look what happened to the kiwi!

In the case of constitution we are not dealing with a character capable of this complete elimination, but with an essential which must be retained.

Production Demands

The primary danger under this heading is occasioned by the economic necessity to develop the "thrifty" animal—the animal which uses the maximum possible of its feed intake for commercial production and the minimum possible of that feed for the business of living. Such animals are, and always have been, the aim of the breeders. We have included that fact in our overall definition of "constitution," but in all cases the key is not the word "production" but the word "possible."

As one of the greatest Merino men has pointed out, "A live cull must always beat a dead champion," and when production demands

place too great a strain on animal health, we must re-examine our conception of what is possible.

An increasing awareness of this fact is becoming apparent among breeders (a quite spontaneous and world wide thing). It has, in fact, been accepted for many years in most of the breeds capable of multiple production, the fact that an accepted low production in one characteristic permits the animal's available constitution to sustain very high production in another. The constitution of the Merino is deliberately partly assisted in the ultimate high production of high-quality wool, under minimal feed conditions, by permitting a very slow maturity and making no demands for meat production.

The Clun Forest sheep, with its very high lambing factor, produces this with no demands for wool production whatever, either in quantity or quality, beyond the exact requirements of its environmental needs.

Santa Gertrudis cattle forego much in ideal carcass conformation in order to achieve suitability to environment.

We have it in the Southdown where extremely early maturity is the predominant factor, and weight of wool is not demanded, and foraging ability is not required.

There are many more examples of these highly efficient specialist breeds.

In breeds such as the Corriedale where multiple production is required, a general pattern indicates that such sheep are capable of producing, under suitable conditions, some 12 lbs. of quality wool, a 120-130 per cent. lambing potential, lambs with something less than the Southdown's speed of maturity, sufficient milk to feed them, with adult sheep reaching full maturity with somewhat greater speed than the Merino, and retaining adequate constitution for this balanced output. But under less-favourable conditions, or by over-emphasis on any one of these factors, one can cause a decrease somewhere else—or a possible insufficiency of constitution.

These rough figures are greatly dependent on conditions and represent only the approximate pattern at present. No animal breed reaches a final development except by extinction.

I mention the Corriedale in greater detail because I am more conversant with it, and also because of the greater demands made on its constitution by the very wide range of conditions under which it is used throughout the world. These demands have resulted in overall constitution in this breed receiving possibly more attention than in more localised breeds, and the dual-purpose production of this sheep type requires rather more attention to exact balance in production.

The other familiar dual-production sheep breed, the Romney, produces a similar multi-production pattern where, if a balance is upset in any way, some compensatory factor emerges to re-establish that balance.

All this further emphasises the necessity for the maintenance of that balance between basic constitution, production demands, and conditions.

Conditions

It is probably in this field that science and the stock man reach the widest divergence in their views.

The research worker must, for scientific accuracy, maintain a cold, dispassionate outlook towards the subject of his research. When that research concerns livestock this outlook forces the scientist to consider such livestock, not as animals, but merely as production units.

The scientist's primary object with any animal is (rightly so) the accumulation of scientific knowledge. The stockman's primary object is to keep his animal alive.

A dead or dying animal represents, to the scientist, only a num-

ber on a list or a change in a graph, and even its death will add a scientific fact, one way or another, to knowledge of that animal. It proves something, and this attitude is essential for research work.

A similar animal in a similar condition represents to the stock man a continuing challenge, and a rebuke to his efficiency while the animal lives, and the ultimate affront to his skill and ability when it dies.

A rather more cynical reason for the calm of the scientist and the despair of the stock man in such a situation is that somebody else buries the scientist's animal while the stock man has to dig his own hole.

I mentioned that the consideration of an animal as being merely a production unit was necessary for research work, and so it is— for research work.

But the growing acceptance of this dreadful cult in farming practice, with its attendant deterioration in the management, feeding, and handling of livestock, is deplorable.

We have:

1. The development of pastures with one aim. Efficiency of production of bulk just as bulk, and not efficiency of production as animal fodder at all.

2. The entire elimination of any possibility of animal selection in grazing, caused by the dual-species pasture, without much (if any) investigation into the value of that selective grazing.

3. The conception of palatability as being just something an animal likes rather than considering whether it may indicate something the animal needs. In all natural breeding, no characteristic is developed unless a use for it first exists, thus the sense of taste is present for the avoidance of harmful food and the selection of beneficial food. Here again it may pay to consider the use of this free, built-in method of evaluating this aspect of our pasture plants.

The artificially induced "fertility-spiral" has been already dealt with by much abler hands than mine; Mr Stafford's paper discussing this subject at last year's conference, remains a classic.

In support of his warning one can point to the increasing situation where the use of dual-species, shallow-rooting pastures, of a completely permanent nature, are maintained on this dangerous fertility, where in extreme cases we expect our livestock to "live in health" on what is virtually the product of their own dung; and remembering that this dung in itself is the product of the rejection of many previous generations of animals.

This does give point to the suggestion that the next logical step in efficiency would be the elimination of the grass altogether.

All these practices can be attributed to this "production unit" conception of animals, and to the complete disregard for their requirements attendant on specialised research and development being concentrated by specialists on pasture as pasture and not as animal food.

This cult is also responsible for a growing decadence in our stock handling and managerial practices.

The use of livestock in mixed farming primarily to condition pastures, or prepare for small-seed harvests, and only as a very secondary consideration to satisfy their own requirements is wrong. For small seeds it may be necessary to some degree, but to put consideration of pasture before consideration of stock, borders on the ridiculous.

The violent changes in feed availability occasioned by too literal a translation of the "flushing technique" and, in fact, violent changes in any feeding programme, make for the worst forms of stock management.

The list here is legion right down to the actual handling of animals, including the barking dog and the 30-mile-an-hour lambing

shepherd recently complained of. I do not, in this case, decry the use of "Landrover" shepherding; but do decry the attitude to stock which creates misuse of it.

Conclusion

The overall purpose of this paper is to emphasise that in any period of review and consolidation, and in all future research relating to an agriculture which includes livestock, a far greater degree of co-ordination between the experts must be created, and experts in livestock should be included as experts.

A subject as complex as this one of overall constitution calls for balance, and this cannot be achieved while each branch of science treats its subject as an individual pure science in itself, right to the final stage of its adoption into farming practice. The initial stages of any research must be specialised and individual to that branch of science concerned, but at later stages it must be integrated with all branches of related science, as its final value and use will exist in such inter-relationship. As this then must include livestock, let people with a feeling and understanding of livestock play some part even at that stage. And such a viewpoint becomes essential in the final stage of interpreting the results of such research in relationship to livestock, and also in the application of such results in actual farming practice.

This calls for a rather greater recognition of the stock man even in his specialised form, the animal breeder, than science accords him at present. He is not a charlatan; in some cases he is reasonably intelligent, and in most cases is dedicated to the welfare of his stock as the scientist to his branch of science. But he rather feels that he is entitled to the status of co-operation with science rather than merely dictation from science. Even if his knowledge is unscientific this can be a balancing factor, and at least his viewpoint could be invaluable.

The question of closer co-ordination among all branches of science (and the one branch of art) could only be brought about by some form of overall co-ordinating body, not by any means dictating, but integrating all research. I suggest that some such body would represent the greatest step forward in this country's agricultural advance, that this very devoted, and brilliantly-able science could take.

If the latter part of this paper seems to contain only a critical questioning of scientific theory and practice, I wish to be very clear in my assurance that this does not represent my attitude to the multitude of practice and theory already given to agriculture by the brilliant and dedicated work of scientists, where that theory and practice is wholly beneficial. In this suggested review of our advances, one only indicates those points which may require further consideration. One accepts, in grateful silence, those of proven success.

I suggested the need for far greater co-operation and a greater mutual understanding.

One feature of the whole history of mankind is its endless search for more knowledge, and eager acceptance of new facts. The more obscure or mysterious the source of these facts, the more readily the facts are accepted, and the greater the veneration of the layman for the source of these facts becomes.

In its most primitive form, this phenomenon is evidenced by the power wielded by witch-doctors and medicine men among native tribes, through the special positions held by the philosophers of medieval times, and the "teacher" throughout the ages, right down to the present day where science has become our coping stone of knowledge.

It is possible that we render a great disservice to science by our unquestioning acceptance of every statement emanating from a scientific source, just because of that magic word. It is unfair, in that it

places all responsibility on science and demands an utter and complete infallibility. Unfortunately, history also points to a dual danger inherent in this veneration.

An unreasoning acceptance of infallibility can cause an equally unreasoning rejection of the whole thing at the first isolated sign of fallibility.

One neither should nor can question pure scientific fact, but it is the specialist layman's responsibility to at least assist in any specialised interpretation of those facts, and even more so in the application of them to specialised usage.

Shakespeare may have had this in mind when he suggested that there may be more things in heaven and earth than are dreamed of in one man's philosophy.

Q.: What are your views on the crossing of two distinct breeds and its effect on constitution?

Mr Little: It's a thing I have mixed views on. From the beginning you do get hybrid vigour—undoubtedly; but it is a fading factor. You can retain it by breeding for constitution as a separate factor. The ultimate fate of your crossbred depends entirely on how you breed for constitution. The variation which you get in your third and fourth generations means that your culling has to be severe to get the characteristics you want and you are inclined to reduce your culling for constitution.

Q.: We find in the stud flocks (it is true at least of Romneys and Corriedales) that over one third of the ewes in the flocks are two-tooths and a large proportion of stud rams are sold out of two-tooth ewes. How can you select for constitution under conditions like that?

A.: I assure you that is not the position in the Corriedale studs I'm most familiar with. In my own stud it has been a policy for many years to have at least two-thirds of the ewes six-tooth and upwards and we have many ewes 12 to 14 years old. They are kept for the express purpose of breeding for longevity and constitution. It is a very dangerous practice to rely on young ewes.

THE IMPROVEMENT OF FRONT HILL-COUNTRY IN CANTERBURY

H. C. A. Sidey, Hawarden.

I farm an area of 2,300 acres near Hawarden. The area of tussock is 1,600 acres running to 2,000 ft. which is the beginning of the Virginia country.

Up till 1939 we were doing what most farmers on that type of country were doing. We burned fairly extensively and over the 18 years previous to 1939 I had seen gradual deterioration in the country particularly on the sunny faces. We burned in the spring, the latter part of August and early September, in fairly large areas. Through the country not being sufficiently subdivided, sheep could camp on the freshly burned country giving it little opportunity to get away. The unburned country not being so palatable got away to a rank state and had to be burned the following year or so.

This system is still being followed by some farmers throughout the area.

In 1939 I felt convinced that if I continued with the existing policy the real value of the land would before long be reduced by half. On the other hand, an improvement programme, if followed through for 15 years, could double the real value of the land in that time.

The main species present in the area were Silver tussock, a fairly heavy coating of Danthonia, some cocksfoot and some wild white clover.

I planned three forms of development.

1. Surface sowing the ridges where it appeared most necessary.
2. Experimental topdressing.
3. Restriction on burning.

1. We sowed cocksfoot, white clover and perennial ryegrass. This was before the days of the use of the aeroplane on hill country and all seed was sown by hand while riding a hack with a bag of grass seed on the saddle in front of the rider. With this height we got a fairly good distribution of seed. With a good walking hack we were able to cover a lot of country in a day.

We sowed in the spring on country which had been burned 12 months previously. There was then sufficient cover to protect the seedlings.

We saw very little of the ryegrass but got good strikes of cocksfoot and white clover, cocksfoot being slower to establish.

2. Experimental topdressing.

The same spring we started topdressing with 1 cwt. Serpentine superphosphate with a topdresser drawn by two horses. In this first year we did patches on various parts of a 400-acre block covering about 30 acres in all. The results were so obvious that the difference in the topdressed areas could be seen up to a mile away. For a few years we continued to topdress suitable areas with the horses with encouraging results.

Then came the aeroplane. In the first two years we did 200 acres each year and in the following year the 1,200 acres remaining.

3. Restriction on burning.

This is essential, as before cattle can be grazed a certain amount of roughage must be left for them. In other words, the roughage is the hill-country farmers' hay. At the same time we found it necessary to burn areas which had a thick covering of matagouri. Cattle will often avoid matagouri as much as sheep.

When burning country where a certain amount of burning off is essential, it is a good policy to light the fire near the top of the face and work downwards lighting fires every chain or so down the hill. By this means, one does not have the roaring fires that eventuate when they are lit at the bottom of the gully and go to the top. It is the intense heat of the fire raging up a face that does so much harm to the vegetation and even on good country starts erosion.

Sheep numbers were increased only slightly as far as the tussock flock was concerned but wool weights increased by at least one third. Before the development programme started the tussock country was not good enough to carry the stud ewes if we wanted to spell the paddocks. Now the stud ewes go on to the tussock about the beginning of February until about 20th March. The feed provided at this period has been particularly valuable during the last two drought seasons.

Fencing

With an improvement programme more subdivision is necessary unless the area has already been fenced into suitable blocks.

In our case the profits from the cattle were used to finance the topdressing programme as well as the subdivision. The 400-acre block nearest the homestead was divided into four blocks of 100 acres each. The 1,200 acre area was divided into seven blocks varying in size with the larger areas towards the back.

In the earlier stages fencing for water was the main consideration.

While still keeping water in mind the more recent subdivision has been planned to facilitate the handling of the stock.

Last year we experimented with the electric fence using it to concentrate ewes on to the darker and rough faces. It would appear that ewes need some education to the electric fence prior to applying mob-stocking. This is best done after shearing using a fairly high voltage.

As tussocks or matagouri will earth the wires it is wise to run the electric fence down the barer ridges if possible. This reduces the necessity for cutting the tall vegetation under the wires.

Mob Stocking

It is essential to select, in the first place, southerly faces or sheltered gullies for mob stocking. If this practice is carried out on the nor'-west country it could be most harmful to the country.

The stud ewes are mob-stocked during the six weeks on the tussock. This mob-stocking considerably reduces the necessity for burning and in addition we have noticed mob-stocking causes a distinct improvement in the country. However, for best results from mob-stocking you must have the time to watch the sheep closely and move them on when they show early signs of possible check.

Present Policy

The present topdressing policy is to try and maintain the various blocks in good condition. I would like to stress that we have never aimed at a spectacular change of tussock vegetation to English pastures. Rather by a gradual process of improvement have we raised half a sheep to the acre country to one sheep country, retaining the basic native grasses as a background for the cocksfoot and white clover and as an insurance against severe drought periods. Again I would stress that the development has been done out of income on a long term plan.

Cattle

The use of cattle has been somewhat restricted owing to lack of running water in the summer months, but we run a steer to 15 acres

for approximately eight months of the year and lighten up by selling the two- to three-year-old steers in the November-December period and replace with calves in April. This is not as good a policy, I feel as running one's own cows as the cows with a bit of age are better workers in the rougher gullies and reduce the necessity to burn.

The development programme I have outlined has obviously meant more work but it has given a tremendous amount of satisfaction.

Q. Have you never considered putting in dams in gullies where there are small catchments not likely to cause trouble by scouring?

Mr Sidey: Only yesterday we put in a fairly large one and two small ones. I am not terribly happy about them because the cattle push in the edges and the sheep get bogged. For sheep I much prefer to have the water running in the natural state.

Q.: What's your rainfall, and what effect does it have on the success or otherwise of oversowing?

A.: We have an average of 28 inches. It isn't really as good as 28 because we get a lot of dry nor'-westers. We have been successful with oversowing about October. There is then a certain amount of cover and if you don't get the rain the seed lies protected and starts off with the autumn rains.

Q.: What are your ideas about oversowing in winter?

A.: I've been so succesful with spring sowing, I don't like risking the winter sowing.

Mr Burdon: In Otago we find winter sowing better. We sow with the hardest frosts. The seeds get cover from the frost lift and do not germinate until the warmer weather in the spring.

Q. Do you burn matagouri before topdressing?

A.: If you have any extent of matagouri you must burn, sow seed and topdress. I then do my utmost to control regrowth with sheep, using the electric fence. If it gets away I like to burn it again in two years. Of course with the improved pasture it is difficult to get a burn. The answer then seems to be to stop grazing to get a growth of roughage and then burn. Where we have cocksfoot there is no difficulty in doing this.

THE MANAGEMENT OF HIGH COUNTRY

Geo. Burdon, Mt. Burke, Central Otago.

Since I started high-country farming in 1922, owners have entirely changed their outlook to their land and gone are the days when one carried as many sheep as would struggle through the winter. I can well remember high-country sheep being so thin in the spring that when one barked a dog, many would fall over.

That this changed outlook has come about is due to various causes. The first is that most of us have a real desire to endeavour to make two blades of grass grow where one grew before, and to be able to pass on to our sons a firm foundation for future improvements. The old idea of taking as much as one could and then selling out is definitely a thing of the past. A healthier economy has enabled us to realise that the joy in farming is to have good stock looking well.

A second factor is the improvement in tenure. It was not until 1948 that the then Government made a wise and statesmanlike move when the 33-year lease with a permanent right of renewal was brought in. Prior to this if you made your property too desirable it was either subdivided or you were penalised by an excessive rental. The Land Board was only a debt collecting agency with apparently little or no interest in its vast number of acres. This again has fortunately entirely changed and the Crown Lands Ranger is a person welcomed and respected. The limit set on the number of stock carried is a long-overdue measure. Many hard words have been expended and earlier high-country tenants too, but the blame was largely due to the amazingly short-sighted policy of the administration by the Crown. In Otago especially we owe a great debt of gratitude to Bart Baker and his merry men on the Rabbit Destruction Council for the wonderful change that has come to our still-dry but once barren lands. Today you see magnificent, fine-woolled hoggets cutting 10 pounds of first-class fine wool; blue tussock, the best of all winter feeds, flourishing where only scores of rabbits and some excellent coveys of quail lived only a few short years ago. This, in my own case, has had repercussions as I have always sold lines of two-tooth ewes and wethers which we find harder and harder to sell as our buyer clients of the past are now all sellers.

The next great help to high-country farmers was the introduction of dieldrin dip; gone are the ticks which used to infest our sheep in countless scores and got on to the lambs, and at tailing time a black patch of them congregated under the tail.

This was in no way due to the inefficiency of the owner. Because of the nature of his country many stragglers were left behind and the dipped sheep very soon became re-infected and in many cases one double-fleecer had enough ticks to infect literally thousands of clean sheep.

Oddly enough the weaning muster which was the usual time for dipping, was the worst muster of the year due to the extreme heat of that period. All high-country farmers will agree that there was an unaccountable shortage of sheep numbers between shearing and the autumn muster for which there was apparently no reasonable explanation. It is only since we have been able to dip off shears with this wonderful discovery and give our sheep adequate protection from fly that we have been able to eliminate that serious loss.

The aeroplane has opened up vast possibilities on our high country and certainly in Otago has been one of the major factors in the suppression of Bred Rabbit, thereby allowing the owner to

control his grazing and in a large measure overcome the worst disease of all—starvation.

The Department of Agriculture has been experimenting with the application of sulphur for a number of years starting about 1916, but it is only in the last few years that we are realising what wide fields in expanding production this can bring about. Here again we must look to the aeroplane for distributing phosphate and sulphur and seed on country which in the past comprised only hard tussock and sweet vernal. The experimental plot on Mr Scaife's property at Glendhu is a real eye-opener. What was once largely sweet vernal has, with the application of 1 cwt. of super and 50 lb. of sulphur plus seed, become a really first-class pasture.

Coupled with this improvement a fencing programme must be carried out. Here again the plane can put material on the ground in as many minutes as it took hours with a pack horse. On the larger properties it is easy to lose large mobs of sheep especially if fog, rain and snow intervene in the autumn muster and, if left out, a large proportion would fall victims to keas or perish in the winter snow. With a plane even hare tracks are plainly visible and the whereabouts of stock easily located.

Last year we had snow in May and many run-holders had sheep caught on the high summer country. The plane carried hay to them keeping them alive till they could eventually be brought down to safer levels.

April, I always consider the beginning of the new season, one of the most pleasant months of the year as one can look back over the past season seeing the mistakes one made and making plans to avoid those in the future.

On the 10th I start feeding oats to the rams, one pint daily, and driving them along the beach for exercise. This serves the double purpose of making them really fit and keeping their feet in good order. It is quite amusing to watch the difference that exercise and feeding make in a very short time. I start off by driving them about half a mile for the first few days as they are in good but soft condition and puff and blow but very soon walk along as if they enjoyed it and finish up by breaking into a smart run when within about 100 yards of the feeders. I also class up the rams ready to put out with the ewes in May, a job requiring a lot of time and not to be done in a hurry.

I select the top rams to be put out with the best ewes, medium for medium, and fine for the strong. The feet are also trimmed at this period as good sound feet are essential if they are to tread the mountain.

In 1919 I was going home to England and when we called at Adelaide there was a mob of rams on the wharf which were being sent to South Africa, and I was most impressed as I had never seen anything like them in New Zealand. They were big, bold sheep with tons of constitution and nice clean faces, a picture I can still see clearly at the back of my mind.

When I came to Mt. Burke early in 1929 I decided to import some and got 20 from the well-known Bungaree stud owned by the Hawker family since 1840. I used them on ewes in the paddocks. I marked the ewes they were put to and when the ewes started to come in in the spring I ran off a few hundred, lambled them separately, dotted the progeny and followed them through till shearing. This introduction was a great success.

Although we still shear approximately the same number of sheep, the Australian sires have added 100 bales to our clip and have raised the quality to a marked degree. Our lambing percentage has never varied more than five per cent over the last 30 years, ranging between 75 to 80 per cent in spite of snow, rain and hail which have from

time to time occurred during the lambing. We still get 20 rams over each year and try to have them arriving in October-November so that they are thoroughly acclimatised by May when we mate them with the ewes. The rams come from Central Bungaree and are second-quality flock rams; they thrive from the day they set foot on the property.

During the last two years we have got five polled rams in each shipment but I still prefer the horny ones. This may be mere prejudice on my part but it is certainly easier to pick out the horny ones when out with the ewes or perhaps getting out when they should not be.

In Australia all the flock rams are graded into selected first, second and third grade. We get second grade as I do not consider our country will support a better sheep. The first thing that happens if one tries to grow a better sheep than the country will support is a reduction in the lambing percentage.

In May we muster our ewes, an operation taking five days. As the ewes come in I put our best rams out at one to 100 ewes. We tup 1300 on the farm and 1700 on the Peninsula, a block of about 4000 acres. When drafting up the ewes we take off the selected and strong and medium and the dry ewes, which we marked at shearing time and these are the ones we tup in the paddocks. The Peninsula mob, consisting mainly of ewes that have reared lambs the previous season, is taken out at once and three rams to 100 ewes are put with them. In spite of a six-hour drive involving a climb of about 1000 feet, rams will be found at the head of the mob due to our programme of hard feeding and exercise prior to mating. The ewes in the paddocks are shifted each week and I drive them along the lake beach which cleans out their feet and prevents any foot troubles.

On 25 May we start feeding 1000 to 1200 hoggets on turnips and hay. It is by no means easy to get the hoggets to take to turnips, especially if the diamond-backed moth has had a good nibble at the leaves. After trying different methods every year to induce them to eat before they lose too much weight, I find that the most successful method is to lock them up on a small turnip break by day, and feed two bales of hay per 100 fenced in on the shingle beach by night and never let them see a bite of grass till they are really eating the turnips. I like the turnip breaks to last five days.

In June the winter snows are expected and I keep a very close eye on the glass as more can be done in a day before it snows than possibly three weeks after. If we can get seven hours of daylight, three men can hunt most of the sheep down to comparative safety. Our country goes up to 5000 feet, and usually sheep will winter safely up to 4000 feet on the sunny sides. I always write to the Director of the Meteorological Office in Wellington and ask him to give me as much warning of an impending snow storm as possible. This is a great help and we tender our grateful thanks to that department.

In our climate I always like to have our ploughing finished and our hoggets thoroughly accustomed to eating turnips before the shortest day.

In all the years I have been on the high country, with one exception, it has snowed during the period from the shortest day till 1 July, and like Caesar of old I endeavour to be in *Castris Hibernis* by that date.

When we do get snow I always like to look round immediately. It is much easier to move strong sheep than weak ones, and the lower they are the quicker the country clears. Fortunately we have not had to do any snow-raking for the last number of years but I certainly did my share when I owned a property on Lake Wakatipu.

On one occasion we had to snow-rake the wethers off the back of Mt. Creighton to get them shorn.

Perhaps those earlier experiences have developed an extra sense as I have usually been able to smell out a snow storm before it arrives. Certainly after doing a month's snow-raking as I did in 1923 one is apt to lose one's enjoyment of winter sports.

July and August are largely spent in feeding hoggets and rams and in general maintenance of fences and machinery, with always a wary eye on the possibility of snow storms. When, under ordinary winter conditions, the high and cold basins are filled with snow we consider our sheep fairly safe.

In September we come to the burning season. At the outset, relations between the Otago Catchment Board and the farmers were very indifferent but I am happy to say that is a thing of the past, and now co-operation is very good. The bad feeling that existed was largely due to the policy of the Catchment Board who wanted small areas burned early. In this way the burn came away before general spring feed was available over the rest of the property. This is the surest way of attracting a large concentration of stock on a small area, with devastating results. On the other hand if a large area is burnt at a later period when there is general spring growth on the property it is most unlikely that any harmful concentration will occur.

I always remember my old neighbour on Lake Wakatipu whose lower country was largely covered with fern and scrub. To work the stock, fires were essential, but being on the foreshore burning was discouraged. His reply when asked by the Crown Lands Ranger if he was responsible for the fires was, "I did light my pipe on the way to Queenstown." Eventually he was asked to appear before the Land Board to explain why he continued to burn. His reply was, "Why should a man pay rent and rates for that which he wishes to destroy?" This had a marked similarity to what the Catchment Board wanted runholders to do in the first place.

Another bone of contention was that officers of the Catchment Board did not fully realise that there has always been erosion and it always will continue. It is only when Mother Nature fails to heal her scars that damage is done. I always remember an avalanche coming down in the Young Valley, a tributary of the Makarora, and wiping the bush as cleanly as a newly-washed plate. In spite of a large number of deer on the country the forest came up as thick as hairs on a dog's back and today, some 15 years later, it would be quite impossible to find the course of the avalanche without a careful inspection. We all agree that a good vegetative cover is essential but to preserve this cover from disastrous summer fires, adequate precautions must be taken by systematic burning at the right time. A good illustration of my point was the serious tussock fire in North Otago; a previous burn was the only thing that saved the day.

If country is allowed to become too rank, stock will not graze that area, and this upsets the stocking elsewhere on the property. It is difficult to lay down hard-and-fast laws for burning, as individual properties have separate problems. On a property I owned on Lake Wakatipu I always burned tussocks and snow grass as near to 15 September as possible and by mid-December snow grass had put on at least 15 inches of growth. When I came to Lake Wanaka and did the same thing I found it a rank failure due to the fact that the rainfall was lighter and we were more subject to nor-west winds. The snow grass had to be burned a month later to avoid having any undue concentration of stock.

I believe we can refrain from burning where cattle can be used but unfortunately much of our country is far too steep; then we have to fall back on the fire stick. Where the country is not too steep

and adequate subdivision is possible, cattle can, and I am sure will, take the place of the match. We all agree that this is much better for the country and also the owner's purse.

Unfortunately the two properties that I have owned were mostly too steep for cattle and had a considerable area of fern and scrub, so I am strongly in favour of controlled, systematic burning with due regard for local conditions.

In September, too, gates are opened and our ewes start to drift in. We gather them up and feed them on turnips and grass and eventually end up by feeding about 1800. Prior to putting on feed, ewes are crutched and feet inspected and pared if necessary. Hoggets are crutched and we always keep about ten acres of swedes for the last month before the grass comes. By this time we leave the run-off gate open and they very largely look after themselves.

In early October, hoggets are put on to grass, ewes drafted up and dry ewes put out on the run. About 1400 are inoculated for pulpy kidney and 1100 early lambers put in a mob and shifted daily till lambing starts about 12 October. Ewes are then used to being shifted when shedding off the lambs. Just prior to lambing, the wether country is mustered and the wethers crutched and put on to the blocks that we have grassed on the Hawea side. By feeding here for five or six weeks before shearing it puts an extra pound of wool on the sheep, spells the wether country and, with the increased condition that the sheep are carrying, acts as an insurance against shearing losses. A weak sheep is much more likely to succumb to a cold snap than one in good condition.

All the hoggets we have on hand, amounting to about 1500, are shorn at the latter end of October. Very sheltered paddocks are spelled as an insurance against cold snaps after the hoggets are shorn. We carefully cull them in the wool prior to shearing. The ones we keep have to have three inches or better in length of wool, showing nice character from 58s-60s quality with a few down to 56s quality. Always remembering what fills the hand fills the bale and what fills the bale fills the pocket. We also look for a good, clean face and plenty of constitution. We cull 33 per cent at this period, having culled roughly 10 per cent at weaning time. The culls are sold early in December and in days gone past brought roughly the equivalent of fat-lamb price but unfortunately now are only worth about half that figure.

Lamb marking starts about 1 November. We have had losses from pulpy kidney in spite of inoculation, but we find if we give the ewes and lambs a round up with a huntaway each day for about ten to 14 days the loss is negligible. A knife is used for tailing and the wound swabbed with two parts tar, one part kerol and one part veterinary iodine; this has practically stopped the incidence of arthritis.

November is the busiest month of the year as we start our main shearing about the tenth, mark lambs any spare moments we have and make time to cut lucerne, muster the run and sow the swedes.

A hay crusher has proved a most useful machine as we find our hay drying time can be cut down to three days which gives a good sporting chance of getting our first cut in. It is so nice to have that cut safely stored in a barn.

Shearing is done by contract utilising Australian shearers. These men do a really excellent service to the back country and shear one and a quarter million of the hardest sheep in the Island. They use the narrow gear as the wide comb cuts into the fleece on the angular Merino carcase causing a lot of double cuts and diminishing the value of the fleece. We must certainly give these Australians every encouragement we can in the form of allowances in taxation as they enable the high country man to shear his sheep at the proper time, harvesting his clip before sand and seed deteriorate the wool. An

early-shorn sheep very quickly puts on condition and the sale sheep get a flying start for fattening.

As shearing seems to put a stay order to any other job on most properties the sooner it is over the sooner one can get back to cultivation, hill fencing and other summer occupations. Our ewes are brought in in small mobs and when the weather is settled. I always keep a mob of dry ewes on hand so as to be able to get the wet ewes shorn without having to take the lambs away overnight. A plantation is a very handy place to put a mob of ewes and lambs as a shower will only wet the backs which dry in a very short space of time. We use a basecolt spray dip and include one pound of zinc sulphate per 50 gallons of dieldrin wash to minimise the incidence of dermatitis. We spray everything at shearing time. One man can do a thousand dry sheep in an hour. Ewes and lambs are allowed a week from shearing to spraying. If feed is scarce we have dipped dry sheep off the shears but we make a point of cleaning the dip out each day to avoid infecting shear cuts. All the sheep are culled in the wool before being shorn and if the wool is not as long as my first finger out they go. At this time all the best ewes are raddled on the nose with blue and culls a different colour. After shearing the selected ewes are branded blue and these are the ones we mate with our best sires. Two, four and six-tooth and over are branded differently and dry ewes dotted, so I know almost as much about them in or out of their fleece.

In December we finish marking our hill lambs which have been previously dipped. We keep these ewes and lambs in the paddocks for some six weeks and put out the ones lambing in the paddocks as this benefits both ewes and lambs. The second cut of lucerne is taken and the turnip ground harrowed down to a fine tilth so as to retain as much moisture as possible. Calves are marked and yearlings dehorned.

In January cull two-tooths are sold and the first draft of fat wethers taken. These kill out at 54 pounds.

From 20 to 25 January, green feed and turnips are sown, cocksfoot seed harvested and hill fences mended. The most important job in this month is a fishing trip with the family when we penetrate far into one of the river gorges and forget that such a thing as farming ever existed—so far we have always lived off the land.

Each year we endeavour to bring in some new country allowing hill country to be spelled over those important seeding months. Even if all the sheep cannot be taken off a block the ones left behind naturally do very much better.

New grass is sown on turnip ground. Our programme includes two crops of turnips and in the third year we sow turnips and grass. The ideal feed for ewes in the early spring. The ewe block is mustered; lambs are drenched, crutched, and weaned; cull ewes and cull lambs are sold; stragglers are shorn with the blades, leaving as much wool on as the earlier-shorn ewes have grown. Ten per cent of lambs are culled at this period, comprising any short, fine ones, woolblind and small, late lambs. The rest of the lambs are drafted into three lots and 600 tops put out at the top of the run where these stay till shearing. A further 600 are put on the Peninsula at a later date and the balance kept on the farm at home.

Hoggets often go blind when hay feeding is started but one or two drops of Argerol is the most effective cure.

I am a strong believer in culling young sheep drastically and then keeping the rest till seven years old so as to obtain the maximum production from your best sheep.

The death rate can be lowered by various means. Ours has been lowered by breeding a clean-faced sheep.

Dipping off shears in strong dieldrin, growing sufficient winter feed and making full use of your lower ground, never turning out a poor conditioned young sheep on the mountain, and no rough handling when putting mobs through gates and yards are all important practices.

There have been suggestions that much of our high country should be closed to production, but with the increasing knowledge our scientists are making available to us, and the determination of the land owner to improve his property for succeeding generations this would be a national disaster.

If such a course were adopted the State would have to spend a considerable amount of public money in policing the country from pests of all descriptions and who is there better to look after our high country than the man who lives by it and loves his land?

Q.: Could you tell us something of your land development programme at Mt. Burke?

Mr Burdon: We've been disappointed with the aerial oversowing on the tussock country and lack of economic results but on the lower fern country we have worked with the bush-and-bog discs and sowed 10 lb. cocksfoot, 10lb. ryegrass, 1 lb. dogstail and 7 lb. clovers. This has been a great success. We find it absolutely essential to add 1 cwt. superphosphate annually. On an area of 100 acres where we once carried six sheep per acre for one week of the year we now carry about seven per acre from spring until February.

SOME ASPECTS OF THE BOTANY OF TUSSOCK GRASSLANDS

H. E. Connor, Botany Division, D.S.I.R. Christchurch.

Introduction

The tussock grasslands of New Zealand are by custom separated into two major kinds: tall-tussock and low-tussock. Tall-tussock grasslands are traditionally again divided into two: the snow-tussock grasslands and the red-tussock grasslands, while the low-tussock grassland, apart from the recognition of the presence or absence of silver or blue tussock, is left at that. (Cockayne, 1928.)

My first aim in this paper is to outline briefly the current status of some of these grassland associations, and my second aim is to direct attention to one aspect of the many steps necessary if these grasslands are to be maintained and used on a sustained-yield basis.

All observations reported and discussed here are related only to South Island tussock grasslands, and are of necessity incomplete.

Tall-tussock Grassland

The red-tussock grasslands are as far as can be judged still much the same as the original concept of them, but these grasslands are found in many unexpected places, often at reasonably-high altitudes. The factor for this association is wet, sour soil.

The snow-tussock grasslands are somewhat more difficult. In 1954 a paper on the high-altitude snow-tussock grasslands in South Island was published by the Tussock Grasslands Research Committee (1954). Some important advances in the study of this plant community have been made since that date. Firstly, the taxonomy of the group has improved greatly, so much so, that names frequently used in the "High-altitude Snow-tussock" paper are not correct.

Danthonia flavescens is the name now restricted in use to plants with wide leaves, which are found at high altitudes, and in higher rainfall areas in both Islands. This species occurs along the Main Divide, advances east at Porters Pass, retreats back to the Divide and continues along to about the Clarence River area where it spreads eastward and up through Marlborough. It can be concluded that for a good many pastoralists wide-leaved snow-tussock is not as important as other species of the tall-tussock *Danthonias*. *Danthonia rigida*, a name incorrectly applied in the recent past to red-tussock, is a species of much wider distribution and often of more strategic importance than *D. flavescens*. *D. rigida* is one of the narrow-leaved snow-tussocks particularly abundant in South Island from sea level in some places, up to 5000 ft. This plant is not as stout or as tall as *D. flavescens*, and the leaves are much narrower and not keeled down the back. It is the dominant snow tussock south of the Marlborough area, but runs up through Marlborough in a mosaic pattern with *D. flavescens*. It is probably the most important of the snow-tussocks and it is therefore important to have a clear picture of what the plant looks like and to be able to distinguish it from broad leaf snow-tussock and others. *D. rigida*, then, is spread throughout the South Island.

Above the beech forests in Canterbury, and probably elsewhere, though I am not sure of all the sites, is another *Danthonia* which lacks a scientific name at this time. This species could be mistaken for *D. rigida* but has a strong keel down the middle of the leaf. This species is found only in the areas of higher rainfall and above the beech forest near the main divide. In areas where, in the past, beech forest has been present this species is still found. The relationship

between this undescribed keeled-leaf snow-tussock and *D. rigida* is not yet known but ecologically the two appear quite different in their choices, though they do grow together on the Craigieburn Range.

I want to expand here a consideration of the *D. rigida* grasslands. There are certain subdivisions that can be made at this stage and there are probably more that will be made when knowledge of the tussock grasslands increases. The first major subdivision occurs along the "Barker Line." Miss A. P. Barker (1953) working in the Hunters Hills worked at the margin of major development of cotton plant in the *Danthonia rigida* grasslands, and she defined this association. South of the line Two Thumb Range-Hunters Hills cotton plant (*Celmisia spectabilis*) is not as important a member of the community as it is from this line north. This is subdivision I. Subdivision II is found in the wetter western valleys south of the Mackenzie Plain though it extends into drier areas in some places. Here *Festuca matthewsii* grows in association with narrow-leaved snow-tussock (*D. rigida*) and marks subdivision II definitively from the snow-tussock/cotton plant association. *Festuca matthewsii* which lacks a common name but which could be called Matthews' Fescue, is a blue, erect tussock with angled branches on the seed head, short leaves, and prominent nodes on the culms. It seems to be easily confused with blue tussock (*Poa colensoi*) but can be readily distinguished from it on a closer examination than is often afforded native grasses. It lacks the leaf-fall line which gives blue-tussock the appearance of being heavily grazed. Matthews' fescue seems very palatable to sheep and is always grazed, often quite hard. This species, which so far is my indicator plant for subdivision II of the *Danthonia rigida* grasslands, is found along the Main Divide extending eastwards near Hanmer and having its next eastward expression at the Twizle River in South Canterbury. From here it can be found commonly around Lake Ohau, Ahuriri River, Lindis Pass, Kirkliston Range, and St. Mary Range, while in Central Otago it is found on many mountain ranges, eg. Dunstan, Crown, Rough Ridge, Old Man. Undoubtedly the range of this species is greater than I have outlined, but further work will clarify that. Southland, for example, I have not explored.

By taking out these subdivisions one automatically creates at least a third, and possibly more, but I have not yet made a sufficient study of these others to be able to comment at this stage.

What was previously a somewhat simple state of affairs in snow-tussock country is revealed as a slightly more complex pattern, and with the developing complexity for botanists there is also a new complexity for land users, for although a group of species may act in general in a similar manner it is also certain that the individual species will not react in exactly the same way to a common treatment. Nor for that matter will grasslands having different associated species react to grazing and burning in the same way. Burning and grazing pressures in cotton-plant country have frequently led to undesirable consequences, while burning in Matthews' fescue country does not appear always to have had the same effect.

The responsibility for the initial recognition of grassland types lies with the botanist, though he fully realises that land occupiers can often point out differences which have important biological significance.

Low-tussock Grassland

The remaining grassland I have not yet discussed is the low-tussock grassland. I can add nothing new at this stage to the already long list of papers on low-tussock (cf. Drummond and Leatham). These grasslands in general can be divided into the *Festuca novae-zelandiae*/*Poa caespitosa* grassland common throughout most of the

country, and the *Agropyron scabrum/Poa colensoi* grassland which probably dominated at lower altitudes in the Central Otago Basin. I have not been studying the local variation pattern in these grasslands largely because of the studies at the higher altitudes in areas which might be described as key areas in soil conservation and flood prevention. However, despite all the land-improvement measures being used today in these grasslands, it still seems wise to consider a programme of investigation and classification of these large areas.

Growth of Flowering Stems

I wish to consider for a short while one aspect of the interaction of grassland use and management for continuation, of any of these grasslands. The particular work is the growth and development of the flowering stems in some species of native grasses from the time the flowering heads are just formed (and they are then much less than one tenth of an inch long) to the time when the seed heads are fully developed. The importance of such studies has been discussed by Scott (1956) in relation to changes in the structure of the African veldt. One aspect is immediately evident. Should an area of grassland need spelling so that the maximum amount of seed can fall for autumn or spring germination, the seed heads need protection from grazing animals during the greater part of their development to avoid grazing and trampling damage. The timing therefore of animal management is important for plant management and may conflict with normal animal management procedures. There is no particular value in waiting for the head to emerge before shifting stock—the damage has been done to the palatable species.

The developmental phases in the species studied are outlined below. In *Poa colensoi*, blue tussock, the seed head and the stalk on which it is borne develop at about the same rate until the seed head (panicle) is fully developed; this is followed by a rapid elongation of the stalk which elevates the seed head. Silver tussock (*Poa caespitosa*) differs a little from blue tussock in that both elements grow equally for a time, the stalk then grows faster for a short period, there is then rapid elongation of the panicle followed by quick growth of the stalk.

Hard tussock (*Festuca novae-zelandiae*) behaves much the same as *Poa colensoi*. Here culm and panicle grow at the same speed for a time, then the seed head grows rapidly to its maximum, and this is followed by rapid elongation of the culm.

The tall *Danthonias*, red tussock and broad-leaved snow-tussock both show the same pattern. For a very short time the panicle and the culm grow at about the same speed, then the panicle grows markedly and there is little culm elongation. In the next stage after the panicle has reached its maximum length the culm starts to elongate at first somewhat slowly, but later quite rapidly.

It can be seen that there is some variety in the way the flowering stems develop and your activities in terms of conservation must be centred round these plant-growth habits.

It is not possible for me to predict in any year exactly when these developments will take place, as seasonal differences will occur. In addition aspect differences will have an important effect as on warm sunny faces flowering will be earlier, and as for all blocks there will be a mixture of sunny and shady faces, the sunny faces must be the guiding ones in any attempts to estimate for the whole block the flowering time and condition of the species. Spelling for seed set then depends to a great extent on the treatment at these early stages of growth.

In blue tussock in the season studied, flower buds were well developed in late September as they were for fescue and silver tussocks, and somewhat earlier for red and snow-tussock.

The use of fire in relation to this phase of growth is important. A late fire will destroy the growing flower heads, while an early fire will markedly change the temperature-light reactions which are important in the timing of flower development. Barker (1953) reported an incident following burning of snow-tussock where in one season, only tussocks on the burnt area flowered and those on the unburnt area did not flower. This has been noticed by others in snow-tussock. There is what might be termed a rule in natural grasslands that flowering is profuse in the season after burning. Some may consider that this is then a benefit but in the tussock grasslands this is hardly the case. I do not know what is the effect of late snow or severe late frost on seed heads which are emerging from the burnt stumps of tussocks.

In a grassland where most species are annuals, fluctuations or even pronounced changes of pasture composition can result depending on the treatment in relation to stage of growth of flowering stems. In the tussock grasslands where perennial species predominate, changes in pasture composition will probably be long-term ones.

While I have no direct evidence of this, it may well be, that some of the changes that have happened during the century of utilisation of the tussock grasslands may in some way be ascribed to interruptions in flowering pattern.

This brief report on the development of flowering stems is only the beginning. Examination to determine the phase of flowering-head development should become part of the normal work of any land administrator, soil conservator, and farmer. It takes little effort, and at least you can determine whether or not there is going to be a heavy seeding of any species.

In conclusion, it is important if natural grasslands are to be used and maintained as such (and a large area must remain so for a long time yet, despite agricultural advances) that full recognition be given to grassland types. The maintenance of these grasslands depends in some measure on the careful use of natural seeding and on the management necessary to effect this. I have outlined here briefly developments in both these fields of botanical work.

REFERENCES

- BARKER, A. P. (1953)—“An Ecological Study of Tussock Grassland Hunters Hills, South Canterbury.” D.S.I.R. Bull. 107.
- COCKAYNE, L. (1928)—“The Vegetation of New Zealand.” 2nd. Ed.
- DRUMMOND, HELEN M., LEATHAM, E. H. (1959)—“Bibliography of New Zealand Tussock Grassland.” D.S.I.R. Bull. 133.
- SCOTT, J. D. (1956)—“The Study of Primordial Buds and the Reaction of Roots to Defoliation as the Basis of Grassland Management. Proc. 7th Int. Grasslands Cong. 479-489.
- TUSSOCK GRASSLAND RESEARCH COMMITTEE (1954)—“The High-altitude Snow-tussock Grassland in South Island, New Zealand. N.Z.J.Sci.Tech. A36; 335-64.

Q.: As regards burning off tussock; is it advisable to burn before September and thus reduce the damage done to the developing flower head?

Mr Connor: If we accept the fact that we must burn, then I believe that we should not burn in the late winter or spring as is done now, but in the autumn. I realise you expose the ground to frost action but what is one lot of frost lift in a ten-year burning cycle compared with the damage done to the plants by a spring burn?

PRODUCTION IN THE MOUNTAINS

K. F. O'Connor, Grasslands Division, D.S.I.R., Lincoln.

The Tussock Grasslands Industry

The total extent of non-forest land of the hills and mountains of the South Island that is not sown in pastures or crops is about 40,000,000 acres. Included in this total are areas of ice, rock, scree and all varieties of vegetation described for you by Mr Connor in the previous paper. These 40,000,000 acres are diverse in climate and soil as well as in vegetation. Only approximately 11,500,000 acres are occupied under various forms of tenure from Pastoral Run License to Renewable Lease and Freehold. The area of effective occupation at present is probably not much greater than 10,000,000 acres. The total domestic animal population is probably not more than 2,500,000 sheep and 40,000 cattle, a total stocking rate of about one sheep or sheep equivalent per four acres.

This wide and varied tract of land of about ten million acres I wish to discuss from one viewpoint only, one that this audience of primary producers must surely share. That viewpoint is production. (For the purposes of comparison between past and future potential production, production is considered solely as pastoral production and no attention is given to the important role of water production nor to the potential production of pulp and timber or of cash crops on arable land of developed fertility.)

Production History

In the last 100 years, these 10,000,000 acres have produced, as rough but generous estimates, 500,000 tons of wool, 25,000,000 sheep and a few thousand cattle. Most of these animals have eventually found their way into the meat market to furnish about 1,500,000 tons of meat of poor to fair quality. In addition this store stock surplus of the hills and mountains has played a role of varying magnitude in the breeding of fat stock on the lowlands. The first century of high land occupation in South Island, New Zealand, has therefore produced an annual average of about 5,000 tons of wool and 15,000 tons of meat in mostly unfinished condition. At present day values this would mean a gross annual return of about eight shillings per acre overall.

Our present purposes are to review our resources, to see what choices we have in our patterns of land use and to form some estimates of our immediate future possible annual production. I propose to give you such an outline, as the fruit of the research with which I have been actively or indirectly associated during the past few years.

Our Present Resources

A. Land:

Land as a factor of production is best considered as a combination of soil and climate. A tabulated summary is presented in the first five columns of Table 1.

1. Brown-grey earths in semi-arid climate. Rainfall is from 11 inches per annum to a little over 20 inches, with generally sustained and serious summer drought. Winters are severe but of moderate length, especially at lower altitudes. Spring and autumn are both short but good potential growing periods. A large proportion is of easy topography. Soils are severely eroded on driest sites, especially at low altitudes. Soils are deficient in nitrogen and sulphur throughout and also in phosphate on older terraces and more eroded soils. Typical areas are Central Otago basins and warmer and lower

slopes, similar topography in Upper Waitaki and Mackenzie, dry valleys in Canterbury and Marlborough.

2. Yellow-grey earths in sub-humid climate. There is a marked but generally not sustained drought period in summer, high potential growth in spring and autumn, winters milder and of short to moderate length. A large proportion of these soils are on foothills near the coast. These soils are deficient in nitrogen throughout, in sulphur in most if not all localities, in phosphate in some localities but this shortage of phosphate is seldom acute except where the soil has been seriously eroded. Molybdenum deficiencies are common.

3. Yellow-brown earths and related soils in humid climates. Phase droughts sometimes affect shallow soils. Winters are long and generally severe. Growth potential is high in late spring and early summer, and in lower localities, in autumn as well. Most if not all of these soils were probably formed under forest, much of it destroyed before the arrival of white settlers. Included is a high proportion of steep and mountainous land and of this in particular a large area has been severely eroded. Nitrogen, sulphur and phosphorus are deficient throughout. In many areas, especially old leached terraces and downs, phosphate deficiencies are acute. Molybdenum deficiencies are widespread and potash deficiencies may develop in some areas. These soils belong to two subgroups, the one mostly in mid to high altitudes centred on inland Canterbury, the other varying from low to high altitudes and principally located in southern areas.

4. Recent and Intrazonal soils. These soils are differentiated from the soils of the zones in which they occur by their youth or by their derivation from unusual parent rock. Younger soils and lime-rich soils are generally less deficient in nitrogen, deficient in sulphur, but seldom deficient in phosphorus or molybdenum. Their extent is not large in comparison with the groups described above, but they are for the most part of high growth potential, suffering little from drought, except where recent soils are formed of coarse material. Strong contrasts in natural fertility occur within this loose group, arising from differences in parent material.

This review of our land resources in columns 1 to 5 of Table I is a working integration of the surveys of the Soil Bureau of D.S.I.R. conducted during the last twenty years and of a survey which I have made of the results of more than 400 trials investigating the manurial requirements of these soils. These trials were carried out by extension and research officers of the Department of Agriculture during the period 1956-1959. The data in column 6a have been compiled on the basis of more than thirty actual harvests of resident vegetation, supplemented by over a hundred estimates of yield from enclosures. All of these latter, together with the integrated compilation of Table 1, are the work of the present author. The data in column 6b have been similarly derived. In their case, however, only ten different sites have been harvested of improved vegetation after manurial treatment. These have been supplemented by more than 100 estimates of yield.

From these data it can be seen that differences in climate affect the total production of herbage that can be obtained from land. To approach the limit set by climate, different levels of deficiency of nutrients, again dependent on the genetic character of the soil, have to be made good. On the flat mid-altitude yellow brown earths, for example, major emphasis must initially be given to phosphate and molybdenum, along with sulphur, for successful clover (Dingwall, 1956, O'Connor, 1959). On the better brown-grey earths and on some of the lime-rich soils, by way of contrast, no phosphate or molybdenum is needed, and attention can be given solely to sulphur, in the developmental stage at least (O'Connor, 1959, Ludecke pers. comm. 1960).

B. Plants:

Our second great resource is plant material, the plants now growing and the seed available for use, together with the collections of breeding material. In the low and mid-altitude zones our present available resources of plant material can go a long way towards the limit of production set by climate. For general purposes, the following appear the most valuable for immediate future production under conditions of improved fertility: white, red and alsike clovers, lucerne, birdsfoot trefoil, *Agropyron scabrum*, browntop, sweet vernal, yorkshire fog, cocksfoot, ryegrasses, tall oat grass, tall fescue. None of the other native plants or introductions so far tested appears to be generally capable of high production when well fed. Indicative of this situation is Table 2. No plants appear capable of even fair production for grazing use when poorly fed. For the future we can hold out hope of considerable improvement in plant capability by breeding and selection. This may well come in the form of Fescues, Bromes and Cocksfoots, as well as in Medicago and Lotus. Suffice for the present that even the fodder grasses that we have in unimproved low and mid altitude grasslands now are producing only from five to 30 per cent of what they can because they are often 70 to 95 per cent starved. (See Table 3.)

For the higher altitudes we have at present no material that is clearly better than what we have there now. Although many attempts at sowing clover at altitudes up to 4,200 feet have been successful it is highly questionable whether we should mention such precarious success in the same breath as production. Certainly, land condition there demands plant production for protection, not for animal use. (Gibbs Raeside et al, 1942, T.G.R. Committee, 1954.)

C. Fertilisers, Farm Stores and Plant:

Our next resource is the already organised and developed stations, our existing fences and our supplies of light, durable, and relatively inexpensive material for more fences, our farm equipment and vehicles, access tracks and airstrips and, perhaps above all, our aircraft services and fertiliser supplies.

D. Animals:

Our breeding population is probably well over a million ewes and a few thousand cows plus the sires available both within and outside New Zealand.—Don't let us forget the dogs.

E. Labour:

The present labour force in the existing stations is perhaps 5,000. Any increase will have to be reared or hired.

F. Capital:

I shall not even guess at reserves—if there are any. I will emphasise three points: (a) Funds are needed for investment, (b) loans on long term may be necessary in many cases, (c) in the long run the only source of new capital is production.

These are the material resources we have. We have three courses of action we can take. Let us have a look at these and their effects on production.

Possible Courses of Land Use

First, we could go on as we did for nearly 100 years, skimming the cream off the bucket.

Second, we could go on as we have during the last five years gently stirring the cream can.

Third, we could work the churn for real production.

First—skimming the cream: The landscape is proof that this is not a permanent system of good farming on steepland, highland, dryland, or short-of-phosphate-land. There isn't much land besides! The only question is: how long till ruin? Fifty years or less as on

the high yellow brown steepland soils or 200 years or more as on some of the hilly yellow brown earths? This appears a low cost system but it is also a low or erratic returns system and the only way it could approach permanence on even the better land would be as a high cost system with miles of fences, stock herding, seed sowing and a great deal of luck. Inherent in the system is the need to spell country both for seeding and for winter feeding. High altitude "summer country" and catchment stability have been expended for this purpose in the last 100 years. Who or what would pay for the same system in the next 100?

Second—stirring the cream can: Here we have the situation of many properties at present. Characteristics are: topdressing and clover sowing on a fraction, perhaps up to one fifth, of the improvable country; little or no increase in subdivisional fencing; little or no use of insecticides for control of grass grub and porina caterpillar; insufficient application of sulphur for maintenance of improved cloverly pastures, especially in lower wool price years; inefficient use of such pastures for either soil building or flock building; increased wool yields per sheep; reduced use of high altitude country in summer; and a strange feeling of mixed-up well-being and uncertainty in the mind of the runholder.

Such a system could be an erratic but lasting pattern of land use but not a very profitable one for it represents the danger of new wine in old hides. The cost structure is high, the established cost of the original enterprise plus the costs of the improvements. The returns structure is not quickly or greatly altered unless there is fair to good utilisation of the improvements. Moreover, there is risk of real loss if insect damage or failure to maintain fertility levels leads to depletion or reversion to poorly-fed browntop.

The third course is one which is being gradually adopted on a few, generally small, properties—working the churn. Its characteristics are thorough topdressing and legume sowing of all improvable country at a rate little faster than the speed of erection of new fences; little or no use of high altitude land; full utilisation of herbage in early summer by hoggets and ewes with lambs to build soil fertility by organic return and animal size by adequate nutrition; careful use of autumn and spring feed for maximum advantage in flushing and lambing; development of fat surplus stock; increase in ewe numbers as breeding permits even at the price of lower production of wool per sheep.

Vegetation Trends with Development

Characteristics of grassland conditions during this development are two or three year build up to clover dominance (see Table 4) accompanied by a suppression of other light-demanding small herbs, native and exotic (see Table 5), a temporary but substantial increase in the production of browntop and sweet vernal, a lasting and large increase in the production of Yorkshire fog (see Table 6), and in some places *Poa pratensis*, and a clear-cut difference in the density and vigour of native low tussock grasses, depending on the grazing management. Severe defoliation in hard grazing conditions reduces them. More lenient but not lax grazing increases them (see Table 7). These changes in pasture composition are accompanied by marked increases in palatability especially in Yorkshire fog but also in browntop, sweet vernal and blue tussock and to some extent in fescue tussock, silver tussock, red tussock, and low altitude snowgrass.

If molybdenum, sulphur or phosphate level is allowed to decline dangerously there is partial reversal of the process. Nitrogen becomes deficient within two years of serious clover decline and palatability and vigour of grasses suffers. Yorkshire fog is one of the first to fade and browntop, the last (see Table 8).

If insect control is absent or inefficient, populations of grubs and caterpillars will build up on the higher food supply available from the intertussock plants and will direct their attentions to the softer, higher fertility grasses and clovers. (Kelsey, 1960, pers. comm.)

In the later stages of clover dominance in development programme, grasses such as ryegrass and cocksfoot can be established with some success either by overdrilling or by oversowing of well-grazed opened up nitrogen-rich swards. (See Table 9.) Pasture management from that time is essentially the same as for easy country—a degree of violence to plant and beast for mutual productive survival. (McMeekan, 1952.) The research on animal production to match these conditions has not been done. It seems that the essential feature would be to alter the character of the animal production system so that feed requirements were concentrated in the period of high feed supply. These features are suggested—low proportion of dry sheep, high lambing rates, fattening of surplus. If winter feed for them is short, cattle could be a liability to such a programme but if they are easily fed in winter they would greatly assist in pasture management in the flush season as well as in the station economy.

Estimated Increase in Carrying Capacity

On the basis of the conservative estimates of potential herbage production obtainable by appropriate manuring of plant material available for immediate use (Table 1, column 6b), an estimated carrying capacity for each one of the developed soil resources has been arrived at. As a basis for this estimate, it has been reckoned that a sheep will eat up to four pounds of pasture dry matter per day. Theoretically, therefore with full utilisation and a pattern of feed supply adjusted to feed demand over the seasons, it could be argued that a sheep, eating wastefully to appetite throughout the year could be supported by 1500 pounds of dry matter and carry out full production. Generous allowances have therefore been made for difficulties of utilisation arising from topographic conditions as well as from the need to carry over supplies of feed from the season of growth to the season of use. Carrying capacities so estimated have been expressed in column 7 of Table 1 as Sheep Months per Acre, in the knowledge that sheep are seldom to be carried on the one land unit throughout the year. No estimates of carrying capacity have been made for the steep yellow-brown earths totalling 5,000,000 acres for it has not yet been shown that these lands can be developed to a safe condition for grazing use.

From the estimates of carrying capacities of each kind of land when developed and from the area of each class, recorded in column 3 of Table 1, a total estimated carrying capacity for developed tussock grasslands can be calculated, approximating 9,500,000 sheep equivalents on 5,300,000 acres.

During this high level production farming it will probably become necessary to fence in these improved pastures as well as to subdivide them. If the high altitude or steep snowgrass country finds itself on the other side of the production fence, then at least its rate of deterioration will not be accelerating while we in our research discover how to manage such Protection Land. If we discover that in some areas, as perhaps in the schist mountains of Otago, there is a possible safe productive use for the high altitude land, our production boundary fence could become a subdivision fence once more and its repair an expense deductible for income tax purposes.

This system is a high cost one per acre without doubt, relative of course to present levels. I believe, however, that it could have a much lower cost per product unit than either current North Island land development or the extension of irrigation on Canterbury Plains. This will arise from three principal factors—an expected high level

of manurial efficiency because of low phosphate fixation, the large stocking units possible, and the invaluable exploratory work of Soil Bureau, D.S.I.R., and Dept. of Agriculture extension personnel.

If these average immediate potential production figures and estimates of average carrying capacity for the five soil groups appear irritatingly high, you may be consoled that the early runholders also had a very anxious time building up their flocks sufficiently fast to stock their country. I think we are more fortunate than they were in spite of the destroyed soils on our mountains. We have the resources which they did not have—manures, productive plants, capital, labour, machines. We have a practical target of seven million more sheep on the tussock lands.

Since I began speaking to you there are approximately two thousand more people in this world, two thousand more were born than died in the last twenty minutes. More than half of them are destined to spend their life in hunger unless we do something drastic to help them. They have a right to food and fibre. I have shown you that we have the knowledge to use this land to grow food and fibre in plenty. What I ask of you is: "Have we the will?"

REFERENCES

- DINGWALL, A. R., 1956. Tussock Grassland Research in the Broken River Area. N.Z.J.Ag. 93, 277-283.
- GIBBS, H.S. and RAESIDE, J. D. (et al), 1945. Soil Conservation in High Country of the South Island. N.Z.D.S.I.R. Research Bulletin 92, 72 pp.
- McMEEKAN, C. P., 1952. Interdependence of Grassland and Livestock in Agricultural Production. Proceedings of Sixth International Grassland Congress, 149-161.
- O'CONNOR, K. F., 1959. Plant Production in Difficult Environments. Proceedings, N.Z. Inst. of Ag. Sci. Conference, 1959. 86-94.
- TUSSOCK GRASSLAND RESEARCH COMMITTEE 1954. The High Altitude Snow Tussock Grassland in South Island of New Zealand. N.Z.J.Sci.Tech. A.36. 335-364.

Q.: Very often our snow grass seeds prolifically but you rarely see a young snow grassplant. Why?

Dr O'Connor: It is certain that snow grass in its original condition had to germinate in entirely different physical conditions from what it experiences today. A great deal of rotting material formed a wet, spongy mass with dry litter on top. Those conditions are much rarer today. However, in the right conditions there are still plenty of seedlings but it is difficult for most people to recognise them.

Q.: What is being done about the introduction of herbaceous plants suitable for high altitudes?

A.: We have tried a large number. The Grasslands Division is also developing a breeding programme. So far the things we've bred ourselves promise the most success.

Q.: Why do runholders in the back country not do more with the vast areas of flats?

Mr David McLeod: The flats in the high country are not half as fertile as they look. They look well in the spring certainly, but they have severely leached soils with a great deficiency of phosphate and lime. When you plough them up they lose their structure, turn to dust and are exposed to the hazards of wind erosion. The fertility of the hills is often much greater and that is why stockmen have gone there for this improvement work.

TABLE 1

Land Resources and Production from South Island Tussock Grasslands and Related Rangeland in Pastoral Occupation.

I Soil Group	II Topo- graphy	III Occupied Area (Millions of Acres)	IV Potential Herbage Growth Allowed by Climate (when nutrients are not limit- ing growth of plants available at present)				V Nutrient Deficiencies 0=None or slight. 1=Occasional or small. 2=Widespread or large. 3=General or severe.			VI Herbage Production Pounds Dry Matter per ac. per an. (unirrigated)		VII Carrying Capacity (estimated) Sheep months per ac. per an.	
			Win.	Spr.	Sum.	Aut.	N	S	P	Present Actual	Present Potential	Present Actual	Present Potential
Brown-grey earths and related soils (B.G.E.)	Easy	1.0	Nil	Fair	Poor	Fair	3	2-3	0-2	50- 500	4,000	0-3	15
	Hilly	0.5	Poor	Good	Poor	Fair	3	2-3	0-1	50- 1,000	4,000	0-6	15
	Steep	0.5	Nil	Fair	Poor	Fair	3	2-3	0-1	50- 500	3,000	0-3	10
Yellow-grey earths and related soils (Y.G.E.)	Easy	0.1	Poor	Good	Good	Good	2-3	3	0-2	500- 3,000	10,000	2-18	40
	Hilly	0.3	Poor	Good	Good	Good	2-3	3	0-2	500- 3,000	12,000	2-18	45
	Steep	0.3	Poor	Good	Fair	Good	2-3	3	0-2	500- 2,000	10,000	2-12	35

Yellow-brown earths and related soils at mid to high altitudes (mostly Canterbury and Northern Otago) (Y.B.E.)	Easy	0.5	Nil	Good	Fair	Poor	3	3	3	100- 500	6,000- 12,000	1-3	25-45
	Hilly	1.0	Nil	Good	Good	Poor	3	3	2-3	100- 1,500	6,000- 10,000	1-10	20-35
	Steep	4.0	Nil	Poor	Fair	Poor	3	2-3	2-3	0- 1,500	2000 ?	0-2	Nil
Yellow-brown earths and related soils at low to high altitudes (mostly Southland and Southern Otago) (Y.B.E.)	Easy	0.2	Poor	Good	Good	Fair	3	1-3	3	100- 1,000	10,000	1-6	40
	Hilly	0.8	Poor	Good	Good	Fair	3	1-3	2-3	500- 2,000	10,000	2-12	35
	Steep	1.0	Nil	Poor	Fair	Poor	3	1-3	2-3	0- 1,500	2,000 ?	0-2	Nil
Recent and Interzonal soils	Easy	0.02	Poor	Good	Good	Good	2	1-3	0-2	1,000- 3,000	12,000	4-20	50
	Hilly	0.04	Poor	Fair-	Poor-	Poor-	2-3	3	0-3	500- 3,000	5,000- 12,000	2-18	20-40
	Steep	0.04	Poor	Fair-	Poor-	Poor	2-3	3	0-3	500- 2,000	2,000- 10,000	2-12	Nil-30

TABLE 2

Plant Performance in Early Growth for Several Species and Strains of Grasses Under Conditions of Good Nutrient Supply at 2,500ft A.S.L., Castle Hill, Canterbury.

(Period November 1958 to February 1959 inclusive: Rainfall 10.5in.)

Species or Strains	Tillering Rating (1-10)*	Leaf Length (inches)
Ryegrass:		
Short Rotation	9.8	8.5
Perennial (N.Z.) (Average of 3)	8.3	9.0
Italian (N.Z.)	8.3	10.3
Other Perennial (average of 6)	7.5	6.3
Cocksfoot:		
Grasslands	7.8	8.3
C.23	7.3	7.8
S.37	4.3	5.3
Other (average of 7)	6.5	6.8
Fescue:		
Tall (S.170)	6.3	5.0
Tall (K.31)	4.0	4.5
Meadow (S.215 and S53)	4.9	4.4
Red (S.59)	6.3	2.6
Chewing's	6.3	2.5
Hard (tussock)	4.0	2.8
Matthew's (tussock)	4.5	2.5
Timothy:		
N.Z.	4.3	4.5
Other (average of 3)	4.4	4.5
Brome:		
B. catharticus	6.3	8.0
B. popovii	6.0	7.5
B. mollis	5.3	3.5
B. carinatus	5.3	5.8
B. marginatus	4.8	6.8
B. coloratus	4.0	7.0
B. inermis	3.5	4.0
Phalaris:		
Average of 5 species	4.2	6.7
Agropyron:		
A. scabrum (N.Z.)	7.0	6.5
Other species (average of 5)	3.5	4.8
Other Native grasses:		
Dichelachne crinita	3.9	3.5
Poa colensoi	5.8	1.5
Danthonia racemosa	4.8	3.8
Other Exotic grasses (adventives):		
Dogstail	3.5	4.5
Sweet vernal	7.5	6.3
Browntop	7.3	4.5
Hairgrass (Vulpia sp.)	8.0	3.4
Yorkshire fog	8.8	10.8

* Tillering rating is numerically equivalent to the actual number of tillers per plant for ratings below 4.0 but is equivalent to only half the actual number of tillers per plant for ratings above 8.0. Generally, the odds are twenty to one that any two species or strains which differ by more than 1.4 in tillering rating or by more than 1.3 inches in leaf length are really different in such characters.

TABLE 3

Yield of Herbage of Different Species of Grass from Unmanured Plots Expressed as Percentage of Yield from Adequately-manured Plots (Base = 100) on Two Soils.

(Castle Hill 1957-1960)

Soil	Stage	Brown top	Sweet vernal	Fog	Native grasses
Soil deficient in N, P, S, Mo (2,500ft.)	1st year	10	5	Absent	?
	2nd year	30	25	0	25
Soil deficient in N and S only (3,000ft.)	1st year	20	15	15	70
	2nd year	13	10	18	65

TABLE 4

Progressive Changes in Clover Content of Oversown and Topdressed Tussock Grassland Subject to Infrequent Defoliation.

(Castle Hill 3,000ft. a.s.l. 1957-1960)

	1957/58		1958/59		1959/60	
Clovers as % cover	Summer	Autumn	Summer	Autumn	Summer	Autumn
	8	30	50	85	80	75
Yield of Clovers lb. DM/ac.	160		7,000		7,800	
Yield of Total DM lb./ac.	2,490		7,600		8,500	

TABLE 5

Composition of Vegetation Under Grazing Use Following Introduction of Clover Into Unimproved Tussock Grasslands.

Soil, Site and Method of Clover Introduction	Native Grasses including Tussocks		Exotic Grasses		Other Herbs		Clovers	
	Unimp.	Imp.	Unimp.	Imp.	Unimp.	Imp.	Unimp.	Imp.
Fan BGE Simons Hill, Mackenzie (Airsown)	13	18	17	14	63	42	6	22
Hilly BGE Pyramid Hill, Ben Ohau Mackenzie (Airsown)	27	16	2	8	56	38	0	32
Hilly BGE East Face, Te Aka, Kurow (Airsown)	14	12	21	22	64	11	0	52
Moraine YBE Pukaki Downs, Mackenzie (Drilled)	24	15	5	11	50	28	0	28
Alluvial Soil Pukaki Downs, Mackenzie (Drilled)	22	13	0	0	59	8	0	73
Fan BGE Ahuriri, Omarama (Drilled)	21	11	52	52	26	28	0	8
Fan BGE Tara Hill, Omarama (Broadcast)	62	57	5	6	33	32	0	5
Calcareous Soil Castle Hill, Canterbury (Broadcast)	15	9	33	33	21	17	10	30
Terrace YBE Castle Hill, Canterbury (Broadcast)	6	6	34	30	56	30	0	32

TABLE 6

Relative Increases in Growth of Resident Grasses With Increases in Supply of Available Nitrogen.

(Castle Hill 1958-1960)

Species	Increase of Nitrogen			
	Nil	Low	Medium	High
Height of flower stalk:				
Browntop	100	115	123	138
Sweet vernal	100	119	124	127
Yorkshire fog	100	124	132	140
Herbage production per unit of sward:				
Browntop	100	270	438	438
Sweet vernal	100	241	259	482
Yorkshire fog	100	216	348	528
Fescue tussock	100	122	148	201

TABLE 7

Relative Basal Area of Living Fescue Tussock in Grassland Subject to Different Defoliation and Nitrogen Treatments.

(Castle Hill 1957-1959)

Cutting Treatments	No Nitrogen Added	Nitrogen 50lb./ac./an.
No cutting	100	150
Autumn cut only	127	234
Spring cut only		
—short cut	162	72
—tall cut	152	127
Cut spring and autumn		
—short cut	67	75
—tall cut	157	114

TABLE 8

Relative Yields of Different Components of Semi-Improved Tussock Grassland in the Presence of Different Nutrient Deficiencies.

(Cass Soil deficient in N-P-S and Mo Castle Hill, 1959-60)

Yield of total herbage when all deficiencies are corrected is treated as base = 100.

Herbage Components	Deficiencies Present after Treatment							
	None	N	S	P	NS	NP	SP	NSP
Total	100	25	98	72	25	25	50	25
Clovers	5	3	0	0	0	0	0	0
Cocksfoot	3	0	0	0	0	0	0	0
Fescue tussock	3	1	1	1	1	1	1	1
Yorkshire fog	2	0	0	0	0	0	0	0
Sweet vernal	20	5	5	14	5	5	4	5
Browntop	64	14	90	55	17	17	43	17
Weeds	3	2	2	2	2	2	2	2

TABLE 9

Establishment, Growth, and Production of Cocksfoot in Relation to Available Nitrogen Supply Following Broadcasting of Cocksfoot into Untreated Fescue Tussock Grassland.

Plant Performance	Level of Applied Nitrogen (with S & P)			
	None	Low	Medium	High
Cass soil—poor natural fertility, sown spring, 1958—				
No. plants/sq. yd, Jan. '59	1.6	—	—	11.2
Av. length of leaves Jan. '59	1.0"	—	—	5.0"
Yield lb. DM/ac. 1959/60	0	—	—	10
Calcareous soil—deficient in N and S only, sown spring 1957				
No. plants/sq. ft. Jan. '58	4.9	8.4	9.0	12.6
Av. length of leaves Feb. '58	1.8"	3.0"	2.9"	4.1"
Yield lb. DM/ac. 1958/59	0	5	5	20

THE PRODUCTION AND MANAGEMENT OF BEEF CATTLE ON MOLESWORTH FOR THE STORE MARKET

M. M. Chisholm, Department of Lands, Molesworth.

Molesworth, Tardale and St. Helens comprise some 458,600 acres on the main run and also an adjacent farm of 425 acres situated at Hanmer, which is on part of the original St. Helen's home-stead area.

The station is situated 80 miles south of Blenheim, is 25 miles west of Kaikoura, and almost bounds the township of Hanmer in the south.

The property is also the main catchment area for the headwaters of the Awatere, Wairau and Clarence rivers.

The run is 3,000 feet above sea level and runs up to over 6,000 feet. A small portion in the Elliott is slightly under 2,000 feet. There are some wide and extensive flats at 3,200 feet.

Summers are usually dry and warm, and winters cold with snow to low levels, and very often the property is completely covered with snow—the depth dependent on the storm.

Rainfall varies from 27 inches in the east and north-east, to 30 inches in the south and around Tardale, and increases to approximately 60 inches in the west and north-west. The average rainfall over 11 years since rainfall has been recorded is: Molesworth 27.73 inches; 17 miles west at Red Gate the average is 26.80; Tardale 26 miles 29.73; Wairau 32 miles 57.64; Tennyson 48 miles 53.77. Clarence Accommodation House 38 miles south of Molesworth averages 33.61. Rainfall is usually confined to early spring and the late-autumn months.

Temperatures range into the 80's in summer and at times to zero in winter. Molesworth has an average of 230 recorded frosts per annum.

Snow can be expected after April and the liability of early falls makes for rigid adherence in the programme of stock movements on to the winter blocks. All winter country on the property is subject to snow, and in the event of an exceptional fall, some of the country is positively dangerous.

It will appear that history on Molesworth is being repeated. Cattle were the first stock run on Tardale in 1863 and Molesworth in 1865, and drafts were driven to the diggings on the Coast by way of the Wairau, Hope, Hurunui and Teremakau rivers, and via the Ada, Cannibal Gorge, Maruia and Grey. An instance is the sale of Molesworth in 1878 when, as one unit, over 1,500 head of cattle, not included in the sale, were sold on the West Coast. Although cattle have been run on the property since its establishment, the period of cattle alone seems to have been of short duration in the early days.

Reports indicate a peak of some 50,000 sheep on Molesworth, Tardale and Rainbow. I have seen the doubtful figure in print of 70,000 having been run; however, from the period 1900, with the exception of 1902-08 when the sheep population stayed at the 44,000-45,000 level, a positive decline is evident, the minimum being reached in 1925 with only 14,000 being shorn. A slight increase was made in numbers prior to the property being abandoned in 1938.

A similar trend existed on St. Helen's, although the peak years since 1900 appear to have been 1932-33 with a sheep population of 47,000. The lease of this run was surrendered in 1949.

It is evident that the constant early burning gave the rabbit a man-made environment that it was quick to take advantage of, and

the then combination of increasing rabbits, the sheep population, deer, goats and pigs, was more than the country could stand. Snow losses, low prices, and a deteriorated country seem to have led to total abandonment.

The story of 22 years of war on rabbits, providing access, fencing, buildings, stock-yards, grassing programmes, and the building up of the cattle population on Molesworth must be left for some other occasion.

The Acheron river flowing north and south to join the Clarence practically splits the run in the centre. A range east of the Acheron is the western boundary of the winter country—some 200,000 acres. The north boundaries are with the Muller, Langridge and Bluff stations, and on the eastern side the Clarence river acts as boundary with Clarence Reserve, Cloudy Range, and the Hossack in the south.

This area of country is saved from the month of October to the first week in May for the cows and calves to winter on.

There are eight blocks. Awatere, Elliott and Yeo Creek take the cows and calves coming from Tarnedale. Hossack Corner, Bullen Hills down Clarence, Dillon, Half Moon and Guide take cows and calves from Leader and Upper Clarence.

Dry stock are run in the Acheron, Five Mile, Mt. Scott, Yarra, Travellers Valley, Severn, Saxton, Isolated Flat and Waimea all the year round, but are shifted during the summer to the higher country so as to spell the sunny country mainly used for winter within this area. The division of this portion of the run is not yet 100 per cent but sufficient control is gained to allow growth for the winter grazing.

In the grassing programme a considerable area of this sunny country has been sown with 4 lb. cocksfoot, 2 lb. white clover, $\frac{1}{2}$ lb. alsike and $\frac{1}{2}$ lb. Montgomery and red clover. The early sowing of five or six years ago is now coming into production and showing excellent promise for the future.

The remaining summer country is used entirely for the breeding cows and this country includes Tarnedale, Alma, Upper and Lower Crimea, Wairau, Clarence, Serpentine and Beggs. This area is grazed by cows from Tarnedale.

Leader, Timms Creek, Bush Gully, Jollies Block and Bridge Paddock run cows from Bush Gully.

To handle the stock, yards are now situated at Molesworth, Tarnedale, Bush Gully and Hanmer.

Cattle have been built up from purchases made in 1940-41 which included some very well-bred heifers, both Angus and Hereford; also included were some breeds of very doubtful origin.

The stock numbers on the property at the moment are as follows:

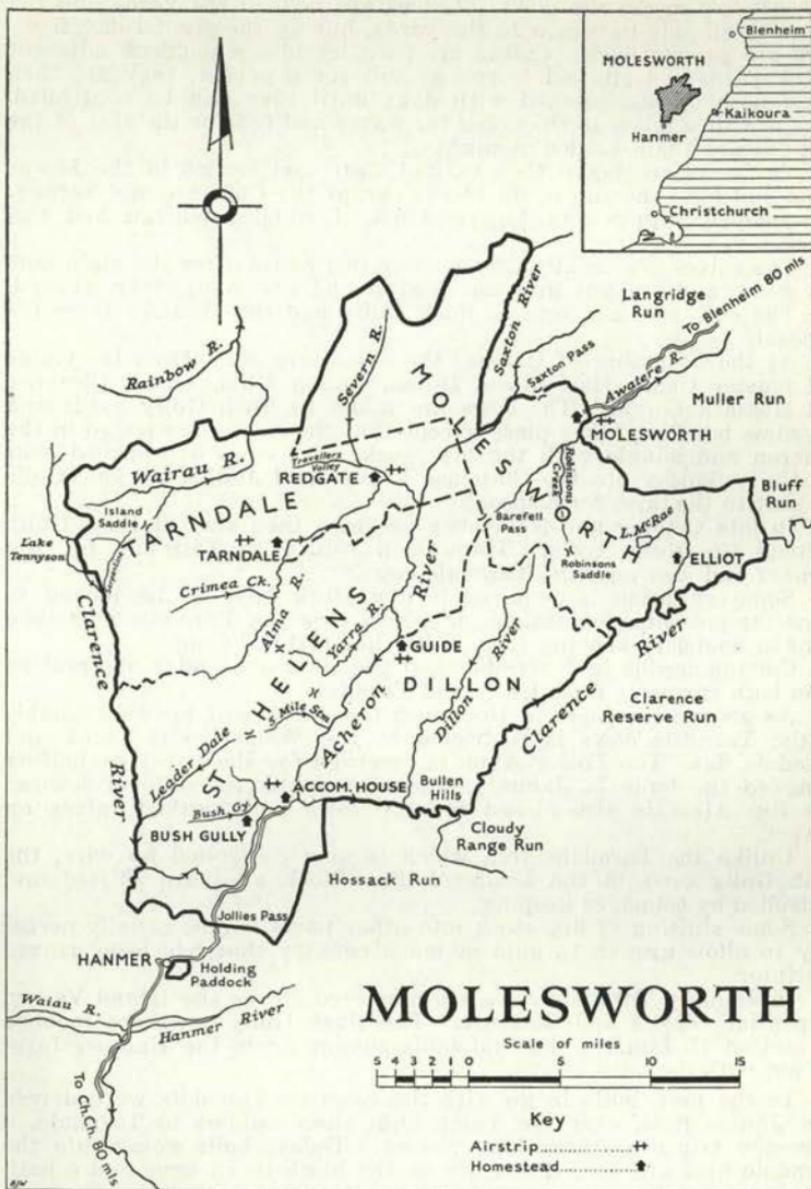
Breeding cows (included are some 650 2-year heifers)	2,736
Calves marked this year	2,114
Dry stock including 1-year heifers	2,916
Bulls	126

giving a total of 7,892 head to be wintered this winter.

In spite of persistent rumours in the spring after a fairly hard winter that substantial losses had been sustained on Molesworth, it has been possible to maintain very substantial sales—the sales being as follows:

Steers	1,085
Cull heifers	354
Dry cows	541
Bulls	2
	<hr/>
	1,982

Estimates for sales in 1961 seem to indicate a continuation at the present level.



Losses per annum are slightly less than three per cent over the past 20 years.

Starting the routine stock movement in the spring (September) cows and calves are mustered off the Elliott Block and are taken up over the Robinson Saddle—of over 4,000 feet. These cattle mix with the Awatere cows and calves and the lot are mustered into the Molesworth yards.

Calves are drafted from the cows, and aged cows and any poorly-coloured and small-framed beasts are culled. Some dehorning may

be necessary in the run cows. Calves are held in the yards and the cows are all able to return to the yards, but by the second day few cows are coming back. Calves are then let into a paddock adjacent to the yards and allowed to run at will for a period; they are then taken in hand and worked with dogs until they can be controlled. They are then taken to the creek for water and fed for the rest of the day, but are again yarded at night.

The cows are taken then to Red Gate and let go in the Lower Alma and have the run of all blocks except the Clarence and Serpentine—namely Upper and Lower Alma, Tarndale, Wairau and Cat Creek.

The calves are usually driven some two hours after the main mob has gone, and are put into the Saxton and are completely weaned.

The cull cows are sent to Bush Gully and the Hanmer farm for disposal.

At the beginning of October the musterers start from the Guide and muster Guide, Half Moon, Dillon, Bullen Hills, Lower Clarence and Hossack Corner. The cows are taken to Bush Gully yards and the same handling takes place except that the calves are let go in the Acheron and mingle with the dry stock. The cows are pushed over the Gully Saddle into the Clarence, Leader and Jollies blocks. Culls are sent to the farm for disposal.

In late October and November two men then stay at Bush Gully to tend the Gully cows. Three men return to Tarndale for the summer and also tend the Tarndale cows.

Some variation is required if dry stock have to be moved to allow for poisoning operations, in which case the Tarndale men take turns at boundary keeping from either Red Gate or Guide.

Calving begins in November and the cows are under observation from both camps at Bush Gully and Tarndale.

As growth increases in December the number of blocks available to the Tarndale cows is restricted to the Wairau, Cat Creek and Tarndale flat. The Lower Alma is reserved for the two-year heifers going to the bulls in January, and also spells recent over-sowing. The top Alma is also closed for the cows and marked calves on 1 April.

Unlike the Tarndale area which is now controlled by wire, the Bush Gully cows in the Leader/Jollies Block area are shifted and controlled by boundary keeping.

Some shifting of dry stock into other parts is also usually necessary to allow growth to gain in much country that has been grazed in winter.

In January Tarndale cows are mustered out to the Island Valley, Serpentine, Beggs and Clarence. The Bush Gully cows are mobbed up and on 15 January the first bulls coming from the Hanmer farm are put with the cows.

In the past, bulls to go with the cows on Tarndale were driven over Jollies Pass, over the Yarra and Alma saddles to Tarndale, a three-day trip over three high passes. Today, bulls going into the Tarndale herd are lorried and are on the block in an hour and a half.

Owing to the size of the blocks usually about four bulls to the 100 cows are run. About 20 January the dry muster is started. Two men from Bush Gully muster up the Acheron and Five Mile and meet, at the Guide, the three men from Tarndale who have come up the Alma from Tarndale and have mustered part of the Upper Yarra and Mt. Scott creek.

The second day the Yarra is mustered and the remainder of the Acheron below the Guide; the third day mustering continues to Red Gate; the fourth day Saxton is mustered and this is the biggest day.

One man has been boundary keeping the Finger Post.

The fifth day the Isolated Flat, Acheron face and Severn to Red Gate holding paddock are mustered.

On the sixth day the mob proceeds to Tarndale via Travellers Valley which is mustered en route including the Waimea.

On the seventh and eighth days we draft two-year heifers and three-year steers for sale.

On the ninth day we draft and cull two-year heifers for size, colour and conformation. About 40 per cent are culled.

On the tenth day cull heifers go to Bush Gully for disposal and steers for sale go to Acheron Bridge, Bunkers and Bridge Paddock.

According to the feed situation some variation is necessary on occasion.

Two-year heifers are put into the bottom Alma with bulls, including some young bulls. Dry stock are taken over the Alma Saddle into head waters of the Yarra and Mt. Scott creek, another mob into the Saxton and another into the Severn for the rest of the summer months.

The mob that has just been mustered and drafted numbers up to 5,000 head, an impressive sight when on the move.

Musterers return to Bush Gully and Tarndale and continue boundary keeping on cows and bulls, stopping bulls from mobbing up and keeping cows down off the hills as much as possible. Particular emphasis is placed on this work regarding the two-year heifers and for a period the boundary keeping of these beasts is done daily.

By 15 March or later if the mob is adjacent to Bush Gully the sale steers are started on the first leg of their journey to Addington. From Bush Gully they are driven over Jollies Pass to the Hanmer farm and if time permits are rested a day or two.

For a special sale on Wednesday at Addington, it is necessary to leave the farm by daylight on Sunday, the cattle travelling via the Hanmer river bed to the Hanmer bridge; the mob is broken up into three cuts to cross the Ferry bridge and is continued on to the highway in these cuts to Brown's Creek holding paddock. On Monday the cattle are continued in cuts to the holding paddock at Culverden. On Tuesday at daylight the first cut is taken to the railway yards and trucking commences.

This year the loading of 88 trucks took from about 6.30 a.m. till mid-day.

The cattle on arrival at Addington are drafted for colour, three ways, and for size groups, and penned in readiness for the sale.

The co-operation over the years of the Railway Department and the Stock and Station Agencies has made this preparation of a large number of cattle to be presented to the buyers a matter of common routine.

During the time the sale cattle have been on the move, at least three men have assembled at Bush Gully in preparation for the marking. On return from the sale, sufficient cows and calves are available and marking is started on the Leader and Bush Gully cows, cuts are taken to avoid mis-mothering and to have the calves off the mothers as little as possible. Also during this operation, dry cows are drafted off and from time to time sent into the farm at Hanmer.

New yards are in the course of erection at Bush Gully and will include a calf yard and race and cradle. The past markings have been done with the old-type cow bail lashed into the existing drafting race. Calves are earmarked, age-marked with plastic tags, and dehorned with a set of small dehorners on those calves showing any signs of horns. Castrating is done with the knife, and all heifers are inoculated against abortion. With six men the operation takes, on the average, one minute per calf.

Towards the end of March and on completing the Bush Gully

marking and having disposed of dry cows to Hanmer, musterers continue to Tennyson and start the Tarndale marking muster from the Clarence, Beggs and Serpentine, over Island Pass to the Wairau. The same drafting of dry cows also takes place on arrival of the first cuts of cows and calves.

At Tarndale, a detached calf marking yard, race and cradle adjoins the main yard. This yard is four feet high, has one filling pen, one crush pen, and a race 15 inches wide holding up to ten calves. The cradle is a fixture immediately in front of the race, with two gates attached to the pen, one serving as stop prior to the cradle and the other as a back stop to include only one calf at a time at the cradle. It is possible to mark 80 calves per hour, performing the same operation as at Bush Gully. The cradle is shaped in two halves and hinged at the bottom, a toothed bar on top holding at whatever distance one half is pushed to. A calf coming out of the race is secured from the point of the shoulder to the hip and firmly held. Little effort is required to pull the calf over on to an old rubber tyre and all operations can be performed from the lying position of the calf. On pulling a trip rope attached to the toothed bar, a 70 lb. weight suspended on a wire rope and attached to the opposite half of the cradle releases the cradle in two pieces and allows the calf the freedom to join the rest of the mob.

As the cuts are drafted and marked they are let into the top Alma and as stated earlier this block has had no stock since December.

On finishing the Tarndale marking, the Bush Gully musterers take the dry cows to the Gully via the Alma Saddle, Yarra, Five Mile and Acheron, and then to Hanmer. Since the first drafts from Bush Gully have arrived in at the Hanmer farm they have been disposed of at the rate of 50 per week. For the last two years these beasts have been mainly taken by lorry to the rail head at Culverden.

Towards the end of April, cows and calves are moved towards their winter quarters. Tarndale cows are drafted toward Red Gate and mix with the two-year heifers, bulls are cut back, and finally the cows are taken across Isolated Flat to the Awatere.

Tarndale bulls are taken to Bush Gully.

The Tarndale cows are allowed a day or two after coming over Ward's Pass to rest in the Awatere. Cuts are taken of some 700 cows with calves and these cattle are taken up the Robinson over the Robinson Saddle and spread around Lake McRae on the Elliott Block. The remaining cows and calves are spread over the Awatere and Yeo Creek.

Spare hacks are also turned into Yeo Creek for the winter.

During the time the Tarndale cows have been on the move, Bush Gully cows and calves have also started toward winter quarters. Bulls are cut back and the cows drifted down the Clarence on to the Hossack Corner, Dillon, Half Moon, Bullen Hills, Lower Clarence and Guide. Tarndale and Bush Gully bulls are taken via Jollies Pass to the farm and are fed from hay cut on the farm during the summer.

In the middle of May dry stock are pushed down out of the high country of the Yarra, Saxton and Severn. Some of these cattle are taken off the 5,500 feet level. These dry stock are spread out in the Acheron, Yarra Spur, Travellers Valley and any sunny faces available. The lack of snow often makes necessary some boundary keeping to keep the cattle clear of bad areas, but this is much preferable to snow. This ends in May the stock movement of the year, and all cattle stay in the blocks mentioned until the spring.

All staff are withdrawn from out the back and the back stations closed for the winter.

Aircraft have been used for cattle spotting and used in conjunction with the musters since 1944. The work done by the aircraft in assisting takes the place of an additional man and with considerable

advantages and at a cost of less than half of a man's salary. Notes have in the past been dropped to men on the ground directing them to missed stock and recently an aircraft with amplifier attached was used to advantage.

In the past, pack horses accompanied musterers to the various camps with gear and supplies, but today all stores and gear are shifted by motor transport.

Cattle on the property do not consist of all the beef breeds but we do have two popular breeds and the cross, the Aberdeen Angus and Hereford. These two breeds and the cross are both adaptable to the rigours of the country and when drafted up for sale are attractive and keenly sought after by the down country fatteners and the butchers. Agreement on the merits of the various beef breeds can never be reached and individual choice must be dictated by the country and conditions cattle are to be run.

The Aberdeen Angus and the cross on Molesworth appear to have just a shade on the Hereford in ability to forage, climb, and to weather out blizzard conditions. On the debit side, the blacks are more temperamental and inclined to deteriorate in stature. In the bulls of this breed there is an alarming incidence of weakness in the feet.

The Hereford is an old and reliable breed usually well-boned and can be trusted to make good under most conditions. Herefords, and especially ones with little or no pigment in the eye, are liable to eye trouble; some of this eye trouble is experienced at Molesworth from time to time.

The cross of the two breeds gives a good sized and useful beast and a most profitable one.

Long winter conditions can quickly reduce stature of the beast and efforts are always directed at maintaining size, an exacting and difficult job.

The cattle beast in most country, and especially run country, must have good feet to travel, good head and eye denoting character and constitution, and a good, wide muzzle to gain feed. Many of the lesser defects can be usually smoothed out with grass.

Abortion has been a real and serious problem for the dairy man —no less serious has it been for the run man with beef. On Molesworth abortion 12 years ago reduced calving to 50 per cent; by inoculation, the percentage has been brought up to the 80-83 per cent mark. All inoculating of the heifer calves is done during the marking.

Stock on the property are handled firmly but with little noise and no excitement; they are wire conscious and can be handled on foot with a dog comfortably. The cattle are used to the yard race and run freely in all yards on the property.

Mention may be made at this late stage of an additional dry muster that takes place every three years. This muster allows for an independent check count of all live stock on the station for the Audit Department. The muster and count is made to coincide with the shifting of the cattle into winter country.

The running of cattle on Molesworth, Tarndale and St. Helens has over the years shown immense benefit to the country. Blocks are improving annually and with a grassing programme are being still further assisted in restoration. In the autumn of the year the many head of cattle are adding still further to the spread of desirable seed. The profusion of clover on many areas where it was lacking before is evidence of the quiet work cattle are doing on the run; still further evidence of fertility build up is the appearance of ryegrass in many places.

Although much more has to be done and many, many years will

elapse before the job on Molesworth is completed, the improvement augurs well as a firm foundation for a slow and continuing increase in stock numbers.

Consideration could be given as to the possibility of cattle on a good deal more of our back country, and even to a slight decrease in our sheep and with all likelihood of an increase in wool weight.

It is certain in time an immeasurable improvement could be expected in the country and a very reduced catchment risk brought about into the bargain.

Cattle for many years have been of value. Of late years the value has increased financially, and still of further value has been their acceptance in land development and their improvement to much hill and run country. The door is wide open for their further increase in the South Island.

Molesworth over 20 years has broken even in its operations apart from meeting full interest charges on capital outlay. Profits of later years have reduced the amount owing and by June 1961 the sum owing will have been repaid plus a surplus, the property in the meantime having both improved and appreciated in Lands Department control.

Q.: How many permanent employees have you at Molesworth?

Mr Chisholm: There are eleven on the payroll, including myself. Five men handle all the cattle.

Q.: When will the country be fit and safe to carry sheep again?

A.: I doubt whether you and I will see sheep being run on Molesworth.

Q.: To what altitude do the cattle go?

A.: They go up to 5000 feet. There are a few English grasses at that height but the feed is mainly carpet grass and a little snow grass.

Q.: At what age do you cull your cows?

A.: No one has asked me why we don't wean; this comes into the story of culling. We don't wean because of the type of country; we have no suitable areas on which to put the calves and we have to calve late because of the high passes (up to 4000 feet) and the late spring. By not weaning, the calves get the shelter of the cows during the winter. To offset the drag on the cows we try to keep them youthful but we do have cows up to eight and nine years. We use age tags which, while not 100 per cent efficient, are better than fire brands. The excess hair in the spring makes the brand difficult to read.

INCREASING THE ANNUAL CALF CROP

E. D. Fielden, Ruakura Animal Research Station, Hamilton,
(Formerly of Gisborne Veterinary Club.)

Managing a breeding herd efficiently is both a stimulating and a satisfying experience. But efficiency is the operative word, for the maintenance and overhead costs in this type of venture are high. Success or failure depends primarily upon the successful production of healthy, vigorous calves. It is this foundation of herd fertility that I have been asked to discuss with you.

It is only of latter years that any data on breeding performance in beef cattle have become available, and this is largely due to the efforts of various officers of the Gisborne Veterinary Club. The data collected have been based largely on information gained during routine herd pregnancy diagnosis. A few comments about this technique may be worthwhile.

Pregnancy diagnosis of run cattle, if carried out six to eight weeks after the bulls have been removed from the herd, can be done quickly and with a high degree of accuracy. A rate of 40 per hour is readily accomplished with reasonable facilities; much higher rates have been achieved.

The advantages of the technique, together with the keeping of a few simple records, and the use of a simple system of identification as shown in Fig. 1 may be summarised as follows:

1. Cows not in calf and/or late calvers can be either sold before the winter or run as separate grazing mobs during periods when the demand for feed supplies by other stock is at a premium.

2. In large herds the running of early- and late-calving groups facilitates the operation of calf marking.

% COWS DIAGNOSED IN CALF BY AGES, 1954-59.

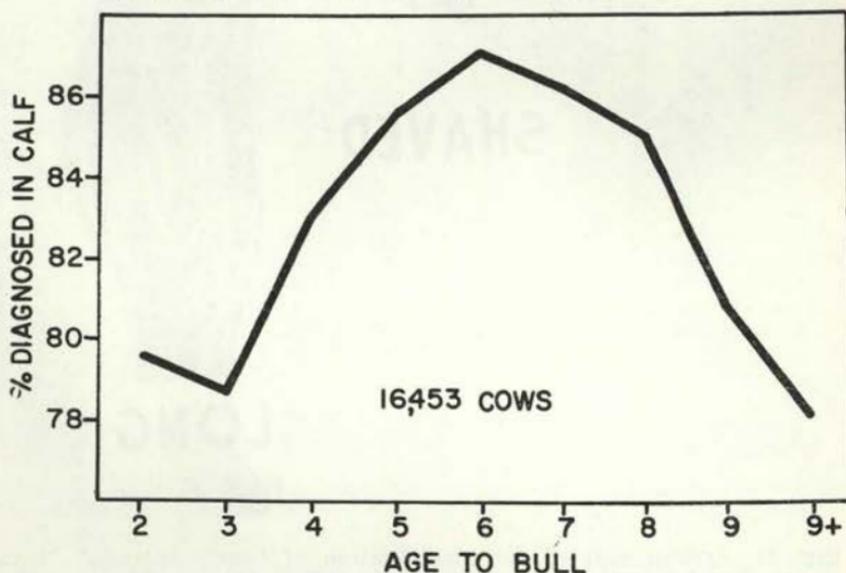


Fig. 2

3. The recognition of a herd-breeding problem can frequently be made at a time which allows a programme of investigation to be started well before the subsequent breeding season begins.

4. Taken in conjunction with calf-marking figures, an estimate of the losses taking place between early pregnancy and calf marking may be obtained. Measures may be taken to counteract such losses



Fig. 1: System adopted for identification of "early calvers," "late calvers," and "empties" following pregnancy diagnosis. These marks last about twelve months.

if they are abnormally high. The value that can be derived from herd-pregnancy diagnosis depends entirely on the effort both farmer and veterinarian are prepared to put into the job; the potentials of the technique as a source of information in cattle farming have hardly yet been realised.

The next few figures show some of the data which have been collected at Gisborne.

Fig. 2 gives some indication of the breeding performance of the various age groups of cattle in the area. The criterion of breeding performance being used in this and the subsequent two figures is the "in-calf percentage." This is

$$\frac{\text{the number of cows diagnosed in calf} \times 100}{\text{the number of cows mated.}}$$

Note from Fig. 2 the relative inefficiency of the younger age-groups, and again of cattle nine years of age and over.

Fig. 3 contrasts the performance of the various age groups in good- and poor-performing herds. The important point to notice is the rather erratic performance of the three-year cattle in the poor-performing herds, i.e. in herds with a definite breeding problem.

% COWS DIAGNOSED IN CALF BY AGES, 1957-1959.

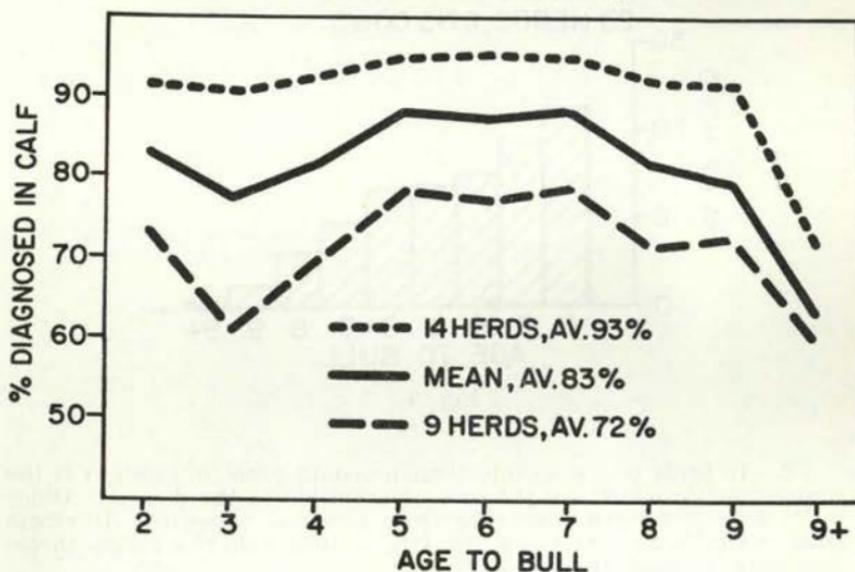


Fig. 3

Fig. 4 illustrates the extremely important part the younger age-groups play in contributing to the annual calf crop. It may be seen that they make up a very high proportion of the total breeding herd. The oldest age groups contribute little to the overall herd performance.

Before passing on to the next stage, I shall endeavour to forestall an obvious question arising from the figures I have just shown you, namely, why do these younger cattle perform on the average poorer than the more mature animals? My answer is purely a speculative one, but it seems to me that at least three factors operate to bring about this state of affairs:

1. Because a common practice in the area is to cull cattle which have been "dry" for two years in succession, it is not until the fourth year that permanently-barren and shy breeders are removed from the herd.

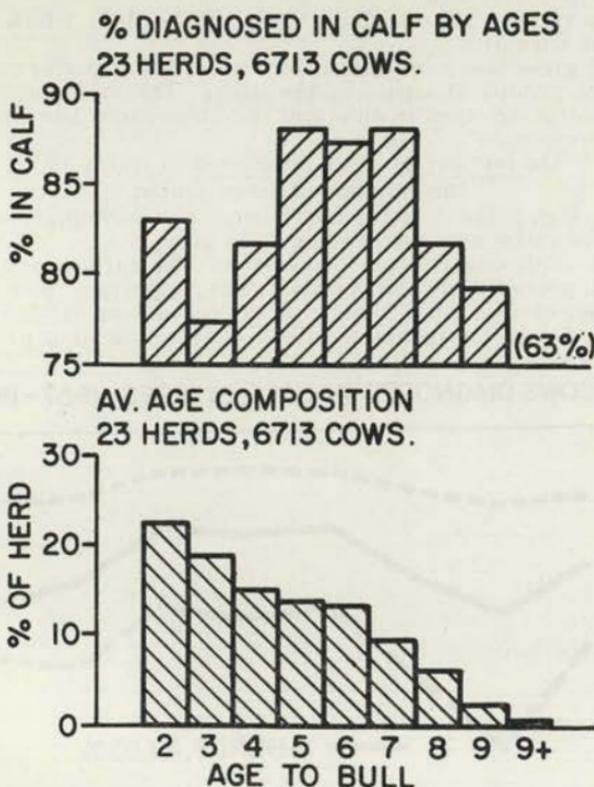


Fig. 4

2. In herds where an infectious breeding problem exists it is the younger cattle which are the most susceptible to the disease. Older cattle have developed resistance from previous exposure. If virgin bulls and heifers are run as a separate mating mob, this makes three-year-olds the most vulnerable group.

3. The level of feeding in beef herds often leaves much to be desired, and inadequate supplies of food for young growing stock, together with the demands of early lactation, may well impose sufficient stress on the animals to produce impaired fertility in the subsequent breeding season. Older stock may also be affected to some extent by such circumstances, but they have not the same demands of growth to meet, and they have had a greater opportunity to adapt to their environment.

I have been talking until now about the in-calf percentage. What about the number of calves actually marked? This may be defined as the "effective calving percentage" and is

$$\frac{\text{number of calves marked} \times 100}{\text{number of cows mated.}}$$

TABLE 1

Reasons for Differences between In-calf and Effective Calving Percentages

In-calf percentage =	$\frac{\text{Cows diagnosed in calf} \times 100}{\text{Number of cows mated.}}$
Average loss 7 per cent of calves diagnosed in-calf. Range was 0.12 per cent (23 herds).	1. Early abortions, early foetal death (trichomoniasis, vibriosis, unknown) 2. Late abortion, calves born dead (brucellosis, leptospirosis, fungal abortion, difficult calving, unknown) 3. Deaths birth to calf marking (mis- cellaneous causes such as no milk, etc.) 4. *Cow deaths.
Effective calving percentage =	$\frac{\text{Number of calves marked} \times 100}{\text{Number of cows mated}}$

* Although cow deaths will affect the effective calving percentage, they have been allowed for and are not included in the average loss figure of 7 per cent. As a general recommendation, if differences of the order of 10 per cent exist between in-calf and effective calving figures the situation should be critically examined.

Losses between marking and weaning are usually very small in the Gisborne area, and so the effective calving percentage virtually indicates the weaning figure. Unfortunately it usually differs from the "in-calf percentage," sometimes quite markedly. Table 1 illustrates this point, and indicates some of the possible causes; the properties referred to in this table averaged only 93 calves at marking from every 100 cows diagnosed in calf.

Turning now to some of the more obvious factors that affect the annual calf crop. They are most conveniently discussed under the three headings—management, breeding and disease control.

MANAGEMENT

Overmating

All this system involves is the mating of more breeding stock than it is intended to winter, and the subsequent elimination of dry cattle and surplus pregnant cows by pregnancy diagnosis in the autumn. Strictly speaking it contributes little, as far as is known, to the actual fertility of the herd. It can, however, increase the annual calf crop and is well worthy of consideration as a practice of meeting this end.

Feeding

Feed requirements for optimum fertility in cattle are unknown. A poor plane of nutrition during rearing will delay the onset of sexual maturity, and may limit final body size, while an inadequate food intake will inhibit oestrus in all animals. I can only suggest that if feed supplies must be severely restricted the first two thirds of the pregnant period is the time to limit grazing; every effort should be made to provide an adequate level of nutrition during late winter and early spring when stock are either approaching calving or in early lactation.

Age and Size when First Mated

Obviously the earlier in life an animal can be bred from, the smaller becomes her overhead cost. Pregnancy as such does not appear to have any deleterious effect on the development of the cow, provided she is given an adequate level of nutrition—the problem is to know what constitutes this adequate level of nutrition. The Americans suggest that a heifer should reach 650 lb. liveweight at 20 months to give of her best performance. Until we know more about it I think we should aim to have our heifers well enough developed for mating at two years (around 700 lb. liveweight or better) under hill country conditions. Yearling mating can be successful under better conditions.

Mating Practice

One bull per mob appears to give better results than several bulls per mob. If single-mating mobs are run, it is desirable to switch bulls every three to six weeks to counteract the effect of sub-fertile sires. Thirty cows to each bull should be satisfactory on most places, but this will depend on the type of country.

Bulls should be in good health and condition when they are turned out with the herd, particular attention should be paid to the condition of the feet. Routine semen examination of all run bulls does not seem to be a practical proposition at present; collection from a quiet cow currently in oestrus is satisfactory if it can be arranged with your veterinarian. The use of electro-ejaculation as a method of collection with bulls in this country does not, at the moment, seem to be adequately understood.

BREEDING

The heterosis or hybrid vigour which occurs in the first-cross animal is a winner in terms of fewer losses, faster growth and higher calf crops. In my view it is time that a critical appraisal of hybrid vigour in cattle was undertaken in New Zealand.

DISEASE CONTROL

Five infectious diseases which directly affect calving percentage have already been mentioned. I will make a few comments about the three more common ones.

Brucellosis

Usually known as "contagious abortion," this disease is still very prevalent in both beef and dairy herds. Fortunately it can be readily diagnosed and effectively controlled by vaccination with Strain 19. All potential breeding heifers should be vaccinated, preferably before they reach the age of sexual maturity, in practice between about eight to 12 months of age.

Leptospirosis

This disease may cause severe outbreaks of abortion in mid or late pregnancy. It, too, can be readily diagnosed, and a vaccine is available which appears to give satisfactory results.

Vibriosis

This is a venereal disease which appears to be fairly widespread in beef herds, particularly in areas where neighbour boundaries are only semi-existent. Vibriosis is spread by the bull at the time of service and results in cows either not getting in calf or being late calvers. Unfortunately control is difficult under run-cattle conditions. The use of a two-herd system in which virgin heifers

and bulls are run as a separate unit, will permit control if the property lends itself to this type of management. Very few in Poverty Bay do. An efficient vaccine would be very welcome in handling this disease.

I regret that I cannot offer you a complete recipe for ensuring 100 per cent calving, but at long last a closer look is being taken at this aspect of the beef industry.

Professor McFarlane, whom many of you know, and who has now left these shores for the University of Sydney, deserves much of the credit for this. I hope such work will continue.

Q.: I do not mate my two-year-olds. I find if I do I get poor calves. If I don't mate at two-year-old I get good calves from three-year-olds.

Mr Fielden: Nevertheless I don't agree that you should hold off to three-year-old. If you take a herd of 200 breeding cows you will have 40 two-year-olds which leaves 160 older beasts for mating. Suppose you get 90 per cent calving from them alone you won't do as well as if you also got 75 per cent by mating two-year-olds.

WOOL : RESULTS OF RECENT RESEARCH AND ITS APPLICATION ON THE FARM

A. E. Henderson, Lincoln College.

In common with many other things, wool in all its forms has to try to satisfy many criteria. For example, the farmer wants it to do one particular job and the processor and user want it to do entirely different things. Thus anyone who grows wool or who handles it subsequently has to constantly negotiate some intermediate course towards a series of objectives. A great many of these objectives conflict with one another and are not easy to resolve. It is the task of specially trained research workers to deal with these problems and all over the world there are people so engaged. Many are measuring and examining things that are largely incomprehensible to the sheep breeder or wool grower. Further some are working with peculiar-looking sheep. However, all of this work has a very real purpose and today I have to attempt to tell you something of what is happening and how this relates to your work.

First of all, what are the problems and what are the objectives? As you well know the fleece is a complex conglomeration of fibres of different sizes arranged in different crimp and staple patterns. The outside of the fleece is exposed for approximately a year to all the multitude of damaging effects caused by weather and other things; it has in it large quantities of nitrogenous materials and inorganic salts such as potassium chloride and potassium carbonate. Inside it there are quite high body temperatures and the fleece thus forms a good environment for micro-organisms and for chemical change.

Any work done by the sheep breeder, woolgrower and research worker aims to produce, in quantity, an orderly arrangement of fibres that will not deteriorate while on the sheep. From the research point of view this involves studies of fleece development, of fibre numbers, length and thickness, these three being the components of fleece weight, of the preservation of the fleece and not least of the efficiency of the sheep in converting food materials to wool. It is these fields of work that I intend to discuss.

Concerning fleece establishment and fleece structure some of the most outstanding work has been done by Dr Dry and his school who worked with a very peculiar-looking and very hairy variant of the Romney. On numerous occasions this outstanding research worker has been sharply criticised for working with this kind of sheep and the view has been expressed that much more valuable work could have been done if he had spent his distinguished research career working with the normal Romney. Such an attitude on the part of the producer is easily understood; but from a research point of view the normal fleece, compounded as it is of many subtle effects and interactions of effects, offers little in the way of markers by which something or other may be accurately and easily measured. The rough-coated strain of Romney provides many markers and such a fleece is a very valuable research tool. You will find research workers everywhere deliberately using unusual sheep with unusual wool just for this very reason.

Work done by Dry and his associates, and also by a group in Australia led by Schinckel, showed clearly the very strong hereditary basis for hairiness of both the lamb and adult fleeces and established the nature of many of the interacting factors that affect

structure of the adult fleece. Other work in a number of places has shown that the more variable fleece is not only of lower grade because of its variability but it is a poor risk when it comes to fleece preservation during the wool-growing year. For example, under even slightly critical conditions for growth this fleece loses its staple crimp, many fibres may be shed, the fleece is very liable to cotting and following this there may be excessive staining within the fleece and weathering of the staple tip.

Basing an approach on these findings we have lately been attempting within highly selected flocks to predict the potential excellence of the adult fleece from an inspection of the lamb coat. We use the very young lamb because the coat shows many effects which are later obscured and we find that even in our highly-selected flocks the principles established by Dry still hold. In brief the lambs that will eventually have the most variable fleece with a high fault-risk are those with noticeably large numbers of coarse, stiff hairs in the birthcoat and particularly over the hind legs, rump and tail. Moderate to small numbers of these hairs are of little practical importance. In stud and breeding flocks you can therefore do some effective marking for subsequent culling when lambs are two to three weeks old. This, I think, is most important in fine breeds like the Corriedale, Halfbred and Merino.

These studies have been very fruitful from another point of view. They have shown that the difference between the rough, hairy fleece and the refined, high-grade fleece rests on what is perhaps a single event occurring at about the end of the third month of foetal development. This event causes the first-formed primary fibres to be large. Practically nothing is known of this event beyond the fact that it occurs; however it is relatively well-defined and it can be evaluated so that we are learning from it a lot that helps us to understand problems of fleece structure.

Parallel with this approach Australian scientists have been trying to describe the formative events of fleece establishment by making investigations using tissue cultures and skin grafts. With reservations, both have been moderately successful. For example, it has been possible to culture skin away from a blood supply and other immediate influences of the lamb and to achieve full development of follicles and fibres in their normal pattern. Thus some possible influential factors have been eliminated. Secondly, a technique of making successful skin grafts on the unborn lamb has been developed so that the influences of time and position can be studied. However, all the usual process of antibody reaction and ultimate rejection of donor material occurs in the sheep and this so far has prevented any interchange of material between animals.

During our attempt at application of this and to selection, we have encountered, particularly in the Border Leicester breed, a number of odd situations in connection with fibre-succession and fibre-growth behaviour. For example, the appearance of kemp in some sheep and serious cotting towards the tips of staples cannot be readily explained by what is known for the Romney. We are investigating these things and will have to start with the unborn lamb in the third month of its development.

To summarise the objectives of work on fleece establishment we are trying to find the nature of the directive forces that determine how many wool fibres there will be on a sheep, in what patterns or gradients will these be arranged, and how the potential volume of any particular fibre is decided. It appears unlikely that we will be able to exert much influence on any of these things except by precise selection of breeding stock.

Moving now to the next group of problems: once we have the

fleece established we must take notice of the way the components interact among themselves under the variety of treatments that the sheep experiences. For example, density can be an important factor in fleece preservation, while thickness and length of fibres and the relationship between these two measures are important commercial attributes. In the main, some particular balance among these things is optimum.

Recently there has been much research, mainly of a mathematical nature, into the relationship between these characters. In line with common opinion it is consistently found that density and fineness are negatively related—that is, if one is increased the other decreases by some measurable amount. However, contrary to what is generally thought, fibre length may be, and generally is, independent of density and fineness if considered on a breed basis. The methods of analysis are new and only a small amount of information of this nature is available, but it shows that in Merino sheep, variation in density is responsible for most of the variation in fleece weight, while in Romney sheep variation in fleece weight is most affected by variation in fibre length. These two breeds therefore seem to adopt different means of expressing high wool production.

To make sound use of this information we must first of all find out the precise effect any increase in numbers of fibres would have on fineness and further we must understand more about the mechanism by which increased wool-growth rates are expressed in increase in fibre diameter or increased length. We know from work done by Hart and others with thyroxine that extra wool growth is expressed chiefly as length growth. This is a clue to the independent nature of length growth and to one form of control. We have lately instituted a research project which involves an exhaustive examination of the follicle bulb at the point where the fibre is actually built and we have used thyroxine to cause differences between groups of sheep. From this work we hope to gain much information of the forces that decide diameter on the one hand and length on the other.

Since we must translate our findings into field practice it is logical that there is a group of people concerned with the efficiency of any of the processes of fibre growth and this constitutes the third general field to be discussed.

Two years ago I reviewed here some problems of efficiency of wool growth and I pointed out the clear occurrence of diminishing returns as food intake increased. Australian workers have since gone further with this type of investigation and some observations recently made are of value to the woolgrower here.

Firstly, there is increasing evidence that the most efficient sheep in one set of circumstances is also the most efficient in other circumstances—the circumstances largely being ones of feeding. A lot of the information of this nature suggests too that the age-old contention that sheep should be selected in the environment in which they have to produce needs to be looked at more carefully.

The second conclusion has some quite far-reaching implications and it is that sheep can eventually use stored body tissue just as efficiently for wool growth as if the same materials had been used directly. This in part explains the rather remarkable wool-production levels attained by our sheep under recent drought conditions. Linking this information with that on seasonal wool growth which shows a decided peak about January, February and March, it appears that sheep can be on very short rations in these months and yet come to little if any harm from a production point of view.

Thirdly, it has become clear that the best practical measure of efficiency in wool production is a measure of the amount of wool

produced per unit of bodyweight. On a per-sheep basis greater production is usually associated with greater appetite; however, maintenance requirement of a sheep is proportional to body weight and what we are really interested in is what the sheep does with materials left over after maintenance is satisfied. The sheep can divide these two ways, to wool growth or to other purposes, and we are specifically interested in this division. It is well to heed that most work so far has concerned the Merino, a breed in which a heavy bias towards wool growth is acceptable. We are not certain that this principle can apply equally to our Romney and other dual-purpose breeds. Within this College this problem is receiving attention.

So far we have been considering rather isolated sections of wool production but we must of course remember that the animals we use must be bred and the breeder must consider the whole overall situation. Much research into breeding methods has been done and this field has perhaps been the most frustrating. For example, if we do manage to achieve higher fleece weights in our sheep we almost always find that the fleece has become more hairy and the sheep heavier. The nett economic gain therefore becomes questionable.

Breeding experiments take a very long time and formerly tended to be based entirely on the progeny test. Now, breeding research tends to be based on pairs of flocks in which selection in opposite directions is practised. Methods are based on a combination of progeny test and individual merit but a very important part of the selection programme is that upper and lower limits are set for characters that by experience we might expect to change as fleece weight changes. This work is designed specifically to test whether in fact we can overcome this association of characters. Of course, no commercial breeder would entertain the idea of this kind of selection. However, it should in time be possible to set out the most efficient methods by which particular objectives may be achieved. Results from Australian work are most encouraging but again we must remember that they are dealing there with a single-purpose animal.

Lastly I want to say a little about fleece preservation and this includes preservation of colour. As many will know, we have been working here on fleece staining and in particular we have been looking closely at banded stains that occur in wool along the back. To the farmer these fleece effects are known as yolk stain, green stain, fleece rot, and sometimes wrongly as mycotic dermatitis.

Fundamentally these stains result from wetting and/or the activities of micro-organisms. In the fleece we have an environment that is difficult to dry once it is wet and which is a wonderfully congenial host environment for micro-organisms. It is warm, it is aerated, and it contains a very extensive number of substances upon which micro-organisms can live and flourish. As a result of our work we know a good deal about the bacteria mainly responsible and we have good information about many other aspects of the problem. We know some sheep are immune or largely immune to these troubles but as yet we have not found why. As somewhat of an anticlimax the best advice we can offer so far is to select, using plain commonsense, the kind of fleece that will dry most easily. Unspectacular advice, but it has the merit of simplicity.

We might eventually have to proceed to more complicated measures if we plan attack on the population of micro-organisms in the fleece. These populations are astronomically large and can be constantly replenished from the ground and the atmosphere. The prospect of controlling this is a formidable one but the possibility is not being neglected. In recent years it is probable that we have lost ground in this direction because of widespread use of highly efficient

but nevertheless very specific insecticides in our dipping and dusting preparations.

Fields of research that have been mentioned here cover only a fraction of the work going on that has some eventual bearing on wool production. Much of what is being done may perhaps be called fundamental research though almost always there is a recognisable link with production and it will do no harm for me to mention here how this is organised. It will at least emphasise the almost inevitable complexity of a superficially simple problem.

As an example let us take something we have already discussed: that is, selection for higher fleece weight. We find if we do this that there are likely to be associated changes in other economically important fleece characters. Since increased fleece weight must be the result of changes in numbers of fibres and their size, we must enquire into the underlying directive forces which control these characters since they are economically important, collectively and each in its own right. This means that we must make our enquiries within the skin and wool follicle; in fact, we must find out all we can of the actual chemical and physical processes by which the fibre is built and of the things that affect the ability of the fleece to withstand weathering and damage. The objective is of course to be able to bring as much order and efficiency to the wool-growth process as we can. It is most unlikely that spectacular changes or innovations will come of this such as might happen in a bench process in a factory. Indeed such changes would most likely be sternly resisted by a farming industry within which wool growth is integrated with other forms of sheep production. Despite this the overall effect of even a very small and unspectacular increase in efficiency of selection, or in control of the growth process or one which ultimately contributed in some way to fleece preservation, would have a large collective influence.

Q.: What do think is the value of applying some kind of oily dressing to lambs in the autumn to withstand the winter?

Dr Henderson: Every two years somebody asks me that. I know there are a number of people doing it in New Zealand and for a number of years there was a man running Corriedales in a 50-inch rainfall who wrote to me saying that he was getting very good results by using this oily spray and preventing pink tip so common in areas of high rainfall. He considered that the wool stayed in very good condition in the winter. It is a thing we have neglected to test but I cannot see anything wrong with it so long as you do not use an oil that will not oxidise and harden. Do not use linseed oil. Use a stable vegetable oil. It must be an oil which will scour.

You cannot procure any of these things for nothing. If you are going to use it you must include the cost of buying it and the cost of putting it on. When you sell, the yield is less and you will probably get 2d pound less for it than your neighbour and you must weigh this against the other conditions.

Q.: Could you tell us if the stronger-fibred wools are more susceptible to tenderness or break?

A.: No, it tends to be rather the other way round, except that with coarser-woolled breeds you have a greater variation in fibre size. Because of competition effects you get more fibres shed from the skin. In the fine-woolled sheep like Merino the biggest fibres are not much different from the smallest fibres.

Strangely enough, the Australians have used four breeds in their tests running from the Lincoln to the Merino and have found the Lincoln wool withstood extremely tough conditions.

Q.: What causes break in wool?

A.: My opinion is that break is fundamentally caused by the very low rate of wool growth in June and July—it is only one-third of that in January. If you feed poorly in winter it may be only one-fifth the rate of that in January. This causes the break which you normally don't see until lambing.

Q.: Are we losing much because of mycotic dermatitis?

A.: The national loss is very small. We lose far more through the careless use of phenothiazine.

THE MANAGEMENT OF HIGH-FERTILITY FARMS

W. Faithful, Department of Agriculture, Invercargill.

On 17 August 1853 negotiations were completed for the purchase of Murihiku from the Maoris. On that day a deed of conveyance was signed by 58 chiefs, whereby an area of about 10,500 square miles of land "with the anchorages and landing places, with the rivers and lakes, the woods, and the bush, and all things whatsoever within the places" were "entirely surrendered to Her Majesty the Queen for ever and ever." The price paid for this was £2,600 and owing to shortage of ready money, it was paid off in instalments over a period of 15 months.

Nine years prior to the signing of this very important document, a surveyor, F. Tuckett, in search of a settlement for the Free Church of Scotland, had reported that the land on which the City of Invercargill now stands, was a "mere bog totally unfit for habitation." He was no doubt justified to some extent at least, in this opinion, because his approach would be by sea, from what is now Bluff Harbour, and up the course of the estuary he would be seeing part of the huge expanse of Seaward Moss, a peaty swamp of some 80,000 acres which is only now being drained in parts and brought into production.

Despite this very adverse report, there were others who had a broader concept, and a greater faith in the potentiality of this part of the country, because in the course of just over 107 years the tussock, bush, scrub and swamp land, has been developed, much of it into high-production farm land.

The story of the development of Southland is a record of rapid progress and high achievement, but probably the best or quickest way to illustrate this is to convert it into figures. The value placed on Murihiku in 1853 was £2,600, while today the rateable value of the Southland and Wallace counties is £120 million, practically all of which is the result of land improvement.

Topography and Climate

Topography, climate, soil type and soil fertility are all linked and each has a bearing on the others, so it is necessary to take these factors into consideration when discussing the management of high-fertility farm land.

To the west we have the great bulk of the mountains of Fiordland lying to the west, and this mountainous country is continued as the northern boundary between Southland and Otago. From these mountain systems run the ever-widening valleys of the four main rivers, Waiau, Aparima, Oreti and Mataura, all of which flow approximately south into Foveaux Strait. The river valleys mentioned are a particular feature, because they broaden out to form extensive plains which are of significance here in that many of the high-producing farms are located on the more coastal portions.

The most extensive is the Great Southland Plain, located to the west or south of the Hokonui Hills, and lies between the Oreti and Aparima rivers. The area is approximately 600,000 acres (40 by 25 miles) extending from the coast to the Wreys Bush and Fernhills districts, and it is in fact the largest single block of cultivated land in the province.

Other extensive plains are the Waimea, Whakea or Waikaia and the Five Rivers Plains. These are inland plains and have an aggregate area of approximately 500,000 acres. The Five Rivers Plain and part of the Waimea Plain were the "home" of Chewings Fescue seed

production. Other fairly extensive areas of higher-fertility plains land are the West Plains and Wallacetown Plains lying to the north-west of Invercargill with an area of about 100,000 acres. High-fertility farmland is associated with the Mataura River Valley and adjacent valleys. The Mataura Valley broadens out to the south of Gore and becomes the Edendale Plain with an area of about 200,000 acres.

Parallel with the rivers are the Longwood Range, the Taringaturas and the Hokonui Hills. The Hokonui Hills are of rather particular importance because they have an influence on the climate and rainfall in various areas. The prevailing winds are from the south-west and the storm clouds striking the western side and southern tip of the Hokonui Hills are diverted, so that there is a higher precipitation on the country to the west of these hills than on the east.

Rainfall has of course an influence on soil fertility (and incidentally influences to a great extent the type of farming which may be carried on). In the more coastal areas the rainfall is anything between 45 and 50 inches and this dwindles down to 30 inches or so in the inland districts.

Distribution of rainfall is extremely important. In and around the coastal belt the rainfall is usually fairly-evenly distributed throughout the year, although the winter months can be the period of the lightest fall. The grain and seed crop areas in Southland are usually located in the drier inland districts and fat lambs and more mixed farming in the coastal belt. It will be observed that Southland has a particularly favourable farming climate, and in fact the good climate has been a very important factor in farming progress.

Soils

The soils of Southland are in the main formed by rivers, and may be broadly divided into the following groups or classes. First are the alluvial deposits overlaying a coarse shingle or gravel varying to a silt clay sub-soil according to locality. The soil of the more undulating country is a silt loam with a varying clay content according to district and location. The plains lands are interspersed with undulating country derived from loess. The bush land and the country which originally carried a cover of red tussock has generally a higher clay content and a more retentive sub-soil than the other soil types. We must agree at least in part with Mr Tuckett as regards the wetness of at least some of the Southland soils, because a fundamental requirement of a large proportion of the lower, rolling country is drainage.

Scattered throughout the province are areas of peat complex and peat soils. There is still much of this land yet to be brought in, but until such time as it is properly drained, it is not worth while attempting to farm it. It must, however, be recognised that much useful work has been done by the Southland Catchment Board in providing outfalls for the drainage of wet land and improving conditions on a large number of creeks and waterways. The work undertaken has permitted farmers to make full use of this potentially high-producing land.

Soil Fertility

In general, soil fertility or potential fertility decreases from the coastal regions inland, in the same way as does the rainfall. Usually recognised as the most fertile soils of Southland are the recent alluvial silt deposits at Mataura Island, south of Wyndham. Other parts noted for their high fertility are around Otahuti and Drummond (part of the Southland plains), East Limehills and Boggyburn districts and the lower end of the Mataura River Valley extending to the Edendale Plain.

Most of the Southland soils in their original state could not be generally described as highly fertile. Much of the original cover was red tussock, a plant not usually associated with high fertility. On the contrary it is quite at home on poorly-drained thin land. The better-drained areas, such as the alluvial flats and lower terrace country, carried a cover of silver tussock and allied plants, and because this land did not require drainage it was the first to be put under the plough. Other areas of potentially high production such as the Boggyburn and East Limehills districts were swamp and required extensive and expensive drainage before they could be brought in. Parts of the West Plains and Wallacetown areas were originally clothed with black pine bush, interspersed with silver tussock. The bush of course had to be cleared before full farming use could be made of this land.

Changes in Farm Practices

An outline of the changes in the farming practices of the Southland Province is necessary when considering the management of high-fertility land, because the past has had a very definite influence on present-day farm practice. Farming in the south has passed through a number of phases.

In the first phase were the large areas of virgin country where both cattle and sheep were used and the major source of income was derived from the sales of hides and wool—both of which were at that time extremely important commodities.

The next phase, was a long period of the development of the agriculture of the province, when extensive use was made of the plough. Grain growing was of great importance, and dairy farming proved very attractive, because it provided a regular income for those who were developing the land, with much energy and enthusiasm but little money. Sheep farming was of course even then of importance because wool has always been an important item of world trade, but nevertheless there was, during this second phase, a greater diversification of farming activity than at any time before or since. Land development has of necessity, always been a feature of Southland farming, and the methods adopted have embraced various rotations and these have been changed to meet the periodic economic requirements. In the heyday of grain growing, it was not unusual to take a number of consecutive crops—and in some districts it is recorded, that as a result of persistent cropping, the farm lands became red with sorrel.

The beginning of the third phase, and in fact the turning point in the agricultural history of Southland, was the availability of lime. This, together with the fact that the depleted land could be spelled to some extent, permitted the development of dairy farming, and associated with this, there evolved a system of crop rotation. Better pastures were essential and turnips and hay were necessary for winter feeding. Where dairy farming was not practicable, cattle and sheep or both were grazed, but the system of a crop rotation became established, and this has persisted in the farming practice of the province. The rotation has usually included a relatively long lea which has tended to build up and improve the fertility of the land. This trend has perhaps been emphasised more particularly since the recovery period following the world-wide depression of 1929-32.

Farming Progress

Some idea of the farming progress and the build up of fertility of the farm lands may be gauged from the agricultural statistics of the province. The total occupied area is just over 3,000,000 acres, of which approximately 1½ million acres is in tussock, 1½ million acres in sown pasture and the balance in bush, scrub, fern and barren

country. The stock-carrying (sheep and cattle) capacity shows a total of just over 5,000,000 sheep, of which almost 4,000,000 are breeding ewes and 153,000 cattle, of which approximately 36,000 are dairy cattle. Fifteen years ago the figures were: total sheep, 3,330,000, of which 2,250,000 were breeding ewes, and there were 149,000 cattle of which 49,000 were dairy cows. The figures as regards breeding ewes are particularly arresting. The increase in breeding-ewe numbers averaged about 80,000 per year in the five-year period 1945-50, and since 1950 the increase has been in the vicinity of 170,000 per year. The breeding-ewe population of the tussock country is fairly static, so that the increases have, to a large extent, been located in the sown grasslands. A point supporting this contention is the spectacular increase in the number of lambs killed at the three Southland Works. In the 1949-50 season the number was nearly 2,500,000 and last season it was about 3,350,000.

To complete the comparison it is necessary to include the production of grain and supplementary feed crops. There were 10,000 acres of wheat grown 15 years ago and 31,000 acres of oats (16,000 acres for chaff and 16,000 for threshing). At present the acreage in wheat in Southland had increased to over 11,000 acres, while the oat acreage has dropped to 15,000 (10,000 acres for chaff and fed off and 5,000 acres for threshing). There were 130,000 acres sown in supplementary feed crops 30 years ago and this acreage has increased now to 150,000. This increase in supplementary feed is of course in keeping with the general farming trend to fat-lamb and wool production, but nevertheless, the comparative acreages also show that the system of crop rotation has not been ignored, the total area under the plough being in the vicinity of 176,000 acres, approximately one-tenth of the area of sown pasture land.

Crop Rotations

There are many crop rotations practised but almost without exception swedes are ridged out of lea. Very occasionally the lea may be ploughed in early March and a crop of ryecorn put in; this is grazed off in the late winter/early spring (August, September) and thereafter the paddock is re-ploughed and worked and the swedes ridged in at the end of November. The second crop in the rotation is extremely variable. On some farms the paddock is resown to pasture under Club-Root-Resistant rape, or rape and yellow fleshed turnip or chou moellier or Wilhelmsburgher swedes and chou moellier. Another variation is half the paddock in ridged rape for lamb feed, and the other half in grain, either wheat or oats. A pasture mixture may be sown under the grain crop, particularly if it is oats. Or if the harvest is early enough, pasture mixture may be sown in the autumn.

As a further alternative, the area may be used for a grain crop or very infrequently the second crop may be ridged rape. Generally if the paddock has been up for two seasons it is resown to pasture in the third season, frequently under rape, or as straight pasture.

The crops used in the rotation depends to some extent upon the size of the farm and the locality. In the coastal area, farmers generally are not very enthusiastic about grain crops, so that most of the white cropping is done in the inland areas. There are exceptions of course, and some extremely good crops of wheat up to 80 and 90 bushels per acre are grown on some almost coastal land. The acreage under the plough on any one farm also varies considerably. On some of the best-farmed high-fertility land comparatively small areas of swedes are put in for the wintering of a large number of stock. For example, a well managed farm on good land, where heavy swede and turnip crops may be expected, the ewes may be on turnips for only six weeks or so, in which case an acre or even less of swedes may be

sufficient for 100 ewes, while the acreage necessary on the lighter land will be much larger. Crops here are naturally not as heavy and it may be necessary to put in an acre for each 40 or 50 ewes. Winter-feed crops are, however, an extremely important consideration in Southland farming, and owing to the incidence of dry rot and club root in swedes and turnips there is an increasing acreage of chou moellier put in as second crop. Chou is however a very wasteful supplementary feed if fed off in breaks.

Utilisation of Fertility

From the figures presented, it will be seen that the pattern of agriculture of the province has been to utilise fertility without exploitation; consequently, the soil fertility has been built up to a high standard. Present-day Southland farming is to a great extent specialising in fat-lamb and wool production, but as a result of the build up in fertility and the resulting increase in sheep concentration, fat-lamb production is becoming an increasing problem, unless we have recourse to drenching and inoculating. In some seasons even drafts of milk lambs are disappointing and farmers are left with large numbers to fatten either on grass or feed. Particularly does this apply in a year of very lush pasture growth.

Mention has been made of the influence of lime on the farm production of Southland. There is no doubt that lime has been of great importance, but in some parts lime appears to have been used to excess or at least the quantity of lime applied seems to have had an adverse effect on the balance of other minerals necessary for lamb thrift. It has been found that discontinuance in the use of lime is beneficial on some high-fertility farms where the pH has been raised to a figure of 6.7-7. As an example of this a farm may be cited where no lime has been applied for the past seven years. Prior to this the annual application had been 10 to 100 tons over the whole farm during a period of ten years. Lamb fattening was extremely difficult. Benefits have been obtained from withholding lime but carrying on pasture topdressing using superphosphate plus potash. The farm of 240 acres carries 850 Romney ewes, has 14 acres under the plough each year for swedes and closes up 42 acres for timothy seed. A further improvement in the lamb fattening position resulted after the introduction of Suffolk rams instead of Southdowns. The lambing percentage is 120 to 125 per cent and the wool clip averages just over 10 lb. Cattle are not carried on this farm, pasture control being confined to sheep grazing and production of hay and timothy seed.

Pasture Management

The build up on many sheep farms has raised the fertility to dairyfarming standard, and in many other cases the dairy herds have been sold and dairy farms have changed over to lamb fattening.

With this change over, most farmers found that ewes and lambs did well for a number of years, but with the topdressing programme being maintained, there has been an ever-increasing build up in fertility. It appears that as a result of this the lambs on some of these farms are now not doing as well as previously. The pastures generally are very good, dominantly ryegrass and white clover associations which give a vigorous growth, extremely difficult to control with sheep only. The concentrations of ewes and lambs required per acre per paddock, particularly in a year of flush growth, is too high for lambs to thrive and the number disposed of as milk lambs declines.

It has been said that the greatest enemy of one sheep is another sheep, and this applies particularly to lambs on high-fertility pastures in Southland. When the concentration of ewes rises to over six

per acre, trouble may be expected on most farms where the stage of fertility is up to dairy-farming standards.

This state of affairs offers problems in management and on some farms it has been found necessary to reduce the number of breeding ewes carried. Pasture control is important, and it is also important that lambs be given a chance to graze on a fresh bite. Too heavy a concentration of ewes and lambs results in the pastures becoming very badly soiled, so much so that it becomes almost impossible to find clean feed. Alternatively, if the vigorous growing pasture is not adequately stocked, extensive patches of roughage develop, and once again the lambs don't "do" because the feed has got too far away.

An extremely important point in this question of pasture management for lambs on high-fertility land, is that of cobalt availability. Young lambs are the most sensitive of all animals to any cobalt deficiency; in general the cobalt concentration of the grasses decreases with the increase in growth. For this reason, if for no other, pastures must be adequately controlled. In connection with cobalt, it is worthy of note that the application of cobalt either in the form of topdressing or alternatively spraying on pastures is an accepted practice on the majority of Southland lamb-fattening farms. Many farmers spray during November, others apply the cobalt as cobaltised super in August.

Inevitably sheep and lambs concentrate on the short bite, and the rough patches, which result from inability to stock sufficiently heavily, continue to get away. As a result the sheep are actually selectively grazing the paddock and seldom get a fresh bite of feed. Prior to the build up of fertility, lamb fattening was not a particularly hazardous business; there were of course some difficulties, but of recent years these hazards have increased with the increased number of sheep being concentrated, and it seems the stock have become much more sensitive to and react more quickly to these management hazards. On some farms, ewe numbers have been reduced and cattle are being used to control roughage in the sheep pastures with resultant benefit to the lamb thrift. But on the whole, Southland farmers are not particularly partial to cattle, the chief opposition being that there are very real difficulties experienced in getting cattle away at the right time. In the past, three of the four freezing works operating in Southland were not geared to deal with large numbers of cattle. Usually cattle are not slaughtered until after all the lambs and ewes have been put through. And it does happen, that farmers are left to over-winter cattle, which means poaching up of pastures, winter feeding and not infrequently, damage to fences. However, with the opening of the new freezing works, which commenced operations in a limited way last March, and which is geared to deal with 1000 head of cattle per week, the interest in cattle will probably be stimulated.

Farm Management

An endeavour has been made to show the influence of previous farming systems on present-day farm practice, and it will be necessary to give illustrations of farm management on some of the high-fertility land of the province. The first is a farm of approximately 550 acres. This farm has been developed from swamp and is literally sitting on tiles. As may be imagined the development has been per medium of dairy farming away back 40 years ago when development commenced. The dairy herd was gradually increased to 80 with between 900 and 1000 ewes. In 1935 the herd was sold and the sheep numbers have been built up to its present carrying capacity of 2245 ewes plus beef cattle. Up until last season 35 pure-bred Aberdeen Angus cows were carried, calves were sold in April (but these cows have now been disposed of), and 83 or so yearling to 14-months-old

cattle are bought in in October and disposed of before winter. The change over to buying in young cattle was done because the heavy breeding cows (1800 to 1900 lb.) poached the paddocks in the winter months. There is also a Southdown stud of 135 ewes, 50 to 60 surplus 2-tooth rams being sold every year.

Flock replacements are made by buying in about 600 2-tooth ewes each season. Cultivation is kept down to a minimum consistent with supplementary feed requirements, the rotation usually being 35 acres of lea ploughed every year for swedes. In practice a four-row ridger is used sowing one row of chou moellier and three of swedes. Fertiliser used is mixture broadcast prior to ridging. Wheat is sown the following year, the 35 acres being resown to pasture in the autumn immediately after the wheat is harvested. This farm is in the coastal belt and in the event of harvest being too late, pasture sowing is delayed until the spring. It is worth noting that wheat has been introduced to the rotation during the past 12 years or so, and this was done because the lambs were not doing as well as previously.

By taking a wheat crop it has been found that the lambs do much better on the younger pasture. The wheat yield is usually between 80 and 85 bushels per acre; this season Aotea was sown and yielded 112 bushels per acre. The pasture mixture used is 10 lb. perennial ryegrass, 15 lb. short-rotation, 6 lb. cocksfoot, 6 lb. timothy, 2 lb. dogstail, 4 lb. Mont. red, and 3 lb. white clover. The rams are put out in April and lambing commences about 1 September. (Average lambing 120 to 125 per cent.) Paddocks are set stocked at an average of five ewes per acre, but paddocks may be stocked up to eight per acre. Pre-lambing shearing is practised (commencing generally about 20 July). Lambs have done better since this has been undertaken, due probably to the fact that the lambs are not disturbed after tailing until the milk draft is taken early in February.

About 80 per cent of the lambs are drafted at this time (average weights are in the vicinity of 34 lb.) and all lambs are weaned on to the pastures. A second draft is taken as soon as they are ready and any lambs left after this have their teeth cut and are fattened on the swede tops. Excess pasture growth is controlled by the use of the cattle. About 15 acres of hay are made as a minimum every year yielding about 1500 bales or three tons per acre.

Lime is always regarded as almost synonymous with Southland farming. From 1920 up to two years ago this farm was topdressed with lime at 10 cwt. per acre and superphosphate at 2 cwt. per acre every second year. The pH is in the vicinity of 7 and it was decided to stop liming and topdressing. No lime or fertiliser has been used since except when sowing out new pasture. At sowing time one ton of lime is applied and 2 cwt. of potassic Serpentine superphosphate. Approximately 100 acres are closed up from the beginning of April (according to the feed position) and are carried through for use at shearing time, July. The ewes are put on to swedes about the beginning of June, taken off at shearing and then returned to the swedes afterwards. The carried-over pastures are available for the earlier-lambing ewes. The whole farm is treated with cobalt by plane every year, a small quantity of lime being used as a spreader. A point of particular interest is that it has never been found necessary to drench any lambs on this farm.

The use of cattle for control of pasture is a matter of importance to Southland fat-lamb farmers. And it seems that there will be an increase in this method of pasture control provided there are facilities for disposal of cattle before the winter. Instances can be given where over-concentration of sheep has had a very definite influence on lamb fattening, an example being a farm of just over 260 acres of flat land, subdivided into 15 reasonably-comparable paddocks. Carrying capa-

city had been built up to 1600 ewes with bought in replacements, but it was found that this concentration was too high for lamb thrift. The ewes have been reduced to 1200 producing approximately 1700 lambs and 400 hoggets are brought in for replacements. One hundred head of young cattle have been bought in to replace the reduced ewe flock. The results seem to have been an improvement in the lamb draft. This was a dairy farm milking 90 cows up to 1948 and for nine years after the changeover there was a gradual, and later on a rapid decline in the thrift of the lambs. Paddocks are set stocked with ewes and lambs (concentration is anything from six to seven and a half ewes per acre) until the lamb draft in mid-January. Approximately half the lambs go away at this time, and all are weaned. The balance are fattened either on pasture or the tail end are finished off on swede tops. The crop rotation is swedes out of lea, followed by chou moellier, then oats; the oats are chaffed for sheep feeding, the yield being approximately five tons of chaff per acre. Approximately 30 acres are under the plough each year and the pasture mixture is sown under the oats. The seed mixture is 25 lb. perennial ryegrass, 5 lb. short rotation, 5 lb. cocksfoot, 5 lb. timothy, 4 lb. white clover (44 lb. per acre). One ton of lime is applied at the time of sowing down. No additional lime has been used for three years. The pH is up about 7. Pastures are topdressed with cobaltised super at the rate of 1½ cwt. per acre per year. This farm is in particularly good heart. One man is employed in addition of course to the owner.

Another farm of 237 acres divided into 20 paddocks carrying 1090 ewes, tails between 1350 and 1400 lambs. Two-tooths are bought in for flock replacements. Paddocks are set stocked from lambing to weaning in early January. Last season the lamb drafts were 1100 milk lambs in early January with the average weight 32.76 lb. Two drafts of grass-fattened lambs of 140 and 116, average 33.0 and 34.0 lb. respectively and the balance of 29 were finished off on swede tops. The crop rotation is swedes out of lea, followed by Wilhelmsburger swedes in the second year, then wheat. The yield of wheat is usually not under 80 bushels per acre.

Between 17 and 20 acres are resown each year using a mixture of perennial ryegrass 20 lb., short rotation 5 lb., cocksfoots 4 lb., timothy 3 lb., white clover 3 lb., Mont. red clover 2 lb., crested dogtail 1 lb.—a total of 38 lb. per acre. Paddocks are regularly topdressed with superphosphate or Serpentine superphosphate. The farm has been heavily limed in the past so that no lime has been applied for two seasons. Twelve acres of hay are made each season if possible; if hay is in short supply lucerne hay is bought in. An interesting feature on this particular farm is that the ewes are shorn twice a year, in February and August, the contention being that it is more convenient at these two periods and it is justified by the extra wool obtained. Incidentally, pre-lambing shearing is carried out on an increasing number of farms and once this practice is started farmers do not go back to mid-summer shearing.

Diversification of Farming

As mentioned previously, much of the farm land in Southland at present being used for lamb fattening and wool production has been built up in fertility to dairy-farming standard, but the whole farm economy has been geared up to fat-lamb and wool production. Farm lay-out, fencing, buildings and stock-handling facilities are all based on sheep. There are, however, still farms where diversification of activity is practised. An example may be quoted of a farm of approximately 240 acres, located in one of the earliest farmed districts of the province. The soil type is yellow brown earth, free draining and may be classified as high-fertility land. The farm is

carrying 35 Friesian dairy cows and replacements (seven heifers, seven calves) and two bulls. There are 1050 Romney ewes and 29 flock rams and approximately 200 2-tooth ewes are bought in every year for replacements. Included in the ewe numbers is a stud of 60 Southdowns, and there are usually about 35 stud ewe lambs and the same number of stud ram lambs associated with this activity. An additional activity is the fattening of Aberdeen Angus cattle. The number fattened varies according to the season but some beef cattle are always carried. The cattle are bought in either in the spring or autumn according to season, and disposed of at about 18 months as chiller beef or to butchers in April or May. Wheat and oats are grown regularly in the rotation. The butter fat production of the herd is about 400 lb. per cow (393 last season), the lambing percentage approximately 125 and the wool clip averages 11 lb. Approximately 14 acres of lea are ploughed each year for swedes for supplementary winter feed. The crop rotation is swedes out of lea, followed by chou moellier the next year, and in the third year ten acres of the area will be in wheat and four acres in oats. The wheat and oats are both spring sown (late August), the sowing rate of wheat being three bushels and oats four bushels per acre. The oats are grazed by the dairy herd in early October, with day-time grazing only. These oats provide feed for about 14 days; this grazing comes at a period generally rather critical for feed, as it is usually just before the flush of pasture growth commences. After this grazing the oats are grown on and cut at the dough stage for hay, and baled for winter feed for the cattle. The usual yield is approximately 200 bales per acre. The wheat yield is generally between 75 and 85 bushels per acre. The paddock is resown to pasture in the autumn as soon as the wheat is harvested. Under this system about one-sixth of the farm is under the plough. As available, paddocks or part paddocks are closed up for hay and generally 2000 bales of hay (this includes the oaten hay), are made each season.

The pasture mixture sown is 20 lb. perennial ryegrass, 10 lb. short rotation, 7 lb. cocksfoot, 7 lb. timothy, 2½ lb. cow grass, 4 lb. white clover and ½ lb. suckling clover. One ton of lime per acre is applied either before sowing the grass or before the previous crop. The pH of this land is 6.5-6.8 and the whole farm has been given adequate liming in the past. The pastures are topdressed with superphosphate plus potash at the rate of 2½ cwt. per acre, part of the farm in the spring and part in the autumn, but in the future a spring application in August will be made to ensure stimulation of growth. Spring is the critical time on these farms of high carrying capacity.

Rams go out in April and lambing commences on 1 September. As the cows are coming in at the same time, this is a very busy period particularly as there is only one hand employed on the farm. The ewe flock is off the swedes before lambing commences and is kept in two mobs; the unlambed ewes are shed off each day until the paddocks are set stocked at the rate of approximately 95 ewes to a 15-acre paddock. The 2-tooth ewes are lambed separately in paddocks handy to the steading.

The dairy herd is grazed in two paddocks (total 30 acres) from the time they come in, until the first lamb draft, usually in early January. At this time all the lambs are weaned and shearing is undertaken as soon as possible afterwards. The milk draft is usually between 80 and 90 per cent. After the weaning of the lambs the ewes are closed up into two mobs and grazed in four paddocks under a system of rotational grazing. By adopting this system, the ewes are kept in good condition until tuppung; they are not starved to take the condition off them. As well as being extremely satisfactory as far as the ewes are concerned, an additional advantage of this system

is that the paddocks chosen are usually older pastures, and the concentration of sheep helps to restore any lost fertility. The stimulation to the pasture is usually such that these paddocks are also saved for the early feeding of the ewes just before lambing. Another advantage is that by keeping the ewes in good condition, any break in the wool at this stage is avoided.

Winter feeding usually commences about mid-June when the ewes go on to the chou moellier which is fed off in breaks. The ewes have free access to the chou moellier break from an adjoining paddock. This is found a much more satisfactory method than putting them on and off at intervals. By having free access, they do not tend to over-gorge and it is less wasteful than is the feeding by the controlled "on-and-off" method. The dairy herd is accommodated on the oldest pasture (usually approximately 15 acres) from mid-June to mid-July. This is a specially-saved paddock which is generally closed up about the middle of March and is fed off in breaks; hay is also fed out to them during this period. When this saved pasture is finished, the cattle clean up the balance of the chou moellier after the ewes have finished, and the ewe flock start on the swedes. The ewes are generally on the swedes for about a month, from the end of July to the end of August. The old pasture of 15 acres used for the dairy herd during July is the paddock intended for the swedes. And as full use is made of this as a pasture grazing area, it is usually not ploughed up until October. This late ploughing is entirely satisfactory on this land as the lea is not a tough old turf which requires mellowing by time and weather. The land is quite friable and it can be worked down to a good tilth in time for ridging in the swedes early in December.

The land is usually clean, in so far as weeds are concerned, but the scuffler is kept going as this helps to conserve moisture. Usually three scufflings are given with the back shoe removed so that the soil is drawn away from the swede bulbs. In the case of the chou moellier, the scuffling is done with the back shoe on so that the soil is drawn up to the chou moellier plants.

Two varieties of swedes are sown. Two-thirds of the paddock is in Wilhelmsburger and one-third in Crimson King (the Crimson King being fed off first. Fertiliser used for the swedes is reverted or Serpentine superphosphate at $3\frac{1}{2}$ cwt. per acre (borated fertiliser being used in the front box of the ridger when ridging the chou moellier), a mixture of three parts potassic Serpentine superphosphate, one part nitrate of lime at $3\frac{1}{2}$ cwt. per acre is sown down the front spouts and $\frac{1}{2}$ cwt. reverted superphosphate with the seed. Usually the headlands of the chou moellier paddocks are not ridged in this crop, but after the scuffling is completed the headlands are sown in flat-drilled rape and Italian ryegrass. This surround is grazed off by the stud ram hoggets from about early April until the end of May. The hoggets tend to keep to the rape and grass before attempting to take any chou moellier and they do well on this feed. An additional advantage of this method of sowing is that the fencing of the breaks is facilitated.

After the draft of milk lambs, the weaned lambs are put on the pastures; generally those pastures where the lambs have "done" best are selected. About mid-April the tail end of these lambs is put on to the swede crops. Prior to this their teeth are cut and the lambs given a drench of Calciferol. Usually 150 to 200 wether lambs are purchased in late February. These lambs are also fattened on pasture and any remaining are finished on the swede tops.

As mentioned previously the ewes are generally on the first break of swedes in the first week in August. From about mid-July these ewes are given access to saved pastures for about two hours per day, and are fed hay on the run-off paddock. The dairy herd is on

the swedes from the end of August, right up to and during calving. During this period they are given hay in abundance and any additional attention given at this time is amply justified in results during the milking season.

The 60 Southdown stud ewes are usually accommodated in small paddocks adjacent to the steading; they may also be grazed with the dairy herd.

The only feed which is not produced on the farm is a quantity of concentrates for the stud flock. These sheep are not given any swedes but are fed concentrates during the winter months.

It will be appreciated that the type of management I have outlined on this farm, could not be carried on throughout Southland but it furnishes an extremely good example of the management, stock concentration and diversification possible on a high-fertility farm.

Q.: Has the Department conducted any experiments with selenium on these less-thrifty lambs in Southland?

Mr Faithful: Yes; trials are being conducted at the present time but I cannot give you any results yet because this is the first season and the records have not been completed. We are trying selenium, and cobalt, and selenium and cobalt together on about 24 farms in Southland, and these results will be published as soon as they are available.

Q.: At what stage were swede tops fed off, and was there any growth after the feeding off of the tops?

A.: They are generally fed off when the swedes have more or less finished growing about March or April. They are not generally fed in breaks because you do not want to concentrate your lambs too much. We watch to see they don't do any damage to the neck of the bulb.

Q.: You mentioned feeding off chou moellier in breaks. Has feeding off the whole paddock ever been tried, as I find this way there is less wastage?

A.: Both systems have been adopted but feeding off in breaks and allowing sheep access to only part of it has been found the least wasteful way of feeding it.

Q.: It was mentioned that set stocking at up to eight ewes per acre sometimes resulted in dirty pasture. Would it not be better to double the numbers and shift the ewes from one paddock to the next to allow them to clean?

A.: The system of set stocking has proved the most satisfactory for Southland conditions. The movement of ewes and lambs is not generally acceptable to Southland farmers. The concentration of sheep per paddock on some farms is higher than the figures I mentioned; at the experimental farm we have 10 to 12 ewes to the acre. A few farms with these very high concentrations and very lush feed do get dirty pastures.

Q.: How would you account for the apparent increase in farming profit in Southland compared with Canterbury?

A.: We have an extremely good farming climate in Southland; our farming seems more assured. We have a programme we can stick to, whereas in Canterbury due to drought you may be badly stuck for feed in the summer and again in the winter.

NUTRITIONAL ASPECTS OF FODDER CONSERVATION

I. E. Coop, Lincoln College.

The growth of pasture is subject to wide seasonal variations, much wider than those of flock and herd feed requirements. Periods of excess growth occur in early summer and again for a shorter period in the autumn against those of deficient growth during the dry late summer-early autumn period and the lengthy winter period. Feed requirements can only be equated to pasture production by some means of conservation.

On hill country where the mower cannot be used, conservation is effected through the carrying forward of standing summer roughage and autumn-saved pasture in the paddock. This is a low-cost system but the efficiency of pasture utilisation leaves something to be desired. On the flatter country the early-summer excess is mostly conserved as hay, silage and straw—what we usually call fodder or roughage—and the autumn excess as saved pasture.

I hope any dairy farmers in the audience will excuse me if I refer mainly to the use of fodders for sheep since there would be more sheepfarmers in the audience. But the principles of conservation and utilisation are very similar. The purpose of conservation is to meet the deficiency of pasture in the late summer months of January, February and March and the winter months of June, July and August. From January to June inclusive the ewe has merely to be maintained. Her requirements for maintenance are not very demanding for either total feed intake or for quality of feed. But as lambing approaches in July and August, quality of feed especially must improve. From lambing to weaning, feed must be much higher both in quantity and quality.

Now the point of this is that our sheep management is timed so that the majority of the pasture-deficient period coincides with maintenance only of the flock which in turn means that the main or only purpose of conserved fodders is for maintenance. As far as dairy cows are concerned, hay and silage must be fed for at least part of the milking or production period since cows are dry for only two or three months. But these roughages should be considered as supplying the maintenance part only of the ration, and foods of higher quality such as grass, fodder beet, chou moellier, etc., as providing the milk producing part. So that for dairy cattle also, fodders or roughages are primarily for maintenance. I will therefore be stressing the adequacy or otherwise of these fodders in relation to maintenance.

Fodders which are conserved and stored under adequate protection give a flexibility to management which is not otherwise possible in areas subjected to late-summer and winter shortages. The advantages are:

1. The provision of sufficient feed to maintain animals over the periods of deficiency, thus balancing up feed supply and feed requirement.
2. By feeding fodder during the autumn and not consuming all the autumn flush of grass, paddocks may be closed to carry high-quality autumn-saved pasture through to the late winter/early spring period when such feed is a necessity.
3. If a sufficient reserve of fodder can be built up, not only may seasonal variations of production be ironed out but yearly variations may be similarly reduced. As an example of this, the situation at Ashley Dene may be used. Large reserves of hay were built up

during 1956 and stock numbers were increased from 1500 ewes to 2100 ewes in 1957. This was further increased to 2500 in 1958. Nature's reaction to this move was to produce two severe droughts running, in 1959 and in 1960. We were able to carry the full 2500 ewes through the 1959 drought using the hay made in 1956. With any luck we should also have survived 1960-61 but the second drought in succession defeated us and we have had to buy in pea and oat straw to maintain our stock numbers in the hope that we are due for a good spring and summer to rebuild reserves.

Before proceeding to describe the different fodders I must introduce a technical term known as Digestible Organic Matter or DOM. It expresses the amount of the energy-yielding organic constituents of the feed which is actually digested and therefore available to the animal. It is usually expressed as a percentage. If we say that the DOM of hay is 50, it means that only 50 per cent of the hay fed is digested. It is also used as a unit of feed requirement. For example, if we say the maintenance requirement of a sheep is 1.1 lb. DOM per day this means that any amount of food which supplies this amount of DOM will maintain the sheep. For hay of 50 per cent DOM the answer is obviously 2.2 lb. hay.

One other matter must also be stressed. These conserved fodders are very variable in quality. Very good lucerne hay can be nearly as good as a concentrate while very poor hay can be as poor as straw. You will appreciate that one is left with no alternative but to generalise.

You will also know that conserved fodder must of necessity be worse than the original material from which the fodder is made. This is because, in the curing process, the most digestible and nutritious constituents suffer the greatest losses and because, in the mechanical processes of picking up and later feeding out, the more-nutritious leafy component suffers more loss than the less-valuable stem. Consequently to maintain a high-quality product the material must be cut at the optimum stage of growth and cured under favourable conditions. We all know that these ideals are frequently not obtainable.

Hay

When pasture or lucerne is cut, it continues to respire and use up its energy until it becomes sufficiently desiccated to stop the living processes. If rain falls on the cut material, some of the soluble and digestible constituents are leached out. There are further losses, mechanical this time, in picking up and baling the material. The total losses of dry matter are about 20 per cent, while digestible organic matter and protein losses are of the order of 30 per cent.

Generally speaking, lucerne hay is better than pasture hay. The main reason for this is a higher leaf-stem ratio, greater palatability, and higher protein content, all of definite advantage under appropriate conditions, such as in July-August where improved quality and protein content are desirable.

Silage

The green material cut for silage-making continues to respire in the pit, stack or bun until all the enclosed oxygen is used up, and then it begins to ferment. The type of fermentation which develops depends on the material cut, the consolidation effected and the temperature reached in the mass. The more loosely the material is packed the higher the temperature developed, and the greater the losses. The aim is to obtain effective consolidation and a rapid development of acidity by fermentation in the mass. This acidity checks further fermentation and loss of energy, and the degradation of protein.

Lucerne and very young grass, high in protein content, are more difficult to make into good silage than is pasture. Attempts to

increase artificially the degree of acidity by adding such things as molasses or bisulphite have, in general, not been very successful under New Zealand conditions owing to difficulty of incorporating them evenly.

As in hay-making, losses can be extremely variable but on average they are of the same order as with hay. But silage would have the advantage early in the season when hay-making conditions are not good, or in a wet summer.

The dry fodders contain only 10-15 per cent moisture and therefore 85-90 per cent of dry matter. Silages, however, contain about 80-85 per cent of water or only about 15-20 per cent of dry matter. Since silages are usually made from less-mature material than are the hays, they are slightly more digestible and hence of slightly-higher food value per unit of dry matter. But because hays are dry and silages are wet, we usually consider that the silage equivalent of 1 lb. of hay is 3 or 4 lb. of silage.

Straw

The straws are by-products of seed and grain production and are not specifically intended for livestock feeding. Nevertheless some of them can be quite useful. Since the material is already dry when cut and the seed or grain removed for sale, the conservation of the straw residue by baling can be effected with very little loss.

The straws are very fibrous and deficient in both protein and minerals. They are, however, more digestible than one would think and the main drawback to their use is their relative unpalatability.

Concentrates

These are not fodders, but are sometimes used as supplements or alternatives to fodders. They include such grains as oats, barley, and peas and the compounded pelleted material known as sheep nuts. They have a high DOM content and can be used as energy rich supplements.

DOM-Intake-Maintenance Relationships

The maintenance requirement of a 120 lb. ewe is approximately 1.1 lb. of DOM per day. This is equivalent to 1.5 lb. of sheep nuts, approximately 2 lb. hay, or 7 lb. of silage and 2½ lb. of straw.

We might look at the relationships between the food value (DOM), palatability and cost of maintenance of different feeds. This is given in the following table.

DOM (air dry basis) %	Feed	Average daily Voluntary Intake per 120 lb. Sheep (lb.)	Daily Intake required for maintenance (air dry basis) (lb.)	Cost of Main- tenance Pence per day
70	{ Good grass { Sheep nuts	4 (dry equiv.) 3-4	1.5 (dry equiv.) 1.5	6.3 £35/ton
50-55	{ Good hay { Good silage	2-2½	2.0	3.6 10/- bale
45-50	{ Poor hay { Poor silage	1½-2	2.4	2.6 6/- bale
40-45	{ Pea straw { Ryegrass straws { Oat straws	1-1½	2.6	2.3 2/6 bale

We see from this table that as the quality of the feed as expressed by the percentage of DOM falls, the palatability as expressed by voluntary intake falls very steeply. Animals will eat sufficient of the high-quality feeds to allow a surplus over maintenance for growth, fattening or milk production. Average-quality hays and silages will just maintain animals. A relatively small further drop in DOM content causes the appetite of animals for the poorer-quality hays, silages and especially the straws, to fall to a level insufficient for maintenance.

Reference to this table shows some points worthy of discussion.

1. Concentrates are too costly for maintenance and should not be used except in small quantities to supplement poor roughages or an otherwise inadequate diet. The pelleting of foods, especially those containing roughages, does not increase the food value but does lead to increased palatability, a feature which is stimulating much interest in the U.S.A.

2. The higher-quality roughages, good hay and silage, can easily meet maintenance requirements. They are also more flexible in usage since they are good enough to be used at any time over the whole maintenance period from January to July or August.

3. The straws look an attractive proposition on a cost basis but, unfortunately, they are insufficiently palatable for complete maintenance. A proportion of the flock may eat up to 2 lb. per day but quite a number will barely eat 1 lb. Assuming that they eat on average 1-1½ lb. per day their liveweight will drop by about 6 lb. per month.

If the ewes are in good condition at weaning, this loss can be tolerated, so straws may well be used in order to conserve good-quality hay for the winter. In a drought when the feed situation is really critical, straws may also be used to at least retard the weight loss. A solution to the problem of increasing appetite for straws would be of considerable value.

Research in the United States has suggested that the main reason for the lower value of poor roughages is that they cannot sustain a vigorous microbial population in the rumen and that this depressed activity reduces appetite of the animal. As a corollary, supplementation of poor roughages with small quantities of protein and mineral-rich concentrates or grass should increase appetite and roughage utilisation. Though the possibility no doubt exists under the right conditions, we have so far been unable to confirm this. Tests at Ashley Dene showed that supplementation with concentrates improved the diet as would be expected but failed to increase consumption of the roughage.

In spite of these difficulties the use of straws as an economical way of holding sheep while saving pasture and keeping hay for a later period can be recommended. If the droughts of the last two years have taught us nothing else we have at least learned the value of the straws.

In the table already given it was shown that the maintenance requirement of ewes is approximately 2.0 lb. of average quality hay. This is confirmed by experience at Ruakura where, during periods of facial eczema, ewes have held condition over several weeks when stocked at 200 per acre and fed 2 lb. pasture hay per head. Similarly at Ashley Dene 2.0 lb. of lucerne hay per ewe has maintained in-lamb ewes and allowed weight increase for the foetus throughout the whole winter period when the ewes were stocked so densely that pasture contributed next to nothing. Silage was found to be less palatable and an intake of 7 lb. per day barely maintained the ewes. In the 1952 drought we fed hay continuously for seven months as practically the sole diet. Such prolonged feeding depresses appetite and we had to feed hay and silage together to maintain it.

On the question of sheep nuts there are strongly-held opposing views. The pelleting of rations has many advantages for instance in producing high-energy, high-protein supplement for balancing poor feeds. The palatability of poor roughages would be considerably increased if they were pelleted, but the cost at present would be too high. In limited specialised conditions such as with stud stock where a high cost product is produced, or where a small boost can make the difference between success and failure, the high cost of pellets can be justified. But in other and normal conditions we should aim to survive without them. The maintenance requirement of sheep is 1.5 lb. of pellets. A daily allowance of even as much as 4 oz. of pellets per day represents only one-sixth of the total diet necessary for maintenance.

I do not wish to convey the impression that I am a one hundred per cent fodder conservationist. We can save much labour and cost by the efficient management and utilisation of pasture rather than by the costly process of making hay and silage, and it is only in as far as fodder conservation helps to attain maximum utilisation of pasture that it is justified. I have ignored the possibilities of forage crops and these also play an important part. But in the drier areas of the South Island I am convinced that fodder conservation on a considerable scale is an essential adjunct to efficient utilisation of pasture.

Q.: In connection with the feeding of the straws, can appetite and intake be increased by the use of salt or molasses?

Dr Coop: I do not know. We have been playing round with them at Ashley Dene this summer and autumn and we are not much further forward. We really want something that will make sheep eat twice as much straw. You can feed straw in January-February when you can tolerate weight loss. You can also tolerate it in May and June. If you want to feed straw at any time you have to tolerate weight loss.

Q.: Are wheat and barley straws in the same category as oats?

A.: No. Wheat straw is further down the scale than oats and is less palatable. Barley is in between. It is hardly worth while feeding out wheat straw.

Q.: How does oat sheaf chaff compare?

A.: Its value is about half way between good hay and poor hay. You can certainly maintain ewes on oat-sheaf chaff on 2 lb. per day.

Q.: Would it not have been better, for the information of the farmers here, to have brought the hay and everything down to the minimum it takes in cost to handle. We should have had the figures of the grass crop per day to have a true comparison. There is somebody getting a profit in the price of 10/- a bale for hay. These figures do not give a true comparison if the farmer uses his own material.

A.: They do not; they are merely to give you some idea of the relative cost if you assume you are buying material at those prices there. In the case of grass you could put it at something around 1d per day, so the cost of running a sheep on grass is 30/- a year. It does not take into account the fact that cost of labour for feeding nuts is less than for silage.

Q.: Is there much loss in the quality of hay stored over twelve months?

A.: There would not be much loss in the centre of the bale. At Ashley Dene we got through the 1959 drought with hay made in 1956. But to keep hay it must be stored in barns.

A SURVEY OF MACHINERY AND METHODS FOR FODDER CONSERVATION

G. G. Lindsay, Lincoln College.

1. INTRODUCTION

In any country, such as New Zealand, where livestock production is so greatly dependent upon grassland and forage crops, the conservation of these crops is a most important factor. Not only must an adequate supply of winter feed be secured, but also a supply of feed must be available during other periods when natural growth is inadequate to maintain production at the desired level. To ensure maximum productivity it is, of course, important to ensure that the minimum loss of nutrient should occur during the conservation process. This, then, is the basic problem associated with fodder conservation: to ensure the maximum retention of the feeding value of the growing crop at the same time as minimising the cost of conservation.

When one has to make a decision as to which of several possible conservation methods to use under a particular set of circumstances, it is essential to consider the integration of all phases of fodder conservation and handling, between the cutting of the standing crop and the presentation of the conserved fodder to the stock. It is obvious then, that the particular methods to be used for harvesting, storage and feeding of fodder must be related directly to the classes of livestock being kept and to the particular system of management on the property under consideration. The degree to which machinery may be used for each stage of the conservation programme depends, naturally, on economic considerations of machinery cost, availability and cost of suitable labour, and on the gross return which may be expected from the enterprise as a whole.

The purpose of this paper is to describe and discuss all those methods of fodder conservation which are of importance. Some of the techniques and machines which will be mentioned may be in current use overseas but may find widespread application to New Zealand conditions only when certain classes of livestock production become more intensified. At the same time, some of the techniques described are obsolescent and they are included in this paper largely for the sake of comparison.

2. CUTTING THE STANDING CROP

This phase is, of course, the essential beginning of any system of fodder conservation. Two basic principles are involved in the cutting of crops, first that in which cutting depends upon the relative movement of two cutting edges as in a pair of scissors, and second that in which cutting depends on impact with the crop of a single cutting edge travelling at high speed.

2.1. The Cutterbar Mower

This is undoubtedly the most familiar and widespread method of cutting field crops. It consists essentially of a knife made up of a number of replaceable sections, which is caused to reciprocate across the ledger plates which form part of the fingers attached to the cutterbar itself. Clean cutting with this mechanism depends on the sharpness of the cutting edges and on the maintenance of a rubbing contact between the knife sections and the ledger plates. Satisfactory operation also is influenced by other factors such as knife register, cutterbar lead, and the adjustment of the various wearing plates. This means that a rather large amount of maintenance, both preven-

tive and remedial, is required to keep this type of equipment in first-class running order.

The output obtainable from a given mower (of cutterbar or any other type) is affected by two factors, the width of cut and the speed of travel. Mowers with 6-foot and even 7-foot cutterbars are now relatively common, and one American firm is selling a mower with a 10-foot cutterbar; other American firms suggest the use of their 8-foot to 12-foot self-propelled windrowers for cutting forage crops as well as for cutting grain. The average power required to drive a cutterbar type of mower should be not more than half horsepower per foot of cut under normal conditions.

It has been shown that for smooth cutting, particularly in dense crops, the knife speed should be such that one complete cycle of knife movement is completed for every six inches of forward travel. This means that, if forward speed is increased to obtain a higher rate of working, knife speed has to be increased and eventually, as speeds of above five miles per hour are exceeded, the reciprocating out-of-balance can give rise to serious vibration. This is because reciprocating out-of-balance can never be counteracted completely by introducing rotational out-of-balance as in the pitman wheel of the conventional mower. Therefore, the problem of increasing travel speed, and thus also knife speed, has been approached in the last few years through the introduction of a reciprocating counterbalance. This may take the form of a suitably driven swinging counterweight and it is interesting to note that, at one stage, the development engineers were too successful in reducing vibration in this way and were obliged to retain some measure of vibration to ensure that the cut material would not accumulate on the cutterbar under certain conditions. A more recent approach to minimising vibration has been through the development of a doubleknife mower, in which the two knives are caused to reciprocate in contact with one another, there being no stationary ledger plates or fingers. For a given knife speed, the double-knife mower shows promise of clean cutting at greater forward speeds than would be possible with the single-knife mower. It is claimed that the double-knife machine is less likely to be damaged by stones than is the single-knife mower. Double-knife mowers are now manufactured by at least two companies, one American and one German. The German-made mower should be available in New Zealand shortly at a price only about £20 dearer than the standard single-knife mid-mounted mower made by the same company.

2.2. The Cylinder-type Mower

Over the years, many ideas have been put forward in an effort to secure smoother cutting, greater simplicity and reduced maintenance in crop-cutting mechanisms. The cylinder-type cutter, which is familiar to everyone through its use in lawn mowers, has been applied to field-scale mowing, usually in the form of "gang mowers" as used in the cutting of sports grounds. This type of mower certainly works more smoothly than the reciprocating type, but it still demands careful sharpening and a very close clearance between moving and stationary cutting edges. It is thus rather easily damaged by stones or other hard objects which happen to be lying around in the field, and such damage is usually more difficult to repair than the damage which may be inflicted on a cutterbar mower through similar causes. Also, there is a limit to the height of growth which can be handled successfully with gang mowers, which are thus largely confined (in the field) to the cutting of short grass for silage or dehydration, and to the fairly-frequent topping of dairy pastures in conjunction with rotational grazing. In farm practice, the cylinder-type cutter is also used in some types of forage harvester, for chopping into short length that material which has been gathered by another part of the machine.

2.3. Impact-type Mowers

Under this heading are included the rotary mowers and flail-type forage harvesters which have been appearing on the market in increasingly large numbers over the last few years. The cutting action in these mowers depends on the impact with the standing crop of a number of relatively-sharp cutting edges travelling at a very high speed, of the order of 7,000 to 13,000 feet per minute or 80 to 150 miles per hour. This type of cutting mechanism does not require such careful setting and maintenance as the cutterbar or cylinder-type mowers, and will often give satisfactory results with fairly blunt cutting edges. However, more robust construction is generally desirable, the high-speed cutting rotor must be carefully balanced, and the stubble is often left in a more ragged and bruised condition than it is by the other cutting mechanisms.

Rotary mowers, having a number of cuttingheads revolving on vertical shafts, may be tractor trailed or mounted on the tractor, normally at the rear, but under the middle in some cases, or even on the front-end loader. Machines of this type seem at present not to be very well suited to the cutting of heavy hay crops, but are very useful for high-speed topping and grass cutting as they are made in widths up to 14 feet. One of the wider machines has three cutterheads in a rigid central section and two on each of two wing sections. One or both of these wing sections may be pivoted to the central section so that they may follow ground undulations reasonably well, and the machine may thus be used with a cutting width of 6, 10 or 14 feet. On test, the average power requirement of the 6ft. unit varied according to crop conditions and travel speed, and was between 10 and 20 horsepower.

The flail-type mechanism has the advantage that one full-width horizontal cutting rotor not only cuts the standing crop but also shreds or lacerates the cut material. Unfortunately, it has a rather high power requirement, as explained in Section 4.1.3. Most flail-type cutters can also be successfully used for dealing with light scrub, for removing potato tops before lifting, and for a number of other fairly-rough cutting duties as they are not readily damaged by stones and other foreign objects. A specially constructed flail-type cutter has recently been demonstrated in Britain for cutting hedges and delivering the clippings to a trailer.

3. HANDLING THE CUT CROP FOR HAY

The main problem associated with the preservation of a forage crop as hay is that of reducing its moisture content to a safe level for storage, while at the same time minimising the loss of nutrients which will inevitably occur through continued respiration in the initial stages of curing and through spoilage as a result of adverse weather during the curing period. In general, the natural agencies of sun and wind are relied upon for removing excess moisture, but in Europe and North America, increasing interest is being shown in the use of a combination of natural and artificial drying to secure a high quality product. This technique will be further discussed in Section 3.5.3.

In those parts of the world where climatic conditions allow of only very slow natural curing of hay, it has been the practice to employ very laborious methods such as piking, tripoding and fence-rack drying. These methods often result in the preservation of high-quality hay and a fair measure of success has rewarded the efforts of those workers who have sought to apply machinery and labour-saving techniques to traditional methods of hay curing. That maid-of-all-work, the front-end loader, has figured quite prominently in this connection, but nevertheless, such methods can only be considered where a fairly large labour force is available at hay making time.

3.1. Methods for Increasing the Rate of Moisture Loss

Normal field curing can often result in the loss of up to 40 per cent of the dry matter originally present in the standing crop. This occurs as a result of continued respiration in the early stages of curing, together with mechanical and leaching losses consequent upon the treatment given and the weather experienced while the cut crop is lying in the field before collection. Two quite different approaches have been made to the problem of speeding-up the removal of excess moisture and thus shortening the period for which the cut crop must lie exposed to the risk of damage by unfavourable weather.

3.1.1. Tedding and Similar Operations

The term "tedding" signifies the fairly violent mechanical tossing of the cut crop, which exposes the cut ends of the crop to the sun and the wind, keeps the swath in a fluffy, open condition permitting free circulation of air, and repeatedly exposes fresh surfaces to sun and wind. For the full benefit of this operation to be obtained, it should be carried out immediately after cutting and at fairly frequent intervals thereafter, until the crop starts to become brittle and thus prone to severe loss of leafy parts as a result of the violent tedding action. One must, of course, be particularly careful in the application of any such violent treatment of a hay crop consisting predominantly of clover or lucerne. A result somewhat similar to that obtained from the use of a tedder can also be secured by the use of various types of swath turner. These machines turn each swath fairly gently and do not have the marked fluffing-up action of the tedder which is so valuable in encouraging free circulation of air. The action of many swath turners is just the same as that of similar types of side-delivery rake which are used in forming windrows, and the tendency of some such machines under certain conditions to twist partly cured hay into a rope must be watched. There are a number of machines which can quite readily be converted between the three alternative uses of tedding, swath turning and side raking.

3.1.2. Stem Crushing and Bruising

It is common knowledge that plant leaves will lose their moisture more rapidly than will the stems. This is largely due to the presence, in the leaves, of stomata which are substantially absent in the stems. If, therefore, an increase is to be obtained in the rate at which moisture is lost from the crop as a whole, it is to the stem that the major attention should be directed. The moisture which is trapped within the stem may be released by rupturing the stem wall, through the use of stem-crushing machines (often known as hay conditioners) and flail-type forage harvesters.

Stem crushers may be of two types: one in which the crop is crushed between a pair of plain steel rollers (which are in some cases rubber-covered) and the other in which the crop is kinked between a pair of meshing corrugated rollers. The kinking action causes a rupture of the stem wall at intervals of one to two inches, the rupture often spreading for some distance between adjacent kinks, whereas in the plain roller crusher the rupture is more or less continuous along the stem. In most crushers and kinkers, one roller of each pair can move away from the other, against the force of strong springs. Results of experiments carried out at Lincoln College into the effect of kinking on the rate of moisture loss from lucerne cut for hay have shown close agreement with the results of similar experiments overseas. In general, crushing or kinking has been shown to bring about a reduction of 30 per cent to 50 per cent in the time during which a cut crop must be exposed for curing before collection for storage. It has been shown that, in many cases, the rate of drying

of a crushed crop is slightly higher than that of a kinked crop but the difference in drying rate has generally been very small.

Several experiments, carried out to determine the effect of the flail-type forager in simultaneously cutting and lacerating a crop, have shown that a crop treated in this way usually loses moisture at about the same rate as a crop treated with a crusher or kinker. The lacerated material may, under favourable conditions, dry out more rapidly than that which has been crushed but, if the windrow is too dense or has been driven into the stubble, it will dry more slowly. The simplicity of the flail forager as compared with the mower-crusher combination and the fact that cutting and bruising are done in the one operation would seem to indicate that the flail forager could become an attractive haymaking machine. However, another feature associated with the use of crushers and of the flail forager is the degree to which this mechanical treatment of the crop may result in the loss of valuable leaf material.

Experiments at the University of Wisconsin sought to evaluate the proportion of small pieces in a freshly-cut crop of lucerne by separation on a wire sieve with a two-inch mesh. These experiments showed that about five per cent of the crop as normally mown would pass through such a sieve, that from 8 to 15 per cent of the material crushed between smooth rollers would pass through, and that for a crop cut with the flail forager, the proportion of small pieces varied according to the type of crop and the speed of travel and was between 13 and 45 per cent. These figures cannot be translated directly into quantities of material left behind on the ground by the pick-up baler, but they do give some indication of the relative severity of mechanical treatment by crushers and flail foragers. Some work in Massachusetts showed that the following weights of hay per acre were left behind the pick-up baler after different preliminary treatments: where the crop was mown and not crushed 160 lb., for a crop mown and crushed 225 lb., and for a crop cut with a flail forager 325 lb.

In some experiments at Lincoln College last season, results were obtained which showed close agreement with the Wisconsin sieving-loss figures quoted above. It is hoped that some investigation may be possible next season into the actual magnitude of losses of material which the baler fails to pick up after various mechanical treatments. Much of this material which the pick-up baler fails to gather will consist of valuable leaves and small stems, but much of this loss of valuable material may be avoided if it is picked up, not by a baler-type pick-up, but by some other machine. For example, a flail forager may be used to pick up the cured windrow and deliver it to a wafering press (see Section 3.6) or to transport for subsequent storage as loose, chopped hay.

The main disadvantages of these mechanical treatments which are aimed at the more rapid removal of moisture from hay are first the expense, particularly in connection with the mower and crusher approach, and second the fact that the crushed or bruised swath, if subjected to rain, seems to be adversely affected to a greater degree than the uncrushed swath. However, as the drying rate is so much improved by crushing, the chances of the cut crop being affected by rain before it becomes fit for collection are very much reduced.

Another crushing technique has been tried at Michigan State University, but would seem not to have any direct practical application to New Zealand conditions at the moment. It is termed "hard crushing" and depends upon feeding the crop between a pair of rollers with a fixed clearance of only fifteen thousandths of an inch. To further increase the rate of drying, the crushed material was laid on strips of black polythene sheet, which served both as a vapour barrier between the ground and the hay and also as a means of absorbing solar radiation thus raising the local temperature in the vicinity of

the hay. Using this technique, lucerne was ready for storage in about six hours after cutting, whereas normally-crushed lucerne on black polythene required 25 hours of drying, uncrushed lucerne on black polythene required 49 hours, and neither normally-crushed nor uncrushed lucerne on the ground were dry enough for storage 56 hours after cutting.

Some people have found that rotary mowers cause a certain amount of bruising, particularly to a fairly thin crop, and thus increase the drying rate, but the tendency of these machines to windrow the cut crop would probably mask this effect in heavier crops.

3.2. Preparing the Cured Hay for Collection

If the hay is to be collected with some form of pick-up machine, it must first be formed into a compact, tidy, uniform windrow. Uniformity in the windrow is particularly important to ensure smooth, trouble-free working of the pick-up baler or pick-up chopper. Where a roll baler is to be used, the windrow must be made substantially wider than is necessary for other types of baler, because of the markedly different method of bale formation. The machine generally used for making a windrow is the side-rake and there are several types of machine under this category. They vary considerably in respect of the severity with which they handle the hay and of the average length of the "hay path," i.e. the distance through which a given piece of hay must be moved from its original position to its final place in the windrow. By the time that hay is ready for collection, it is usually quite brittle and the most valuable leafy parts are quite readily detached by rough handling, therefore gentle treatment by side-rakes is most desirable. The three commonest types of side-rake, in descending order of hay-path length, are the cylinder type, the rake-bar type, and the finger-wheel type. Investigations, both in Australia and in North America, have shown that it is possible to construct a side rake which will give a hay path even shorter than that obtained with the finger-wheel rake, but whether this new type will prove to be a practical proposition is as yet unknown. The finger-wheel rake has enjoyed widespread acceptance in this and other countries, largely on account of its simplicity and its smoothness and high speed in operation, and also its gentle treatment of the hay. However, it is not possible to obtain a true tedding action from a rake of this type. Complaints of excessive breakage of tines and throwing of soil and stones into the windrow are probably a result mainly of incorrect setting, allowing the tines to bear too heavily on the ground. For satisfactory working on side slopes, the wheels and the steering arrangement require to be modified slightly. Some side rakes of the rake-bar type are designed to be driven from the tractor power-take-off rather than from their own wheels, and this arrangement undoubtedly has attractions in allowing the operator to vary the speed of the tines in relation to the speed of travel and thus exert some influence over the severity with which the hay is handled.

3.3. Handling Long, Loose Hay.

For the collection and transport of long, loose hay, the hay sweep may be used, or the pick-up loader may be used for elevating the hay to a truck or trailer on which a man rides to build it into a load for transport. The sweep is perhaps the simplest mechanical aid to hay collection and transport, and where the hay is to be stored close to where it is grown, it may be pushed directly by sweep to the storage site. Another possible approach is the use of the push-off sweep for collecting hay and loading it into some transport vehicle. In general, it is undesirable to transport loose hay for any distance because of the relatively poor utilisation of the weight-carrying capacity of the vehicle used, and because of the fairly large amount of labour required.

Where hay is to be stacked outside, the push-off sweep may be used for lifting the hay up on to the stack, a so-called overshot stacker may be used, the hay may be forked on to an elevator, or a simple derrick hoist and grab may be used. Outside stacking may be done in an orderly manner, with manual building of the stack, or particularly in those areas where farming is extensive rather than intensive, the hay may be stacked in random piles with the push-off sweep or overshot stacker and then covered with tarpaulins or plastic sheets. Stock may well be allowed to help themselves from "random-piled" hay, but the feeding of stacked hay generally requires a fair amount of labour.

Where loose hay is to be stored indoors, as used to be the widespread practice in many parts of North America and Europe, some form of hoist or grab is generally used for transferring vehicle loads to the barn; even so, a fair amount of hand labour is required.

It is possible to apply the technique of "mow drying" or "barn hay drying" to hay which is stored indoors. The use of the mow-drying technique means that hay can be collected from the field after a fairly short period of curing, and at a relatively high moisture content which may then be reduced to a safe level for storage by using a fan to blow large volumes of cold or slightly warmed air through the hay for several days or weeks. Care must be taken to ensure that the partly-cured hay is spread as uniformly as possible, in order that a uniform airflow through the entire mass of the hay may be assured. Failure to do this will result in uneven drying, leading to mould formation and overheating in the more densely-packed areas.

Some of the factors discussed in Section 3.5.3 are also relevant to mow drying. Unless any building in which long hay is stored has been carefully designed with a view to allowing of self feeding by the stock, a considerable amount of hand labour will be involved in the feeding out of such hay.

3.4. Handling of Chopped Hay

The chopping of long hay into lengths of four to six inches brings with it the advantages of slight saving in storage space and the possibility of greater application of mechanical handling. It also allows greater annual utilisation of the forage harvester which would otherwise be used only for harvesting crops for silage. When used for collecting hay, the forage harvester is fitted with a pick-up attachment, and the chopped hay is delivered into trailers or trucks with high sides and canopies. Hay may be unloaded from the trailers or trucks either by a power-driven conveyor in the floor of the vehicle or by suction, and may then be transferred to a mechanical or pneumatic conveying system which will carry the chopped hay to storage.

With chopped hay, as with long, loose hay, it is possible to introduce the technique of mow drying. It is easier with chopped hay than with long hay to ensure uniform spreading in a mow dryer, and to arrange for some form of self feeding, or for removal from storage by a combination of manual labour and mechanical conveyor.

3.5. Baling and the Handling of Baled Hay

In New Zealand and many other countries, the pick-up baler is undoubtedly the most widely used method of collecting hay and preparing it for storage. Baling has obvious advantages over the handling of long or chopped loose hay. Baled hay is more easily handled, and allows better utilisation of the capacity of transport vehicles and greater economy of indoor storage.

3.5.1. Baling from the Windrow

In baling, one must always bear in mind the relationship between baling density and the moisture content of the hay. If damp hay is baled at too high a moisture content, heating and moulding will result.

In general, if the moisture content of the hay exceeds 25 per cent, the baling density should be limited to between 8 and 12 lb. per cubic foot; if it is under 25 per cent, the density may be increased to between 12 and 16 lb. per cu. ft. Where very damp hay (approaching 30 per cent moisture content) may have to be handled in damp climates, the low-density baler which makes rather untidy bales at between 5 and 8 lb. per cubic foot may be considered. The type of baler most commonly used on farms is really a medium-density machine, the high-density machines which make wire-tied bales of over 16 lb. per cubic foot being primarily suited to the baling of really dry hay which has to be transported for long distances.

What happens to the bales after they have left the pick-up baler depends largely upon what arrangements are available for subsequent transport and storage. Bales may be allowed to drop singly to the ground, in which case they can be picked up later with special bale loaders. An approach which is perhaps more common in this country is the delivery of bales to a sledge trailed behind the baler, on which a man stacks the bales in groups of six to sixteen for subsequent collection and transport. The man on the sledge can be eliminated by the use of certain "bale batchers" attached to the rear of the bale chamber to drop the bales automatically in groups of four or five. Another approach which works quite well in many cases, is to hitch a trailer (preferably of the four-wheeled variety) to the rear of the baler, and arrange for the bales to be pushed up a ramp from the bale chamber to a man who stacks them on the trailer. In the last few years, at least two American manufacturers of balers have introduced automatic devices which throw each completed bale from the end of the bale chamber into a trailer hitched behind. For this purpose, the baler is set to make half-length bales, which readily fall into a relatively compact random mass in the trailer.

Particular mention should be made here of the roll baler, which forms cylindrical bales. These bales, thanks to the manner in which they are formed, are better able to shed rain than are rectangular bales. It has been found that the cylindrical bale will absorb moisture to about 10 per cent of its own weight, whereas rectangular bales will readily absorb 20 to 30 per cent of their own weight, depending on the way in which they happen to be lying. Under certain conditions, cylindrical bales may be left where they fall from the baler and the stock may then be allowed to feed direct from them some months later.

3.5.2. Transfer of Bales from Field to Storage

Where bales have been left singly in the field, they may be collected and elevated to a transport vehicle by means of a suitable pick-up loader. Where they have been left in groups, they may be placed by hand on a similar loader for stacking on the vehicle by another man. A considerable reduction in the manual effort required in handling bales may be achieved by the use of suitably chosen methods of grouping bales in the field, and suitable devices (often attachments to front-end loaders) for handling groups of bales, either on to a transport vehicle, or direct to storage in a barn.

To illustrate the possibilities in this connection, some figures may be quoted from work carried out by the National Institute of Agricultural Engineering in Britain. Through the use of a special sledge, the bales were left in stacks of 16 each in the field. These stacks were then collected with a tractor carrying two slightly-modified buckrakes, one on the three-point linkage and one on a front-end loader. In this way, 32 bales could be picked up and carried to the storage barn, particularly if the barn were fairly close to the field in which the hay was baled. Alternatively, the one buckrake on the front-end loader could be used for loading a number of 16-bale

stacks on to a truck or trailer where longer distance transport was necessary. The double-buckrake method was investigated where the distance from field to barn was 500 yards. In this case, one man was able to collect and transport $6\frac{1}{2}$ tons of hay per hour, which was equivalent to four man-hours per 1,000 bales. Where the front-mounted buckrake was used for loading large trailers, each with a capacity of some 150 bales, three men could handle $11\frac{1}{2}$ tons per hour, which was equivalent to $6\frac{1}{2}$ man-hours per 1,000 bales for loading only.

When bales are brought to the hay barn on trucks or trailers, an elevator may, of course, be used to assist in storing them. Where, however, bales are brought to the barn on buckrakes, then the front-mounted buckrake can be used for much of the lifting necessary when stacking the bales. If half-length bales have been formed in the field and ejected automatically into trailers behind the baler, they can be unloaded at the barn either by tipping or through the use of a power-driven conveyor in the floor of the vehicle. The shape and size of these bales makes them more suitable for mechanical handling to storage than is the case with full-length bales. The half-length bales may be dropped at random into storage from an elevator or conveyor system and, thanks to their short length and more or less cubical shape, the random-stacked short bales require only some ten per cent more volume than an equivalent weight of hay in long bales. Further, the short bales can be removed easily from such random storage.

At the University of Minnesota, experiments are being carried out into the use of bales 12in. x 12in. x 12in. These "foot-cube" bales are even more suitable for mechanical handling than are half-length bales of more conventional cross-section. One of the drawbacks to the practical acceptance of these foot-cube bales will be the higher cost of twine per ton of hay baled, but this disadvantage will, in all probability, be more than outweighed by the greater ease of handling and the better drying characteristics.

3.5.3. Drying Baled Hay

In recent years experiments, both in Britain and the United States, have shown that hay may be baled in the field at relatively high moisture contents, and then dried out to a safe moisture content for storage in some form of artificial drying unit using cold or heated air. The main advantage of this system of "in-bale drying" is that the hay can be baled after a shorter time of exposure in the field, and thus before it gets brittle to the stage of readily losing leaf. Therefore, one can virtually guarantee that the hay will be of high quality and that the loss of dry matter will be far lower than would be the case in conventional methods of hay making and baling. Naturally, the advantages of a higher quality product and greatly reduced reliance on favourable weather conditions for curing the hay are offset by certain disadvantages associated with the greater need for equipment, and the need for burning fuel to remove moisture which would otherwise be removed by the sun and the wind. If hay is baled at 60 per cent moisture content, just over a ton of water must be evaporated for every ton of hay at 15 per cent. If the moisture content at baling is reduced to 45 per cent, the weight of water which must subsequently be evaporated is halved, and if the baling moisture content is further reduced to 35 per cent, then only about a quarter of a ton of water must be removed for every ton of dry hay. A further disadvantage of in-bale drying is the fact that the daily baling output will be limited, not by the capacity of the baler, but by the capacity of the drying unit. Therefore, it may be better to aim at drying only a part of any one farm's total hay crop, rather than trying to dry the whole crop, which would involve considerable problems in management.

There are three possible arrangements for the in-bale drying of hay. First, the bales may be dried in the position where they are to be stored. Second, they may be dried in batches on a special drying platform. Third, they may be dried in specially-constructed trailers. In "storage drying," four to six layers of bales are stacked on a slatted floor, and the fan is then started to blow cold or slightly warmed air upwards through them. Further layers of bales may be added at intervals until the whole height of the storage bay has been utilised. For in-storage drying, and particularly where cold air is to be used, the moisture content of the hay when baled should not exceed 40 per cent.

The major disadvantages associated with batch drying on a platform as compared with other system of in-bale drying is the double handling of the bales which is involved. Hay of up to 50 per cent moisture content can be handled with this system, in which it is customary to use heated air, although where a longer drying period per batch can be tolerated, cold air can be used at first, with slightly heated air for finishing-off. An interesting sidelight on static in-bale drying and also on mow drying of hay, is that experiments are under way to investigate the feasibility of harnessing solar radiation for warming up the air used for drying the hay.

Batch drying of bales in trailers is a practice which has been developed and advocated by a number of State Experiment Stations and commercial firms in the United States. In general, up to four 4-wheeled trailers are used in this system, each one being fitted with high sides and a slatted floor. Hay from the baler is stacked in the trailers, the trailers are parked side by side, and the whole group is then covered with a special tarpaulin. This tarpaulin is connected to a unit which blows heated air into the tops and sides of the loads, the air picking up moisture from the hay before passing out through the slatted floors. In this way, damp bales placed in the trailers in the late afternoon of one day can generally be dry enough for storage by the next morning. This system has the disadvantage of requiring several trailers, but does eliminate the double handling of bales associated with batch drying on a fixed platform. With any in-bale drying system, it is desirable that the bales should be of uniform density and moisture content, although it is acknowledged that this is often difficult to achieve.

Where full-size bales are used, careful hand stacking is essential to ensure adequate air flow both through and around the bales. Randomly-stacked small bales are quite well suited to in-bale drying systems, provided that they are piled to a sufficient depth to ensure uniform air flow. The "foot-cube" bales, mentioned in the previous section, are even better for artificial drying than half-length bales of normal cross-section, because of the greater surface area presented by these bales for a given volume of hay.

Costs of in-bale drying are bound to vary widely, depending upon the system used and upon the moisture content of the hay when it is baled, but the cost would probably lie in the range of £1 to £4 per ton.

3.6. Hay Wafering and the Handling of Wafered Hay

The wafering technique can be applied to long or chopped hay which, with no additive or adhesive, is formed by a reciprocating plunger or a system of roller into wafers one inch to two inches thick and three to four inches in diameter, or of an equivalent size in square shape. Very high pressures, of the order of 3,000 to 5,000 pounds per square inch are required for the formation of wafers, and this means that the power requirement of a complete machine is likely to lie between 25 and 40 horsepower-hours per ton of output.

The development of the process of hay wafering is no doubt due in large measure to the demand, in certain sections of the United

States for a hay "package" which requires less storage and shipping space than baled hay, and which at the same time is better suited to mechanical and automatic handling. The concept of hay wafering rapidly caught the imagination of many farmers, but problems which have to be faced in the development of the necessary machines and handling methods are very great, as may be gathered from the fact that one of the major American manufacturers of farm machinery is known to have been experimenting with a pick-up wafering machine about six years ago, but has so far not announced when they hope to have a machine of this type on the market.

However, another American company has recently announced that it will have a field hay-wafering machine available for sale later this year. The machine is designed to be coupled closely behind a flail forager, which serves to pick up the cured windrow, chop it, and transfer it to the wafering press, in which the hay will be formed into one-inch or two-inch cubes. The machine is said to weigh 2,500 lb. without the engine, the size of the engine depending on the output required and ranging to a maximum of 120 h.p. for an output of six tons per hour. Apart from the machine just mentioned, one other wafering press has been commercially available for a few years in either stationary or mobile forms, but not as a field pick-up machine.

From the figures which have just been quoted, it is quite obvious that the development of the hay-wafering technique has a long way to go before the pick-up hay waferer can be considered as a serious contender for the market currently served by the pick-up baler.

Hay has been wafered successfully in the moisture content range of 15 to 30 per cent but if the hay is above 20 per cent moisture when wafered, the wafers should be dried to prevent spoilage.

The storage or bulk density of wafers has varied from 10 to 28 lb. per cubic foot, in other words, from something little better than baled hay to something requiring about half the storage space of an equivalent weight of baled hay. The process of hay wafering must not be confused with that of pelleting, in which ground material is extruded through a ring die under high pressure. Where hay is to be made into wafers by a stationary plant, it is possible to mix with the chopped hay a certain amount of grain or other concentrate feed, so that the wafers form a complete, balanced food for a given class of stock. As yet, feeding trials do not seem to have been conducted with sheep, but it has been shown that cattle have no difficulty in dealing with the wafers. Feed-conversion efficiency, with meat animals, has been shown to be slightly lower for wafered hay than for similar hay ground and pelleted, but with dairy cattle, the feeding of pelleted, ground hay has been shown to result in a significant reduction in butterfat percentage, whereas no such reduction has been detected after the feeding of similar hay in wafers.

4. HANDLING THE CUT CROP FOR SILAGE, DEHYDRATION AND GREEN FEEDING

These three approaches to the conservation and utilisation of forage crops differ widely in respect of the treatment and final disposal of forage but the fresh forage can frequently be collected and transported with the same equipment for all three approaches.

4.1. Collecting and Loading the Cut Forage

The method used for collecting, loading and transporting the cut forage is directly dependent upon the ultimate disposal of the material, on the scale of the operation, and on farm organisation and layout.

4.1.1. The Buckrake and the Green-Crop Loader

The use of these two units is generally restricted to relatively

small scale silage making, to simple farm dehydration, and to small-scale green feeding.

The buckrake is perhaps the simplest and cheapest mechanical aid to forage harvesting, and is suited primarily to the handling of long material as mown. The buckrake can also be very useful for the collection of green forage which has been baled whether the bales are tied or left loose as discussed in the next section. When a rear-mounted buckrake is used the efficiency of the operation is dependent to a considerable degree on the speed at which the tractor can be driven in reverse and on the skill of the driver. Buckrakes are now readily available for mounting on front-end loaders, in which case the control of the unit as a whole is rather less awkward. The front-mounted buckrake can also be very handy for collecting material and loading it into trucks or trailers. It is not uncommon to see two buckrakes used on one tractor, one on the 3-point linkage and one on the front-end loader, and this double mounting of the buckrake does improve the efficiency of buckrake transport of collected material, as discussed in Section 4.2.1.

The green-crop loader is a machine which is hitched behind a heavy truck or loader for loading material from the ground into a vehicle where it normally has to be stacked by one or two men riding in the vehicle. This work commonly requires a fair amount of physical effort, which can however be eliminated through the use of specially designed trailers in conjunction with certain types of green-crop loader.

4.1.2. The Pick-up Baler

This machine can only be used in this context for the collection of material for silage. The baler is normally set to form half-length bales, but in some cases where the cut crop has been wilted to a considerable degree before collection, full-length bales can be used if the subsequent handling of them is well organised. The baler cannot be recommended as the best machine available for large-scale silage making or where silage making is a regular part of the farm programme. However, where a baler is available on the farm and where silage is only made on a small scale, or where silage is not normally made but an unexpected flush of growth must be conserved at a time of year when weather conditions do not favour hay-making, then the pick-up baler can be very useful. In such cases a special silage-making machine can be dispensed with and the overheads on the pick-up baler can be spread over a greater period of use in the year. The main benefits which may be obtained from the use of a baler in a silage-making programme are as follows: A given weight of material may be compressed into a smaller bulk which will give greater efficiency in long-distance transport. It is possible to obtain a closer estimate of the weight of forage stored and thus of the weight of the silage available for feeding than could be obtained with other methods of collection. Silage is usually easier to remove from storage when it has been baled than when it has been stored in the original long state. Against these advantages must be weighed the disadvantage of twine cost, and possibly of higher labour requirement than certain other methods of silage making.

Where the bales of forage have been allowed to drop singly from the baler they may be collected with a buckrake or with one of the pick-up bale loaders for transfer to the trailer or truck. Some types of bale loader may require to be modified slightly in view of the tendency of these short bales to roll down the sloping elevator. As an alternative to allowing the bales to drop to the ground they may be pushed up a ramp to a trailer hitched behind the baler or possibly some of the bale-ejecting attachments now available for certain pick-up balers may be capable of throwing the heavier half-length silage

bales into a following trailer. In an effort to retain the advantages of greater ease of removal from storage of the baled silage while eliminating the additional cost of twine involved in this approach, some farmers have tried using the pick-up baler simply for pressing the forage into what may be called wafers (though this use of the term "wafers" must not be confused with the hay wafers described earlier in this paper). The resulting wafers may be handled quite satisfactorily with buckrakes.

Much has been said and written in recent years about the possible use of additives such as sodium metabisulphite for improving the quality of silage. While the pros and cons of such additive use are outside the scope of this paper, it should be stated that the general findings have been that if the additives are to perform any useful function they must be intimately mixed with the material going into storage. For this purpose it is possible to arrange for some form of trickle feed of the additive on to the forage as it enters the pick-up baler.

4.1.3. The Cutter-Loader and the Forage Chopper

The essential distinction between these two machines is that the forage chopper reduces the cut forage into short lengths before transferring it to a trailer or truck whereas the cutter-loader loads the material into the truck without any such intervening treatment. A number of cutter-loaders have been developed and used in the past but they are seldom heard of now. However, under certain special conditions where short grass is to be harvested for silage or dehydration, it is possible to arrange a combination of gang mowers and a conveying and elevating attachment to cut and convey this short grass directly into trailers.

Turning now to the forage chopper, this machine is more commonly known as the forage harvester and performs several functions. First, it gathers either a standing crop with the cutterbar or a windrowed and possibly wilted crop with a pick-up. It then chops this material into short lengths, and finally delivers it to a truck or trailer. In what may be called conventional forage harvesters, the crop is chopped into lengths either by a cylinder-type chopper or a fly-wheel type similar to the chaff cutter. The average length of the pieces into which the material is chopped is generally adjustable and would normally be around two inches for silage and one inch or even shorter for dehydration.

A remarkable feature of the development of fodder conservation in recent years both in this country and many others, has been the widespread acceptance and popularity of the flail-type forage harvester. This trend is quite understandable when one considers the many advantages offered by the flail-type machine in comparison with the older, conventional forage harvesters. In the flail forager the three phases of gathering the standing or windrowed crop, reducing the size of individual pieces, and delivering the material to truck or trailer are generally handled by the one rotor. The flail forager is not normally able to chop material so finely as the conventional forage harvester, its action being rather one of laceration.

Where this is a disadvantage some types of flail forager can be fitted with an additional chopper of the fly-wheel type. This additional chopping of the flailed forage has been found to be an advantage in some cases where subsequent feeding-out of the silage is to be mechanised. The main features in which the flail forager exhibits a marked superiority over the older type of forage harvester are as follows: relative cheapness; far greater simplicity; far smaller number of wearing parts; and considerably less need for routine attention, in the way of sharpening and setting cutting mechanisms and lubrication of moving parts. In addition to the advantages just set

out, the flail forager has a far wider range of usefulness than its older counterpart. For example, it can be used without special attachments for the harvesting of maize and chou moellier and it can be very useful for clearing light scrub, cutting roadsides, or dealing with all manner of rough growth.

The main disadvantages of the flail forager are the need for very careful attention to the correct balance of the high-speed rotor, a tendency of the machine to shave the surface of the ground where the ground is at all uneven and, most important of all, the fact that the flail forager requires a fairly large amount of power to operate it satisfactorily. This feature of high power requirement may best be illustrated by quoting some figures from British test reports of conventional and flail-type forage harvesters. When the net output of a conventional forage harvester was 20 tons per hour, it required 20 h.p. to drive it but at the same output the flail forager required no less than 40 h.p. For the same two machines at a reduced throughput of 10 tons per hour, the conventional machine required 13 h.p. and the flail forager required just over 30 h.p. The greater part of the difference in horsepower requirements of the two types of machine is explained by the fact that the flail forager required 15 h.p. to drive it at full speed with no crop going through, whereas the equivalent figure for the conventional type forage harvester was less than four horsepower.

Similar characteristics of extreme simplicity, lower cost, reduced maintenance, and laceration rather than chopping, are exhibited by one other type of forage harvester which is quite well known in New Zealand. In this machine, two rotary-mower units cut the standing crop or pick up a narrow windrow of wilted material. A high-speed fan then draws the crop from the cutterheads, lacerates it within a special housing, and blows it to a truck or trailer. Unfortunately the capacity of this machine is rather low, ranging from 2½ to 6½ tons per hour, and the corresponding power requirement of 15 to 20 h.p. is certainly high.

Mention was made at the end of the previous section of the question of adding chemicals to the forage being made into silage. It is, of course, possible to arrange for a trickle feed of chemical on a forage harvester just as well as on a pick-up baler.

4.2. The Transport of Forage and the Storage and Feeding of Silage

The problem of transporting green forage is far more critical than that of transporting hay because of the far greater bulk and weight of material involved. To illustrate this it may be said that one ton of hay has about the same weight of dry matter as three to four tons of green forage. It is appropriate here to emphasise once again the close inter-relationship between transport method, location of storage, and method of feeding, together with farm management and lay-out. In this connection it is as well to consider whether the green forage may be wilted in the field thus reducing by 25 or even 50 per cent the weight of material which has to be transported. Another important consideration is that, if forage is to be stored as silage and fed to stock at some distance from the field where it was grown, should the silage be stored close to the field or close to where it is ultimately to be fed?

4.2.1. Interaction of Transport Method, Distance and Nature of Material

Undoubtedly the simplest unit for transporting long or baled forage is the buckrake which can, of course, readily be converted into a general-purpose farm transporter. One farmer is known to have used a slightly modified type of buckrake for carrying the material harvested by a small flail-forager mid-mounted on the tractor carrying the buckrake.

The overall efficiency of the normal buckrake method of collection and transport of forage is very greatly affected by the size of each load and by the time required to carry each load to the silo. The degree to which buckrake output is affected by load weight and transport distance may be illustrated by the following example.

Using a buckrake of 4½ cwt. capacity over a distance of 200 yards, the output was 2.2 tons per man-hour. This was reduced to one ton per man-hour when the transport distance was increased to 470 yards. When using a buckrake of 9 cwt. capacity over 200 yards, the output was 3.3 tons per man-hour and this was reduced to just over one ton per man-hour when the distance was increased to 800 yards. Output per man-hour may, of course, be further increased through the use of two buckrakes on one tractor, one mounted on the 3-point linkage and the other on a front-end loader. Charts have been published which enable us to make a fairly accurate estimate of the buckraking output which is likely to be obtainable under any combination of pick-up speed, load weight, transport time, and unloading time. Similar charts have been published, relating the output of forage harvesters to speed, cutting width, field size, crop yield, and time for changing trailers.

Where chopped forage is being loaded from a forage harvester into a truck or trailer travelling alongside or into a trailer hitched behind, careful planning is essential to ensure that the optimum use is made of the available equipment. When one wishes to obtain the greatest possible output in each hour for which the forage harvester is used, it is important that there should be sufficient transport vehicles in relation to the distance to the silo in order that the harvester should not be kept waiting. It has been shown that for a harvesting rate of ten tons per hour, two 3-ton trailers should be adequate for distances up to one mile from field to silo and that two 2-ton trailers should be sufficient if the silo is half a mile away from the field. Some flail foragers are permanently attached to trailers and thus the harvesting unit must be taken to the silo with each load. With this system and a similar one of keeping the trailer permanently hitched to the rear of the flail forager, it is not possible to get as high an output per hour as if the forager were kept continuously in work delivering to separate trailers. However, this system does have advantages under certain conditions where it may show a lower man-hour requirement per ton handled than the separate forager and trailer system.

4.2.2. Unloading Forage or Silage from Transport

Chopped forage when brought to the silo in trucks or trailers may be unloaded either by tipping or by the use of special power-driven conveyors on the floor of the vehicle. Some American manufacturers of farmyard-manure spreaders make available conversion kits so that the spreader may be used for carting chopped forage or silage. The material may then be unloaded by the use of the power-driven floor conveyor fitted to these machines. If the transport vehicle is fitted with a power-driven unloading conveyor it can usually be equipped with a cross-conveyor attachment to deliver forage or silage into rows of feed troughs parallel to a road. This system is widely used in the large beef fattening yards in parts of the United States.

In some cases where forage is to be stored in a trench, bunker, clamp or bun type silo, a tractor and trailer can be driven over the silo and unloaded in appropriate positions on it. Trucks however are not often suitable for this approach. Where it is not possible or desirable to drive the transport vehicle over the silo the load may be dumped close alongside the silo and transferred bit by bit with a tractor-mounted buckrake. Where baled forage is to be stored in

silos it is just as essential as with long or chopped forage that the material be consolidated in order to eliminate as far as possible all air spaces within the silo. At one time it was thought that careful hand stacking of the bales in the silo would be necessary but it now seems that random piling of bales is quite satisfactory, provided that the bales are not too firm and that due care is given to consolidation. When forage is to be ensiled in a stack one can use either a buck-rake on a front-end loader, an elevator, or a grab on some form of hoist.

Where a tower silo is to be used for storing the forage, it is normally filled through the use of a blower or chopper blower. Unfortunately these machines require a fair amount of power to drive them, and a certain amount of attention is being given now to the use of mechanical elevators for filling high tower-silos.

4.2.3. Storage Methods

It is not appropriate in this paper to embark on a detailed discussion of the relative merits of different types of silo but some points are worthy of mention as they exert a considerable influence on the mechanical equipment used. In considering the different types of silo, it is of interest to quote some average figures for the percentage of that dry matter in the freshly-cut crop which may be lost before the silage is finally fed to stock. For the sake of comparison it may be said that haymaking involves losses of somewhere between 25 and 40 per cent of the original dry matter.

Not more than 25 per cent of the dry matter should be lost from silage carefully stored in trench or bunker-type silos. Where the same silos are to be used year after year, it is very desirable that the walls and floors should be concreted so that removal of the silage or self feeding may take place with the minimum of mess. A greater degree of spoilage and loss must be anticipated when bun storage is used, but this method can be very useful for occasional storage, or as an overflow from more efficient types of silo. About 35 per cent loss of dry matter may be expected in clamp or stack storage. In addition it is sometimes difficult to ensure adequate compaction of silage stored in this way. There have been a number of serious accidents as a result of tractors used for compacting clamp silage falling off the clamp when driven too close to the edge. In Italy a stack-forming and consolidating device has been developed; it consists of a steel forming-ring which is progressively raised up the stack through its connection with consolidating rollers which are driven by a small petrol engine.

Another approach to the consolidation of stacked silage has been described in recent Australian literature. A forming ring is used to build up a neat stack on top of a plastic sheet. When completed, the stack is covered with a special plastic sheet which can be sealed on to the base sheet. Air is then exhausted from the plastic-encased stack by the use of a milking-machine-type vacuum pump. Finally, the vacuum cover is removed and the stack covered with another plastic sheet sealed on to the base for long-term storage.

The lowest dry-matter losses with any type of silage storage are usually obtained in the use of tower silos. In standard tower-silos it should be easy to keep dry-matter losses below 20 per cent. Unfortunately, tower silos are expensive to erect, in addition to which special power-driven equipment is necessary for filling them, and is most desirable if not essential for emptying them. However, when appropriate silage-unloading equipment is used the labour involved in feeding out silage from towers is very little. Indeed, where the scale of the operation and the finance available justify it, the feeding out of silage from a tower silo to yarded stock can be made completely automatic and can even be put under time-switch control.

A fairly recent variation on the standard tower silo is the gas-tight tower silo made of special glass-lined steel or some other suitable material. This type of silo is expensive but it is possible through its use to store forage of a wide range of moisture contents from succulent fresh forage down to field-wilted material containing as little as 40 per cent moisture. Dry-matter losses of as little as 11 per cent are readily secured through the use of these gas-tight silos. Forage may be put into the silo at any convenient rate without any consideration of consolidation problems, as preservation is dependent solely upon a certain degree of fermentation and respiration of the forage, which quickly results in the formation of sufficient carbon dioxide to fill the silo and inhibit further respiration and spoilage. The stored forage is generally unloaded by means of a mechanical device set in the base of the silo. In this way the first material to be put into the silo is the first to be removed and thus the gas-tight silo would appear to be an ideal buffer storage for use in conjunction with the zero-grazing technique.

4.2.4. The Removal of Silage from Storage

By far the cheapest and simplest method of removing silage from the storage unit is of course to allow the animals to help themselves. This approach can readily be adopted where silage has been stored in a trench, bunker, bun or stack, but in order that the best utilisation of the silage may be obtained with the minimum wastage and mess, it is essential that the feeding animals be controlled through the use of some form of wooden or steel rack or through the use of an electric fence. Some American research workers have shown that it is possible to design a tower-silo in such a way that cattle may help themselves from the bottom while ensilage is allowed to fall under control until the whole mass has been used.

The most laborious method of removing silage from storage but next to self-feeding the simplest, is of course forking by hand on to trailers. Hand forking almost invariably involves prior cutting of the silage. This may be done with an axe, spade, hay knife or various similar tools. Chain saws have been used for this purpose with a widely varying degree of success. One English firm however is currently marketing a chain saw specifically for cutting out silage.

Much of the physical effort associated with handling silage may be eliminated through the use of a front-end loader fitted with a fork. This method is quite successful when used on baled silage or chopped silage but where the material has been put into the silo in the long state or under certain conditions when it has been lacerated it is preferable to make cuts across the silo at intervals of a few feet prior to using the front-end loader. A possible alternative to cutting the silage before using the front-end loader, is to fit some form of claw or grab attachment on to the fork. When a front-end loader is to be used, and when self-feeding is practised, it is very desirable that the bottom of the silo (and in some cases, the area immediately surrounding it) should be constructed from hard core or preferably concrete so that there is no undue mess created during the winter when feeding out.

Hoists and grabs such as were formerly used for stacking loose hay have in several cases been successfully modified for pulling silage out of trenches, clamps and stacks.

Where silage is made and fed on a large scale or where the saving of labour is of paramount importance, various mechanical devices may be used. In recent years several American firms have developed special unloaders for use in trench, bunker, clamp and similar silos. These machines are designed for mounting on tractors or trucks and consist essentially of an elevator, and a power-driven toothed rotor about three feet wide which is carried on the end of a

hydraulically-controlled boom. The machine is manoeuvred with the rotor raised into a position such that, as the rotor is allowed to fall slowly, it shreds off a layer about one foot thick from the vertical face of silage, the shredded material falling down to be caught by the elevator for transfer to truck or trailer. These machines are capable of loading silage into trucks and trailers at a rate of 700 lb. per minute or more, but of course they are fairly expensive; an average cost in the U.S. is of the order of 2,000 dollars.

Until quite recent times most of the silage which was stored in tower silos had to be removed by hand, but now about a dozen different firms in North America are manufacturing mechanical silo unloaders. These units, costing about 1,000 dollars, are located in the centre of the silo and rest on the silage. They consist essentially of a power-driven radial arm to which is attached some form of scraping mechanism which shreds the silage off the top surface and pulls it to the centre, where it is picked up by a blower and thrown out of the silo.

The newer types of completely gas-tight tower silo are frequently equipped with a mechanical unloader working in the base of the silo. This then permits a flow of material through the silo, the first forage put in being the first silage to be taken out.

Bearing in mind the great popularity and versatility of the flail-type forager, it is interesting to speculate as to whether it may at some time be possible to adapt this machine for the removal of silage from trench, bunker and similar silos. For any such adaptation to be successful, it would be essential to devise some method whereby the flail rotor could be advanced slowly and smoothly into the silage.

4.3. The Dehydration of Forage Crops

Artificial dehydration is a process in which moisture is removed rapidly from fresh forage to give a dried product containing six to 12 per cent moisture. It is worth considering only for the preservation of forage which has a very high nutritive value in its fresh state.

The harvesting of the crop and its delivery to the dehydrator are normally achieved through the use of various combinations of machines which have already been described. Where the material is to be dried in one of the factory-style dehydrators it is often advantageous to use a forage harvester capable of chopping the harvested crop into pieces one inch long or less. This is because the output of many such dehydrators may be increased and the fuel consumption per ton reduced by chopping the fresh material as finely as possible. As simplicity and reliability are very desirable characteristics in field machinery and particularly so where it has to be used 20 to 24 hours a day (as is necessary in conjunction with these factory-style dehydrators) a strong case can be made for the employment of flail foragers in the field in association with a secondary chopping unit at the dehydrating plant.

Two approaches are possible to the problem of rapid dehydration of fresh forage crops. The first of these is the simple, low-output batch-type farm plant where fresh material is loaded into a drying chamber to a depth of a few feet. The second approach is that of the complicated, high-output, continuous-flow factory-style plant where the material to be dried is carried through the plant suspended in an air stream, or carried on a continuous conveyor in a layer a few inches thick.

The major problem involved in any dehydrating plant is that of rapidly evaporating up to 3½ tons of water for every ton of dehydrated product, without markedly affecting either the nutritive value or the digestibility of the product. The magnitude of this problem is further emphasised when one realises that, for the evaporation of every

100 pounds of water, it is necessary to burn one gallon of fuel oil or an equivalent quantity of other types of fuel. This means that where fresh succulent forage containing 80 per cent moisture is to be rapidly dried through the application of heat, about $3\frac{1}{2}$ gallons of oil must be burned for every hundredweight of dried product containing seven per cent of moisture. However, as will be explained in the next section, this high fuel consumption may be considerably reduced, particularly where the simpler types of dehydrator are to be used, by the use of a certain degree of wilting.

4.3.1. Simple Farm Dehydration

The capital cost involved in this approach to forage dehydration is often quite low, but the output is also low and the amount of labour required is high. In English practice, this type of drying is quite often only one phase of the use of a multi-purpose unit. Other uses to which such a unit may be put include the finish-drying of baled hay, the drying of grain in sacks or in bulk patches, and the ventilation of bulk potato stores. The capital cost of providing drying facilities of this nature can often be under £1,000 and may be less than £500 where farm labour can be used for some of the construction. Fuel cost per ton of water removed is usually higher than in the more complicated factory-style dehydrators, because the simple construction does not permit of the efficient utilisation of the available heat.

Fuel costs can be substantially reduced by allowing the cut crop to wilt for a number of hours in the field before it is loaded into the drying chamber. The savings possible may readily be appreciated from the fact that the produce one ton of dried product at seven per cent moisture content, $3\frac{1}{2}$ tons of water must be removed from fresh material at 80 per cent, two tons of water from material containing 70 per cent moisture, and only one ton of water needs to be driven off by the application of heat if the forage has been wilted to 55 per cent moisture content. If weather conditions are not favourable to rapid field-wilting, a fair amount of dry matter may be lost during the wilting process. Under such conditions, the technique of "forced wilting" may be used. This involves the loading of fresh-cut forage into the drying chamber and the use of a fan to blow large volumes of unheated air through it. In this way, even when the relative humidity of the atmosphere is as high as 95 per cent, it is possible to reduce the moisture content of the forage to well below 50 per cent. Final drying from this level is then achieved by blowing smaller volumes of heated air through the forage. These very simple batch-type farm dehydrators are greatly dependent for their efficient operation on considerable care being taken to ensure uniform loading of the material into the drying chamber. If this is not done, the drying air will tend to flow rapidly through lightly-packed sections and thus be very slow to penetrate and dry the more tightly-packed sections.

To give some idea of operating costs, under English conditions, the following two examples may be given. Using an oil-fired batch dryer with an output of 10 cwt. per 10-hour day when working on wilted grass, the average total cost was £12 per ton. In the second example, an output of three tons per week was obtained when drying wilted grass in a very simple, farm-built dryer using electric heating. The cost of electricity was £2/10/- per ton of dried product when electric power was available at one penny per unit.

Disposal of the dried product from these simple batch dryers may be by loose stacking, or by baling, or by hammermilling into meal.

4.3.2. Continuous Flow Dehydration

Some small continuous-flow dehydrators have been used on farms in some countries, but their capital cost is high, thus the overhead

cost per ton of dried product will tend to be excessive unless the plant is utilised to a higher degree than is practicable on most farms.

Commercial-type continuous-flow driers are generally capable of producing between half a ton and one ton of dehydrated material per hour. However, they may well cost anything up to £20,000 or even more, including the necessary auxiliary equipment. It is therefore very obvious that in order to keep overhead costs down to a reasonable level, it is essential that a continuous flow of suitable material should be available to the dehydrator for close on 24 hours a day, and for as long a working season as possible. During those periods of the year when forage crops suitable for dehydration are not available, it is sometimes possible to convert these plants for treating vegetables, brewers' grains and various other materials. In this way the working season may be extended, with consequent considerable reduction in overhead costs per ton of product.

Commercially dehydrated forage is usually ground up in hammermills and either sold as meal or blended with other ingredients before being pelleted for feeding to stock.

4.4. Zero Grazing

This technique, which is sometimes known as "mechanical pasturing" or "green feeding," is not truly a process for fodder conservation but, because the effective application of this technique is so greatly dependent upon the use of many of the pieces of equipment so far described, some brief consideration of its advantages and problems is appropriate to this paper.

Where zero grazing is to be adopted, the key to the whole system is almost certain to be the forage harvester, and because the system is so dependent upon regular and often daily use of that machine, the flail forager obviously has many attractions. Forage from the harvester would normally be delivered either into a truck or trailer equipped with power-driven unloading conveyor, or else into a trailer converted into a "mobile feed-rack."

The technique of zero grazing is suited mainly to the feeding of dairy stock and fattening cattle in yards, and it will probably not find widespread application in New Zealand until such time as more intensive approaches to these classes of farming are called for. There are a few farmers in this country who have attained outstandingly-high levels of forage production per acre, and who are seriously considering the adoption of zero grazing because they have found that they are unable to carry enough stock to fully utilise the forage available without poaching the land when it is wet. The main factors which can be considered as justifying the adoption of zero grazing are: wastage of forage through dunging and trampling is eliminated; the cattle do not have to walk so far and thus do not need to devote so much of their food intake to providing energy; the need for comprehensive systems of fencing and water reticulation may be reduced or eliminated; and there is no poaching of the land by stock so the stock may be kept cleaner. Disadvantages of the zero-grazing system are: it demands a greater investment in machinery and plant; greater reliance is placed on the smooth and trouble-free operation of such equipment; and provision must be made for the disposal of dung and urine. Careful consideration must also be given to the question of providing suitable crops, both for fresh feeding and for storage. The need for storage in association with the zero-grazing system includes that for long-term storage in the form of hay or silage for winter feeding, and also for short-term storage (what might be termed "buffer storage") to conserve forage which is surplus to the daily feed requirements, and to provide supplementary stored forage to tide over temporary shortages of fresh feed. The gas-tight silo with top filling and bottom emptying would appear

to be the ideal structure for such buffer storage, and might well be appropriate for the longer-term storage of winter feed.

5. GENERAL CONSIDERATIONS IN FODDER CONSERVATION

It is not easy to decide which methods and which machines are likely to be the most appropriate to a given district and set of circumstances, but when the decision has to be made, it is important to consider how each of the possible alternatives is likely to be affected by the various factors enumerated below.

(a) Climate. This will exert a very strong influence on such things as the types of forage crop which may be grown, the lengths of growing season which may be expected from them, the desirability of housing or yarding dairy stock, and the degree to which the natural agencies of sun and wind may be relied upon effectively to cure crops cut for hay.

(b) Soil. The soil type, together with local climatic and land drainage conditions, will have a considerable effect on the acceptable levels of stocking on pastures, particularly in the winter, and also on the most appropriate type and siting of silos.

(c) Stock. The type, quality and quantity of stored fodder which may be required will depend very greatly on whether the stock kept are stud or store sheep, dairy cattle, fattening cattle or store cattle.

(d) Farm situation and layout. This factor is of prime importance when deciding on the siting of storage facilities and when determining the transport organisation which shall be used, both for harvested forage and for stored fodder.

(e) Labour. Labour and finance are undoubtedly the most important factor in this connection, and those which will finally determine the choice of method and machine used. One must consider not only the availability of labour, but also the cost and the suitability for the work in hand of that which is obtainable. In the past, and particularly in the more highly industrialised countries, the shortage and high cost of farm labour have often been the major reasons for the adoption of mechanised techniques.

It is only in quite recent years that people have begun to appreciate that the techniques of work study or method study, so long accepted in manufacturing industry, can also make a significant contribution to increased efficiency in the primary producing industries. The following example will serve to illustrate how helpful method study techniques can be. In collecting grass and transporting it to a silo, the original method involved the use of three men and the expenditure of 93 man-minutes per ton of grass handled. In the improved method, which was adopted after a thorough study of the old method and of the objects it sought to achieve, grass was handled at the same hourly rate for the expenditure of only 43 man-minutes per ton, and with the employment of only one man, with occasional help at the silo from another man who for most of the time was engaged on other duties nearby.

(f) Finance. This is undoubtedly the most serious problem facing most people who are contemplating the purchase of machinery or the adoption of new methods for fodder conservation, or indeed for any other purpose. The problem is aggravated by the fact that many of the machines used in fodder conservation cannot be used for other purposes, and must therefore remain idle for a large part of each year. The timing of some operations, such as the baling of hay cured in the field, is quite critical—not only to the day, but even to the hour—and in such cases it is obviously desirable for a farm to have its own baler. Where the time of an operation is not so critical (as may well be the case in harvesting crops for silage) and where

the acreage to be handled on the farm in question does not justify the purchase of a special machine, a contractor may be employed, or the machine may be bought for use on the farm and its overhead costs spread by operating it also on contract in the surrounding district. Another approach which could be considered for spreading the annual overhead cost of a machine over a greater number of acres or hours is the system of joint ownership by a syndicate of two or three neighbouring farmers, which has met with considerable success and a rapid increase in popularity in Britain within the past few years.

It must again be emphasised that the selection of the method or methods of fodder conservation which are best suited to a given set of circumstances must take into account the integration of all phases of fodder conservation and handling between the cutting of the standing crop and the presentation of the conserved fodder to the stock. The successful establishment and most efficient utilisation of the chosen system calls for a high degree of skill in management, coupled with the maximum exploitation of available sources of technical information and of specialised advice.

This paper has sought to present a survey of the various methods and machines which may well come under consideration for use in fodder conservation programmes. It is quite apparent that there is a very wide range of possible alternatives, both as to individual machines which may be appropriate to each separate phase of conservation, and also as to different combinations of machines and methods which may be used in fulfilling the requirements of the fodder conservation programme as a whole. At the same time, it is acknowledged that the time is not yet ripe for the widespread adoption in this country of some of the techniques and machines which have been described in the paper, but as the country's population rises and its degree of industrialisation increases, farming must surely develop along more intensive lines. As it does so, it will become ever more dependent upon the adoption of labour-saving machinery and methods for the production and conservation of high-quality fodder for the livestock upon which the whole economy of New Zealand is so vitally dependent.

Q.: How low should the moisture content be to make ideal lucerne hay?

Mr Lindsay: The closer to 20 per cent moisture content you get the safer it is. It depends on how densely it is baled and how it is stacked. If storing conditions are good it should stabilise down to 16 per cent.

Q.: Have any tests been carried out here with the use of the flail-type forager for cutting chou moellier for feeding out?

A.: I haven't seen one in use. I know one farmer in North Canterbury who uses one regularly for feeding out chou to stock in another paddock. He is very satisfied.

BUDGETING FOR THE FARMER

A. H. Flay, Lincoln College.

Farm budgeting is merely estimating farm income and expenditure in advance. An established farming programme for a given period, usually a year, is a prerequisite. Some forecasting of prices may be necessary and usually current, known expenses and costs are employed. Often the accounts of the current year just ended are used as a guide to estimate costs. Budgeting is a feature of most business enterprises, of public bodies and even of governments; but possibly less than 10 per cent of farmers budget. Can it be that farming is any different from any other business? In general, we can say that the farm has to pay its way. It must have sufficient income to meet all out-goings but, of course, it may be that there is no obligation to earn interest on the farmer's own capital. Where no attempt is made to maximise net returns then farming is surely a way-of-life. For recent entrants into farming with limited capital, farming must certainly be looked upon as a business. It may be a business and a "way-of-life" combined, but nevertheless a business. It must then adopt business methods. It must budget.

Advantages of Farm Budgeting

Some advantages of farm budgeting are:

1. A farming policy and programme must be clearly decided upon in advance for a given period.
2. Thinking ahead is forced upon the occupier.
3. Future prices and costs are studied.
4. Future production is examined.
5. Comparison of two or more policies and programmes can be made.
6. The financial outcome of any programme with its related overdraft position is indicated in advance.
7. The possible taxation position is anticipated and adjustments made where feasible.
8. A cost consciousness is developed.
9. A general all-round business alertness is engendered.

A prerequisite of budgeting is the establishment of a farming policy. On most farms this is already in operation. Production of fat and store lambs rather than just stores, wheat and fat lambs, rather than just fat lambs, dairying and pigs rather than dairying alone, are examples.

An actual working programme for the farm for a given period, usually a year, is an essential. The top-dressing to be carried out, the fodder crops to be produced for winter and drought, the areas to be cut for hay and silage, the labour to be employed in breaking in new land, the new fences to be erected or the old ones to be renovated, and the necessary improvements to the water-supply are but a few of the decisions to be made before a budget can be prepared.

All this forces the occupier to think ahead. There can be no doubt about the fact that forward thinking is vital to a progressive business. The pros and cons of this or that are examined and many matters anticipated. A wet or dry season before the severity of it is fully felt, labour requirements at harvest and potato digging and so on are thought about and arranged in advance.

Future prices are given thought and inquiry made concerning their probable movements, and costs are reviewed as to their stability. The possibilities of greater production are examined. The carrying of more breeding ewes or the saving of more hay for farm use or for sale or of small seeds, the carrying of a few more breeding cows

consequent upon aerial topdressing, are all matters demanding thought.

Frequently comparison of two or more alternatives is under consideration. The carrying of more fat-lamb ewes or the growing of an area of wheat is an example. Labour and harvesting machinery will be examined in relation to the latter. The steady expansion of beef cattle or of store sheep on hill country comes to mind also. Labour again may be a deciding factor here.

All these considerations lead through the budget to but one objective—their probable financial outcome, not the financial outcome for one year necessarily, but the average of years. The budget for the current year and for several years hence will indicate the probable financial outcome of any given programme and, as well, the overdraft position.

A decision once made, after full consideration of all relevant factors concerning a programme for running the farm for a prescribed period and giving a certain net surplus or profit, would generally be adhered to but is not binding. It is tentative. Frequently improvements in details "en route" during the season may be made, seasonal conditions may demand a substantial change in cultivation methods and cropping plans or in stock feeds to be sold or bought, and so on. There may very well be good reason for increasing or decreasing expenditure here and there. It is true that lowered crop-yields in drought seasons or a substantial fall in store-lamb prices can readily turn a useful budget profit into a substantial loss, but it is equally true that a favourable crop-yield or a rise in the price of wool can turn a small profit into a large one. Under both circumstances the farmer reviews the budget; in the first case, with the objective of reducing expenditure in order to reduce the impending loss to a minimum; in the second, to increase useful and economic current expenditure on repairs and maintenance, top-dressing and drainage in order to reduce the profit and consequent taxation while at the same time increasing the asset.

An even profit from year to year is desirable if taxation is to be kept at a minimum. In both cases the budget and the season's accounts to date are reviewed as early as possible, preferably several months before the end of the current financial year in order to allow time for action before the year closes. These upsets are unavoidable and are characteristic of the risk and uncertainty associated with farming rather than indicating any weakness in the budget process. Adjustments consequent upon such upsets must be accepted as features of good budgeting. Because of forward thinking, however, the adjustments are the more readily made.

Without budgeting there is inadequate forward thinking and planning, insufficient clarity of possible financial outcomes of methods being employed, and little likelihood of adjustments of expenditure, small though they may be sometimes, within and during the current financial year.

With our steadily-rising costs—approximately two per cent per annum in sheep farming in recent years, to quote figures of the Meat Board's Economic Service, the development of a cost consciousness by farmers is assisted by budgeting. Full value must be obtained for all expenditure. It could be said that sometimes farmers spend precipitously on expensive machinery because of pressure at the moment such as exasperation because the hay-baling contractor was unable to come at the required time and a few hundred bales of hay were ruined. Calculated forward thinking as to the wisdom of a hay-baler being purchased with full cognisance of the weather hazard is an attribute of the business executive.

Budgeting as a regular feature of farm management engenders an alertness in the business and financial side of the farming ven-

ture. This alertness concerning all features of the running of the farm raises managerial efficiency.

Before leaving this section we should enquire if there are any disadvantages or weaknesses in farm budgeting. Like any other activity, budgeting must be carefully and considerably carried out. The inexperienced and incompetent could well mislead themselves, and likewise the carelessly prepared or incomplete budget would be better left undone.

Feasibility and practical issues of farming dictate that certain things can and certain things cannot be done. A budget for a year, or perhaps for several years, today would show that the farmer should put the whole of his mixed-cropping farm into wheat. While this may work well for a year or two, provided he can organise the concentrated labour and equipment for cultivation, sowing and harvesting, we all know what the effects of such would be in a year or two, reduced fertility, depleted soils, and weeds. A budget might likewise show that a certain hill-country property would pay better with sheep than cattle, but because of a bad infestation of *bidi-bidi*, experienced farmers know that to do so would be folly.

Farm budgeting is then the tool of the competent, experienced and informed occupier and should be handled with caution by the inexperienced. Procedure in farm budgeting is well illustrated in at least three Canterbury Agricultural College bulletins.

Can a Farmer Prepare a Budget?

Established farmers have available to them their past accounts; they peruse each debit before writing a cheque; they receive Federated Farmers Handbooks containing much information on farm costs. and there are available to them publications and bulletins giving budget information. On the grounds of information there can be no reason why a farmer should not prepare a budget. But a budget demands, as a prerequisite, decision-making in advance, consequent upon forward thinking, and the preparation of a farming programme at least for a season. It is in decision-making, perhaps tentatively certainly, concerning a programme that there would appear to be some difficulty; the technique of presenting on paper a co-ordinated plan of working the farm for a year appears frustrating especially when there are so many uncertainties—"ifs," "ands" and "buts." A choice is difficult. The result is that too often nothing is done, with a consequent lower managerial efficiency. But let it be understood that it would be unfair to the farming community to suggest that farmers do not "in-their-own-way" in their heads, plan and programme their work while shepherding or tractor-driving. The weakness is that they do not write it down in the proper sequence and carry it forward into a financial picture, a budget.

There is the further difficulty that such "book-work" is invariably attempted in the evening; there is no time in daylight with the never-ending demands of the general farm routine. So it is tackled in the evening after the farmer has enjoyed a healthy meal at the conclusion of an active day in the field. A warm room and comfortable chair are associated with the good food. Normally a cosy fire-side adds to the picture. Complete mental inactivity, even before the newspaper is read, soon sets in. The result is that a proper programme is never prepared and so there is no budget. It is considered that the average farmer could prepare a budget if he would tackle it in daylight by taking time off to manage his affairs. Few farmers programme and budget at the present time. But if prices fell and farmers began increasing their overdrafts there would be some very definite budgeting by banks and stock firms in the interest of the overdraft position and as an aid to greater efficiency in farm-

ing. Why then does not the farmer assist himself in management by the use of a budget?

Should Farmers Be Encouraged To Budget?

Where farming is a business or even semi-business there can be no doubt about the value of budgeting; planning, programming and forward thinking with its associated decision-making are so vital to maximising net returns. There can only be one point of view here. Farmers should be encouraged to budget. They certainly should prepare a trial balance and a short term budget two to three months before the end of their financial year and follow up with the necessary action.

Farmers diffident about tackling the job on their own should, and are strongly advised to employ assistance. The farm advisory officer of the Department of Agriculture could be employed to put on paper their working programmes and assist in constructing the budget thereon. Farmers joining a Farm Improvement Club get the job done at a small cost. All those who are State Advances Corporation clients might well take greater advantage of their field officers. Stock and station agents' clients might get assistance there; and, where accountants have some knowledge of farming, they might be employed by farmers to assist in this valuable service. The farmer is well advised to employ the professional man to help him with his budget just as he does for his accountancy or his legal business. But the farmer must not let the professional man do the whole job. Considerable value from a budget is obtained in the doing of it oneself, planning and forward-thinking with consequent increased efficiency in management.

In conclusion let me remind you that the Farm Management Department's Advisory Service at this College advises upon the over-all management of some 80 farms (including the Lauriston Farm Improvement Club) with appreciable success. The budget, with its prerequisites of programming, is our essential tool. We could not be fully effective or efficient management advisers without it.

SOME THOUGHTS ON PROVIDING TAXATION AND DUTIES TO ENSURE CONTINUITY OF FARMING

N. B. Fippard, Hastings.

Introduction

I was idly scanning the 1959 Budget recently, when I noted that direct taxation amounted to the staggering sum of £286,000,000 odd. Of this direct taxation, income tax accounted for no less than £190,000,000, with estate duties, stamp and racing duties the comparatively modest figure of £17,000,000 odd. This is a staggering sum to take from a relatively small number of taxpayers, and the heavy burden creates with some people a very dangerous state of mind.

High taxation does create a resistance, but this resistance should never lead a person into the illegal and dangerous practice of evasion. Avoidance of taxation is at all times a proper thing to strive for, and today a great deal of thought is being put into estate planning so that, on death, the minimum legally possible is payable to the State. An eminent jurist, Lord McNaughten, said in 1911: "No one may act in contravention of the law, but no one is bound to leave his property at the mercy of the Revenue Authorities if he can legally escape their grasp." In the intervening fifty years, the worth of this statement has become even more apparent.

None of my discussion today will touch upon evasion, the Courts being a very proper place to show misguided individuals the error of their ways. We will discuss, for a brief half hour, ways and means whereby a farmer can so order his affairs that he pays as little as possible in the way of taxation during his lifetime, and leaves his estate in such a position that the burden of death duties is not so great as to require a sale of the property. My paper might be summed up by saying that it indicates a game of "put and take" with Inland Revenue Departments, a game so aptly described by Lord Greene as "a battle of manoeuvre, in a long and fiercely contested battle with individuals who well understood the rigour of the contest."

The farming community in recent years has faced a decade of generally very high prices for primary produce, good nett returns and, what is most important, a very substantial rise in land values. With the present high rates of taxation, and what I would describe as crippling burdens of duty, this inflation is a very serious matter. It has become increasingly difficult to retain ownership of property during lifetime, and provide for duties at death. When one considers that at top rates for taxation and duty, every additional £1 earned nets 17/4.8d for the State, leaving only 2/7.2d to be effectively saved to benefit one's dependents, it is no wonder that there is general reluctance to save.

Returning to the question of inflation, it would be merely justice if inflation was compensated to some degree by lower rates of duty. Indeed, a very good case can be made for the complete abolition of death duty. While I do not subscribe to this view I feel very strongly about the present crippling and vicious imposts. When all is said and done, a farmer is not concerned with leaving any particular size of estate, valued in whatever currency that may obtain at the time of his death. His concern is to leave a sufficient area of land, complete with live stock and plant, to provide for the needs of his widow, and to supply a farming son or sons with an economic unit. It would be a great tragedy if farming, conducted so successfully over the past century, was unable to continue on the same lines. Coming from a

city, I may be forgiven for disagreeing with the statement that farmers are the backbone of the country. To my mind, they are not, but farming has been the backbone of this Dominion's prosperity, and is likely to remain so in the future. In New Zealand we have large areas of fertile soil, an equable climate and generous rainfall, all factors conducive to profitable farming. While reasonably well off for coal and power, we are deficient in minerals. Therefore we will continue to rely on the production from the land to finance our imports and interest on overseas indebtedness.

Cash Provisions

Provision by means of investment, including investment in life insurance, can save the situation where an estate is relatively small.

When, however, the estate exceeds £30,000 and death duties amount to 12/- in the pound over that sum, investment and the retention of investments is a very laborious process when you consider that only 8/- is left out of every pound invested. Therefore, the mind of an estate planner works more and more along the lines of distributing the assets during lifetime so as to leave as little as possible to be dutied on death. The virtues of dividing income among members of a family are obvious, taking advantage of lower taxation rates by means of separate assessments. In all schemes of re-arrangement, the best advice possible should be taken, and this invariably means close co-operation between the legal and the accountancy professions.

Let me, however, issue a note of warning. Never allow yourself to be placed in the hands of your children. However united a family may be, there are such things as early marriages and early deaths, creating circumstances where the parents may be beggared and forced to rely on the bounty of a stranger. This at all costs must be avoided.

We will now just briefly touch upon some methods which are available to a farmer to keep taxation assessments down and reduce the dutiable estate.

Profit-Sharing Schemes

I will discuss these only from the point of view of members of a family. Any profit-sharing scheme must be sensible because any share of the business profit payable to a relative can be questioned by the Commissioner. When you consider that a relative means a husband or a wife or a relative by blood within the fourth degree of relationship (whether legitimate or otherwise), or a relative by marriage or adoption, and also includes a trustee for a relative, you will appreciate that the definition covers a very wide field. There are five points which must be considered with contracts of employment or partnership, and these are that the arrangement must be:

1. In writing or by deed signed by all parties.
2. On execution, all parties over 21 years of age.
3. Contract binding for not less than three years.
4. Each party has effective control over his share of profits.
5. The share of profits is not so high as to constitute a gift.

In my personal experience, I have never found any difficulty in having a sensible profit-sharing arrangement agreed to by the Inland Revenue authorities. Indeed I feel that they are treated very fairly, and arrangements can be made where a father can remunerate a son generously for the assistance which he gives to the farm. Silly arrangements where remuneration is out of all proportion to the services rendered are treated with scant consideration.

Sensible profit-sharing arrangements do avoid sons paying duties on their own inheritance because the father has lived in the past

and paid inadequate wages with the idea that "You will get it all when I'm gone." In actual practice the sons don't, because of the commitment to the State.

Partnerships

Partnership between relatives, particularly between father and son, is a very useful method of dividing the farming income, and setting up a scheme whereby a father can enter into a gifting programme. One method is for the father to sell the property to the son, taking a mortgage back and then entering into partnership with the son sharing profits on some reasonable basis. This will reduce current taxation and enable the father to gift the mortgage from time to time, paying gift duty where required. By this method, the property can be passed over to the son over a reasonable period of years.

You will notice that I mentioned that the property should be sold to the son. This is done because if the property was gifted the father could have no further interest in it or benefit from it. If he did take any benefit the gift would be ineffective and would fall back into his affairs on his death.

In general, unless done in relatively-small numbers, the gifting of livestock, or a sale of livestock at inadequate values, can create difficulties. I am aware that the law permits livestock to be passed from father to son for taxation purposes at 30/- for sheep and £10 for cattle. At least, these are the values applicable in Hawkes Bay; but for gifting purposes stock must pass at market value. In many cases, standard values bear no relation to market values, being much lower. By gifting the livestock at a low standard value for taxation purposes, the father passes over to the son the deferred liability for taxation on the difference between standard and market values. In this respect, the gift is partly ineffective.

Dealing with the question of the mortgage back from a son to a father, this should be at a fair rate of interest unless the mortgage is on demand, when the mortgage can be free of interest. This freedom of interest is not treated as a gift, as the interest does not accrue from day to day, and there is no way of measuring the inadequacy. If the mortgage is for a term the inadequacy can be measured and a gift established.

By a sale of land from father to son, the increase in the value of the land does not attach itself to the father's affairs, and this has been very valuable in recent years, and for what my opinion is worth, I do not think that the present values of land can fail to continue to rise.

Rental

The father can sell land to members of a family or to a trust or a company, both of which will be discussed a little later, taking a mortgage and in due time gifting the mortgage. He can then have the land leased back to him, paying a fair rent for it. A fair rent is considered five per cent of the capital value of the property, plus rates and insurance, and land tax can be included or excluded as desired. The rent then becomes deductible in the income return of the father and will be taxed in the hands of the lessor, but this would usually be at a lower rate than that of the father. These rentals can if necessary build up a fund outside the affairs of the vendor for ultimate use for estate protection. The gift of any part of the mortgage should not be at the same time as the sale and leasing back, as this would be considered a contemporaneous transaction and the arrangement would fail. There is good legal authority for this statement.

Bailment

At one time, a bailment was considered a disposition of live stock but over the last six years this has not been the case. Live stock can be bailed, and retained in the tax return of the bailor at standard values. Bailment rent, however, must be paid at a fair rate usually considered at six per cent of the market value of the stock. It would therefore be possible for a farmer to sell his land and bail his stock and plant taking in lieu of farming income, interest on the mortgage and bailment rent on the live and dead stock. If so desired the mortgage could be interest free if at call.

Companies

I feel that company formation has been somewhat overworked in this country, and the advantages of earlier formations, say in the 1930's have somewhat clouded people's minds as to the relatively-few tax advantages which exist today. The impact of dividend tax alone cannot be ignored. In general, I do not favour company formation except where it works in with trust formation, or where it is the most feasible method of continuing ownership of a block which is difficult of subdivision.

On the other hand, there is one great advantage in company formation in that a company can be formed to hold the land and the shares in that company gifted away in such parcels as are deemed advisable. This is one of the principal advantages of company formation. If land is sold to a company it is sometimes advisable to float the company with share capital as to half the value of the land, or the equity in value, giving the farmer a mortgage for the other half. This means that the number of shares to be gifted is reduced, and repayment of the mortgage can form a fund for living expenses in the latter years of a farmer's life.

In general, company formation is useful from the duty angle rather more than from the tax angle. One further advantage is that the father can, by being appointed governing director, exercise considerable control over the company while at the same time substantially reducing his share holding. The advantages of company formation may be summarised as:

1. Limited liability of members.
2. Continuity of business is not affected by death of shareholder.
3. Dealing in shares is easier than partitioning of land or selling livestock.
4. Simple system to reduce estate, but also retain control of the farming operations.

A major disadvantage of company formation as compared with a partnership is that, subject to salary and rent allowances, the company income is assessed in one assessment. Frequently, partnership formation gives a better division of income and lower tax rates.

Share Valuation

This subject could form a very considerable part of this paper, but the discussion would be technical, and I do not propose to say very much about it. But there is a tremendous advantage, where a farming company owns both land, live and dead stock. When a farmer dies his executors, whilst stating the full market value of live stock for duty purposes, can continue with the existing standard values, or any figures between these and probate values, for taxing purposes. This creates a very great problem for the executors, because any tax avoided by continuing with low standard values is not included in the Stamp Accounts and therefore the duty increases. If in the future, the stock is sold at prices approximating the probate values the tax will be collected anyway, and the duty reduction lost. When valuing shares in a farming company, the difference between

standard values and market values is treated as a liability at the date of valuation, but as the company does not cease to farm and has not disposed of its stock, this liability for tax does not become payable.

Trusts

A full paper could be written on this aspect of estate planning, but my following brief remarks will indicate methods which can be examined, particularly where the protection of the wife and infant children is the main consideration. You will appreciate that there is an infinite variety of trusts, which in turn can bring into the picture both partnership and company formation. Advice to a farmer could well be to sell the property in whole or in part to trustees of a trust. If this can be done by selling a separate block, then the trust can readily farm on its own account. If this is not possible, the whole property could be sold, or an undivided interest if necessary, with a mortgage back, interest free at call. Then there are a variety of ways of dealing with the property:

1. It can be rented back to the farmer to avoid any disturbance of farming operations.
2. The trust can enter into partnership with the vendor and profits shared in relation to assets used.
3. Live stock can be transferred to the trust from time to time to enable the trustees to derive a farming income.
4. If company formation is entered into, shares can be set aside in trust.

If this form of avoidance is entered into, great care must be taken that the donor never derives any benefit or power of control over the subject matter of the gift. Indeed it is dangerous in my mind that a settlor should become a trustee of his own trust. He may unwittingly do something in the future which brings him some benefit, in which case the settlement will fail. In practice, a settlor who is also a practical farmer would be consulted by his trustees, but this is a different matter than giving him a right of direction.

The destination of income in a trust is one of extreme importance, as also is the destination of capital. I will not develop this point any further than to say that the needs of the beneficiaries, and the protection of the wife, should be kept in the forefront of any re-arrangement.

There is another point I would like to make. If trust formation is entered into, the trustees should be empowered to reserve income for the purpose of debt reduction, building up reserves or improving the farm. This has a tax advantage in that it creates yet another taxation compartment for the trustees, and it can avoid large accumulations of income which would otherwise pass to the beneficiaries when they attained the age of 21 years.

The date that capital should pass is also one of importance and generally speaking this should not pass at the age of 21 years but at a more mature age.

A trust deed should provide very full powers to the trustees. In addition to the normal or machinery clauses and statutory powers, the following points should be considered:

1. Reserve for debt reduction and capital improvements as mentioned earlier.
2. Expend all income and, if need be, all capital at trustees' discretion for benefit of infant beneficiaries.
3. Take shares in companies whose objects are allied to the farming industry, e.g., meat works, dairy factories, fertiliser companies and the like.

4. Take shares or make deposits with Permanent Building Societies. These investments are gilt-edged, but do not rank as trustees' securities.
5. Advance to beneficiaries, with or without security or interest, as the trustees decide. This enables beneficiaries to take advantage of the trust funds in order to be set up in business. If so desired by the beneficiaries when the donor passes on, the trust funds can be used in order to assist with payment of death duties.
6. Take up life policies on lives of beneficiaries, settlor or any person. If a policy is on the life of a beneficiary, it enables him to take up in later life substantial covers at low premiums. If on the life of the settlor, the proceeds of the policy would not be subject to duty at the date of death of the settlor, but could be used to assist with payment of duties.
7. Farm solely or in partnership or otherwise.
8. Concur in company formation for purposes of farming.

These suggested powers are not the only ones, but are some of the more important to keep in mind.

Wills

A will is a most important document, and is the only means of a farmer leaving behind instructions to be effective after he has died. So many times one finds a farmer's will is 20 or 30 years old and completely out of touch with modern requirements. To my mind a will should be reconsidered each year and pulled out of the solicitor's pigeon-hole at least every five years to ensure that it still is fully effective in the light of modern legislation.

Even today, one occasionally finds a will whereby a husband leaves everything to his wife. The impact of double duties, even taking into account the relief which can be given where a beneficiary dies within five years of succeeding to property under a will, can be a crippling burden. In general, I feel that the provision for a widow should be along the lines of an annuity with a maximum and minimum figure. The annuity cannot go below a certain sum, and in good times can rise to the higher figure. The trustees can also be empowered to increase the annuity to take care of inflation.

Looking to the future, if a widow has an annuity, a son or sons in the future could give a satisfactory security to the mother and take over farming operations. This enables a son to enjoy the benefit and pleasure of his inheritance during the lifetime of the mother.

The provision of an annuity for a widow avoids what so often happens, the building up of a large estate in her hands which finally bears duty.

Quite often one finds a circumstance where both the parents and the children are reasonably well settled. Thought can then be given to skipping a generation and benefiting the grandchildren, thus avoiding building up large estates in the hands of the second generation.

When considering a will, the advice of a solicitor is absolutely vital and on no account should an accountant ever prepare a will. An accountant is well fitted to offer advice on broad issues, and is frequently more in touch with a farmer's affairs than is the solicitor.

Deeds of Family Arrangement

In many cases, a will drawn many years ago can create hardship, and in these circumstances deeds of family arrangement can

be entered into provided that all of the beneficiaries are over age, of one mind and are prepared to fully indemnify the trustees. One thinks of the terms of a will which has given a widow complete life interest with the remainder over to children at her death. The children are in the fifties and the mother is hale and hearty in the middle seventies. In such circumstances it is possible to secure an annuity to the widow based on five per cent of the market value of the estate, whereupon the children can take over the farming operations.

Conclusion

In a brief paper of this nature, one cannot cover all the facets of taxation and duty avoidance, nor can concluded schemes be discussed. Every case differs, and the whole circumstances of any farmer must be carefully considered before any re-arrangements are entered into.

The first requirement is to find out exactly what the farmer is worth, and generally speaking a balance sheet tells you very little on this point. The situation should be stated on present-day values, the burdens of tax and duty ascertained, and then the available funds measured against those burdens. Almost invariably there will be a deficiency. It is to find a means of closing this gap and eliminating the deficiency which requires the thought of legal and accountancy advisors.

Some years ago, I was privileged to be a member of a two-man commission which was authorised to grant duty relief in difficult circumstances. It was very distressing to discover that, in many cases, a complete lack of planning had created the circumstances which brought the case before us.

As an advisor to farming clients, one can do no more than to warn a client where he stands and what the situation would likely be should he die. If then he does not do anything about the matter, at least he has been warned and the responsibility lies with him. Any scheme of legal avoidance must be sound and practical, and this can only be accomplished by close co-operation between the legal and accountancy professions. I have never seen a sound scheme attacked on the ground that duty or tax has been saved, but faulty schemes will be attacked and that is the duty of our friends in the Inland Revenue Departments.

Heavy annual taxation bills make it expensive to live, but at least these are met annually and got out of the road. It is the heavy burden of death duties, which was once described as "an object of terror to mortal man," which makes it so very expensive to die. By the acceptance of sound advice, the bringing into being of legal and logical re-arrangements during lifetime, a farmer can ensure that the proper persons succeed by the proper methods, usually sons by direct inheritance. This will enable many farms to remain in full production as the backbone of New Zealand's prosperity.

I have not worried you with quoting chapter and verse either from Statute or Case Law today. I must conclude on this note, however, that my discussions have centred round the law as it stands at present. I could not do any more than that. But the law is changing and vigilance is required to ensure that any change in the law is considered when it takes place.

Q.: Supposing the idea of trusting became prevalent; is there any chance that the powers that be would take steps to pass legislation to wipe out all the advantages mentioned?

Mr Fippard: That could happen at any time. You can only work on the legislation that exists. There is something sacrosanct about trust formation and I feel that it will be the last thing that any Government will attack. If it was altered, normally it wouldn't be back dated.

Q.: Would you say that all children should have their fathers' lives insured by paying the premiums, i.e. where the father has property and the children also have property in the trust?

A.: I would prefer the trust to ensure the father's life. It is very difficult for the children to pay the premiums. With life insurance, if the father comes back into the picture and pays the premium, then the policy would fall back into the estate. Give the trustees power to pay the premium, then the proceeds of the policy go to the trustees to disperse without deduction.

Q.: If a wife insures her husband's life, can she get a tax rebate?

A.: No, there is no exemption. It must be on the taxpayer's own life or the benefit of his wife and children, and he must pay his own premium.

Q.: Is it essential in the formation of a company that the family need be all of the age of 21?

A.: No, you can have shareholders under 21 years of age but you cannot enforce contracts against them.

Q.: When forming a company do you have the capital fully paid up?

A.: Generally speaking, no.

Q.: What do you suggest a young man should do who, on an undeveloped farm, begins without much capital? Should he farm as an individual or form a company, partnership or trust?

A.: That depends on the size of the estate. My advice is to consolidate your position first (do not worry about your estate before you have got it)—once you start to build up and are getting up to the £30,000 mark then take action.

Q.: At what age can farmers' children receive wages, and how much?

A.: As soon as the child is able to work in a manner that produces something for the farm, you can pay a reasonable wage for the work done. I have heard of a boy at secondary school who gets £2,000 a year; this is absolutely ridiculous. You must be able to prove the child is really working and is worth the wages paid. For instance if he takes a full lambing beat he is entitled to shepherd's wages.

