The Proceedings
of the
14th Lincoln College Farmers' Conference
1964
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The Proceedings

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LINCOLN COLLEGE FARMERS' CONFERENCE

1964

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A. T. G. McARTHUR,
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Mr A. T. G. McArthur, Senior Lecturer in Rural Education, Lincoln College.
OPENING ADDRESS
Hon. B. E. Talboys, Minister of Agriculture.

Mr Chairman, Dr Burns, Ladies and Gentlemen,

First I thank you sincerely for your invitation to come back to Lincoln again. As a matter of fact I have had the pleasure of coming to Lincoln on a number of occasions, and I have also come to Lincoln in a number of capacities. First, as an interested onlooker to the 1947 Conference. Then I returned as an agricultural journalist. The task was simply one of setting out in the cockies' language the results of some of the work being done here at the College. After that for a brief period I came as a student on a short course in dairying. Then I have been back both as a Member of Parliament and as a Minister of the Crown and I can assure you that I have been worked over on a number of occasions in the staff common room, and I can tell you that they do it very nicely here at Lincoln. Through those years of contact with Lincoln, of knowing the fellows who make this College what it is, I have formed one lasting impression—that of the really grand team of men dedicated to doing something for New Zealand farming, working together with a team spirit which I find spreads out to embrace those who come close to it. I have found it a very welcoming spirit and it is quite obvious to me today that there are many others who have been caught up in this same atmosphere. This vast attendance of farmers at this Conference is ample evidence of that atmosphere.

Now I want to say something to you about the Agricultural Development Conference. It has already had two meetings. Another is scheduled for the end of this month and at that meeting some of the working parties will present their findings, and others will make interim reports. Now, probably you will have noticed some criticism of a lack of publicity for the activities of this Conference. I must admit that this has come as something of a surprise to me. The task being done by the working parties is being performed by men who are part time on this job. They are giving up their time to study the many complex problems. They are working on an overhaul of New Zealand agriculture and I am certain that their work would be done less effectively if it were carried on in the public gaze. They have called for evidence. Submissions have come from individuals and organizations in all parts of the country. As they complete their allotted task the working parties will report back to the Conference which in turn will fashion recommendations to the Government.

Just to refresh your memories, the working parties are devoting their studies to finance, taxation, land valuation, the scale of farming, the effects of the present laws on aggregation. I am certain that one of the things they will be looking at is this rather interesting proposition that we have all accepted in New Zealand: that the successful farmer is the one individual who can not buy a farm, unless he has a licence in the form of a son.

Another working party is studying manpower, another farm costs, another is devoting its time to the problem of noxious weeds and pest control. Now I am not going to venture into any crystal gazing as to just what the weed and pest committee will recommend, I have wondered whether it would not be possible to place pest and
weed control in one organization. However, frankly I have not been able to think my way through the problem of administration.

The Targets Committee for pasture production has already accomplished something of value. The targets to be met by 1972-73 were published at the March meeting of the Conference. The Targets Committee concluded that to balance overseas payments in 1972-73, we would need to expand our export earnings by 4.4 per cent per annum cumulatively. When allowance was made for the likely contribution from sectors other than farming, we would need to increase pastoral exports by 4.1 per cent. Making a further allowance for likely improvements in livestock productivity, yields per cow for instance, we will need to expand livestock numbers by about 3.5 per cent per annum. On past performance the likely increase is about 2.3 per cent. Now this work of course was done on the basis of certain assumptions. Quite obviously it is possible to make out a fairly valid case for other assumptions which give different results. But to my mind the essential point that emerges is that even when the most liberal allowance is made for contributions to our export earnings by other sectors of the economy (from forestry, fisheries, manufacturing and tourism) it is manifestly clear that the greater part must be earned by the products of our pastoral industries. This is certainly true for the next ten years to come and it will obviously be true for some considerable time after 1973. But I suppose there are limits to the extent to which one should try to peer into the future.

Now it has been suggested that the Conference might have arrived at different conclusions a few years ago. A few years ago the graph of the price of butter looked more like a fever chart. The price for both wool and lamb was much less attractive than it is today. The prices today reflect in part the rigorous 1962-63 winter in Europe. Sometimes the layman is inclined to lose sight of the fact that extremely severe climatic conditions affect production not only in the year in which they occur, but frequently for some time after because of losses of stock and the time required to rebuild flocks and herds. However, I am convinced that a factor, at least as important as climate, is the changing economic circumstances in the world generally, and more particularly in Europe. There is ample evidence to show that as real incomes increase there is an expansion in demand for better quality high protein food. This is particularly true where consumption of these foodstuffs is not at a high level. But even in the United States where meat consumption is already at a high level per head the consumption is still rising. Added to this, there is the demand which can be expected and is coming from Eastern countries—particularly Japan.

Now, however true this may be, and obviously to some extent we are in the realms of speculation, it is also clear that there is a strong feeling rising throughout the world that some more practical and worthwhile assistance must be given to developing countries to speed up the rate of their development in order to lift their standards of living. It is certainly my belief that as a result of this great United Nations Conference on Trade and Development which is still in session in Geneva there will be moves which will lead eventually to a change in the pattern of international trade. There will be changes
in the tempo of development—changes in a manner more favourable to those less fortunately situated countries.

Now I know that New Zealand is in a middle position. At one and the same time New Zealand is a developing country dependent on a very narrow range of primary products for its overseas income and yet a country which enjoys a high per capita income. In fact New Zealand is rich by the standards of most of the countries at that Conference in Geneva. But because of this dependence on the sale of basic foodstuffs and raw materials, we share many of the problems of the developing countries and I am certain that we will benefit from the improvement in their living standards and it is likely, too, that our trading conditions will at least be ameliorated by the results of this trade conference.

Apart from the world trade conference in Geneva there are of course the activities of the G.A.T.T.—the General Agreement on Tariffs and Trade for liberalizing trading. It would certainly be idle to pretend that there are not innumerable problems, and difficulties in the way of trade liberalization. But it has been agreed that agriculture must be an integral part of this round of tariff and trade negotiations known as the “Kennedy Round.” I am optimistic enough to think that in the long run there will be an improvement in trade opportunities for agricultural products.

Now all this leads me to the conclusion that we need have no fear that an expansion in pastoral production at the rates suggested by the Targets Committee can not be absorbed in world markets at prices remunerative to the New Zealand producer. Our problems are rather those of ensuring that the level of increase is attained and of course this Lincoln Farmers’ Conference, with papers on such a wide range of topics concerned with increasing production and improving farm efficiency, is an important contribution toward achieving that end.

Government policy has been aimed at an expansion in farm production. While this is certainly not the forum for a political speech, there are a number of things that have been done to encourage investment in farming and to encourage the use of fertilizer. Also there has also been considerable reorganization of the Department of Agriculture aimed at improving both advisory and research services and obtaining better coordination between the two. You will be aware, as you have him on the programme, Mr Chairman, that we have obtained the services of Mr O. G. Williams from the Ministry of Agriculture in Britain who will examine our Advisory Service and indicate where he thinks some of the experience that the Ministry has had in Britain might be of value here in New Zealand.

Now I know and I can assure you that Mr Williams knows that the decision to bring him to New Zealand was greeted with surprise in some quarters, but I hope that within the next year or so it will be possible to work out a mutually acceptable system of exchanges of advisory officers between New Zealand and Britain. There is no doubt in my mind that both services and all the men involved over a period of time would benefit tremendously.

Following an all too brief acquaintance with some of the activities of the National Agricultural Advisory Service, I made a few comments about their emphasis on the business side of farming. Then apparently a few days later my name appeared in an article reporting
a statement by some anonymous person that New Zealand farming was fast asleep. Of course the association of ideas led people immediately to some quite interesting conclusions. After all my name was in the article, mine was the only name. Well, to me the really valuable part of this has been that it has sparked off some interesting discussion. There are some I know who see English farming through the fact that somebody in New Zealand can shear about 450 sheep a day and there is nobody over there who can come anywhere near it. Others in this country see English farming through the £360,000,000 worth of subsidy that everybody thinks would be a wonderful idea. However, I think that we make a grave mistake when we see their farming through that sort of frosted glass. I think that we should never look at it in that light and jump to the conclusion that we have nothing to learn. Equally am I sure that they don't jump to the same conclusion in Britain. Surely the point is that the New Zealand farmer is highly efficient. But this certainly does not mean that the average level of efficiency cannot be improved. Now, just this morning I was talking with Dr Burns and he told me about a farmer. I am happy to say he was once a Southlander, who came to Canterbury and in a period of 16 years he has multiplied his carrying capacity by at least five. I asked him whether there is much land around him capable of the same increase. I am assured that there is. Now, my point is simply this, that there is a man who is doing it. He is using the knowledge that we have available to us today. There are other cases that we know of where under similar soil and climatic conditions some farmers can obtain production per acre about 100 per cent above that of others. The achievement of this level of production is an indication that they have achieved much more efficiency in the use of their resources of capital and labour. Now to my mind increasing production means in part at least the narrowing of this gap and as I understand it, Sir, this Conference is dedicated to narrowing that gap. Because of that I have very much pleasure in declaring it officially open.
INCENTIVES FOR INCREASED OUTPUT OF FARM PRODUCTS

W. V. Candler, Professor Agricultural Economics and Farm Management, Massey University of Manawatu.

I propose, this morning, to present a proposal for a thoroughgoing revision of the income tax laws as they affect farming. Before presenting these ideas I would like to make it quite clear that they are long term proposals. The proposed changes are fundamental, and considerable detailed study would have to be given to the scheme, before all the objections to it could be said to have been fully met.

In considering the title of this talk "Incentives For Increased Output of Farm Products," it appeared to me that I could either present a shopping list of the sort of small, ad hoc, concessions that I felt farmers would like, and were entitled to, or I could discuss the principles behind my proposal to replace income tax by a land or factor tax. I have chosen to do the latter; this is partly because I am sure the tax change is a more important way of providing an incentive than the sort of short-run budgetary changes in abolishing death duties, accepting increases in farm livestock as a normal tax deduction and providing a fertilizer subsidy; because everybody is in favour of concessions—so there should be no argument before this type of audience; and, partly, because the ideas behind the tax change need to be explained.

I would now like to discuss why we need incentives for increased farm output, how we can judge the success of a taxation system, and the effect of the present system of farm taxation on the incentives for farm development.

THE NEED FOR INCENTIVES

The need for incentives for agricultural production, stems from the need to increase agricultural exports. This in turn rests on our population, of less than three million people. A population of three million in New Zealand can never hope to be economically self-sufficient, whilst retaining anything like our present living standard. From the viewpoint of manufacturing many industrial products, a market of three million cannot support an economical level of production; defence equipment, machine tools, cars, cameras, and it would seem bicycles are amongst the items on which we cannot hope to compete effectively with overseas. In addition there are many raw materials we cannot produce: cotton, petroleum, potash, and rubber are items which come to mind. And, finally, there are the so-called "invisible items" such as transport charges, overseas tourist expenditure, interest on overseas investments in New Zealand, and the like which have to be paid for. There is a minimum below which these items cannot be reduced. Further, our import demands for these goods will increase both with population, and any increases in our standard of living.

Further, it is important to realise that at the present time exports of goods manufactured from imported raw materials, just don't count as a source of foreign exchange. A recent, and very interesting
analysis by Dr David Carr of Auckland University showed that in 1962-63 goods manufactured from imported raw material earned £1,700,000 foreign exchange, or 0.56 per cent of our overseas earnings. That is, total exports of goods manufactured from imported raw material accounted for roughly half as much as the wool industry is spending overseas simply to promote wool sales! This leads us back then to exports of indigenous raw materials, and specifically to agriculture.

The Targets Committee of the Agricultural Development Conference has considered New Zealand's future export needs, and they conclude that to attain a 2 per cent rate of growth in real income per head, pastoral exports will have to rise by 4.1 per cent, and pastoral production by 3.8 per cent per year. This is approximately 50 per cent faster than agricultural production has expanded in the last decade.

I think it would be generally accepted that there is no technical difficulty in increasing production. As a generalisation, I think it would be fair to say that if additional labour was available, and taxes and death duties were abolished there are few farms where production could not be expanded by at least 50 per cent. Certainly, the New Zealand Institute of Agricultural Science, at its Annual Conference at Massey last year, estimated that Agricultural production could be increased by 82 per cent with present knowledge, and present levels of management ability.

Thus, on the one hand we have the need to double the rate of expansion of agricultural production, and on the other hand the technical ability to do the job. If the nation was at war, the remedy would be simple—round up a few good speakers and send them out to stump the country exhorting farmers to achieve 100 per cent of potential production “for the sake of the boys at the front.” We are not at war, and the present levels of taxation, shortage of agricultural labour, lack of really suitable credit arrangements, limited research and extension services, and the like, are the conscious, or unconscious, results of Government policy. In short exhortations, especially Government inspired exhortations to produce more, are unlikely to produce even one extra blade of grass.

In peace time, the test for the individual farmer of whether to produce more, must be the test of profitability—will it pay him to produce more? If the Government, or the nation as a while, requires increased agricultural production, it is up to the Government, or the nation as a whole, to ensure that individual farmers find it profitable to produce the needed extra production. Hence the need for us to discuss incentives today.

OBJECTS OF TAXATION

The primary objective of taxation is to provide the Government with the resources needed to carry out the tasks allotted to Government by the voting public, without causing undue inflation. (It is interesting to note that taxation is not primarily to provide the Government with money, since the invention of the printing press ensures that this is the one commodity which Government can be sure of having in abundance. Rather, taxation is to transfer resources and prevent inflation.)
In addition to financing the Government, taxation may use used:

(a) To affect Income Distribution. Thus it is common in non-communist countries to collect very much more tax from the rich, than from the poor. Government services, on the other hand, are mostly provided on a per capita basis. The consequent redistribution of income is acceptable to the majority of voters.

(b) To affect Production Decisions. Thus the decision to make fencing, drainage and some other forms of land improvement is designed to encourage farmers to undertake land improvement. The limitation of tax reductions for research and higher education to £25 per year per person, is presumably to discourage this type of activity being financed from private sources and so on.

Thus a taxation system may be judged on how well it provides Government financial requirements; how it affects the production and distribution of wealth, and finally the brains and resources tied up in attempting to collect and evade taxation. In New Zealand, our highly (some would say over-highly) developed sense of social justice leads us to pay prime attention to the distribution of wealth. The production of wealth is almost taken for granted.

As many of you here will agree, a progressive income tax would seem to provide for all conceivable Government expenditures, is deplorably simple to collect, and from the redistribution point of view it is a humdinger.

We have, however, seen that in agriculture, at least, it is no longer satisfactory for us to take increased production for granted. Over the last decade we have had half the rate of growth we are going to need over the next decade.

One further observation on taxation. On the production side, all large industries other than agriculture, are either non-tax paying (railways, universities, schools, co-operative factories, etc.) or subject to flat rates of taxation. That is, agriculture is the only large industry where the typical productive unit is subject to progressive taxation.1

THE PROFITABILITY OF DEVELOPMENT

Before examining the effect of the present system of taxation on the profitability of development, it is important to define what we mean by the “profitability of development.” I would like to propose three reasonable measures:

(i) The Payback Period: This is the time it would take the farmer to pay off his overdraft, if he financed his development programme entirely by borrowing. Alternatively, this can be thought of as the length of time before he has extra funds available to spend on himself.

(ii) Tax Free Value of the Development Programme: This may be expressed either as a capital sum (a once and for all gain, similar to winning the lottery) or as an annual payment. By the “tax free value” I mean the value of the extra income available to the farmer

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1 Exceptions to this would be small retail outlets, accountants, doctors, and many small partnerships. It is open to debate whether any of these represent “a large industry.” Even if they do, the major distinction between taxation of production in agriculture and many other major industries, remains.

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for personal expenditures (i.e. after taxes have been paid). During
the initial development period, the farmer will not have any extra
income available to him, but after paying off his overdraft he may
receive quite a substantial income after tax. These future earnings
can be converted (by discounting) into an equivalent single sum
(capital payment) at the present time, or into an equivalent series of
equal annual payments.

(iii) Return on Capital: The return on capital may be defined as
the annual profit (before tax) of the development programme divided
by the capital sum needed initially to avoid having to borrow to
undertake the development programme. This measure is conceptually
similar to the rate of return on capital invested in industrial shares,
or Government stock.

Table 1 shows how these various measures are affected by several
different types of taxation arrangements.

This table is based on the development programme for one parti­
cular farm. It enables us to see that progressive taxation may have
a powerful disincentive effect on farm development. At the same
time it is important to realise that this farm may not be by any
means typical. This reinforces the earlier comment that the proposed
change in the taxation system needs much more careful examination
than it has been possible to give it to date.2

The basic features of the development programme involved scrub-
cutting and pasture establishment on about 1,500 acres of steep hill
country, to raise carrying capacity from 1.9 to 5.2 ewe equivalents
per acre, over a nine-year period. Only the first three years of the
development programme have been completed so far. Costs and
returns have been estimated on the basis of prices ruling in 1962-63,
not 1963-64.

Details of Case Study of Progressive Taxation: The various
entries in Table 1 can now be discussed.

Row 1: “No Tax”: This row reports the profitability of the
development programme in the absence of any sort of taxation. In
a sense this gives the profitability of the investment “to the com­
munity,” since it may be assumed that funds actually taken for taxa­
tion, are later spent in a way which benefits some other members of
the community. Metaphorically, row 1 gives the true size of the
“development cake,” the other rows give the “size of the cake” as it
appears to the farmer after taxation has been “sliced off.”

Looking along row 1, we can see that in the absence of taxation
it would take the farmer nine years to pay off his overdraft (if all
development was financed from borrowing), or that the development
programme adds £55,405 to the nation’s capital assets which is equiva­
lent to an annual tax free income flow of £3,324 or that the develop­
ment returns 35.2 per cent on capital.

Row 2: Income Tax: This row gives the profitability of the
investment at 1962-63 tax rates, if the farmer does not claim any

2 The difficulty of getting any factual information on the economics of New Zealand
farming is illustrated in this case farm. The data was collected, and analysed by
Mr. Alan Wright in the course of his Master’s thesis at Massey into “The Profitability
of Development of some Classes of North Island Hill Country.” To do this thesis,
Alan Wright had to take leave without pay from the Department of Agriculture. His
total income for the 18 months of the full study was £250 contributed by the N.Z.
Wool Board, and the relevant Producer Boards were unwilling to make any contribution
towards the travelling costs inevitably involved in this sort of study—the wonder is that
anyone takes any interest in the welfare of our primary industries at all.

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deductions for the cost of his development programme. The first two columns give the annual tax payment, with and without development. We can see that the development programme would raise the Inland Revenue Department's income from the property from £288 to £2,517; the pay back period has been increased from nine to 15 years; tax free capital sum has been decreased from £55,405 to £15,742; and the return on capital has been reduced from 35.2 per cent to 13.9 per cent. These are very substantial changes!

Row 3: Income Tax (with deductions). This row again relates to 1962-63 tax rates but allows all capital expenditures to be claimed as tax deductions in the year incurred. In this row the value of increased stock numbers has been counted as a "cost" in the year when stock numbers were increased. Thus the tax deductions allowed are rather more generous than actually allowed at the present.

At the same time, it is important to note that row 3 does not take advantage of the farmer's right to spread the claims of development costs over a five-year period. In this sense row 3 underestimates the generosity of present legislation.

To my mind, the important feature of row 3 is how little help the deduction of development expenses is, in restoring the "true" incentive payments, recorded in row 1.

Row 4: Income Tax (with deductions) and Death Duties: This row repeats row 3, except that it is assumed that death duties are paid by the farm every 30 years (and that no attempt is made to avoid these duties!) For the purposes of this calculation it is assumed the farm was worth £20,000 before development, and that after development its capital value was increased by capitalising the extra before tax earnings at 5 per cent.

Row 5: Factor Tax. This row merely emphasises that the factor tax, to be discussed below, leaves the farmer with the "true" incentive payments recorded in the row 1. The amount of tax collected will be the same before and after development, and will depend on the method of assessing the factor tax. This is also discussed below.

### TABLE 1

**Taxation and the Apparent Profitability of Farm Development**

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<th>Taxation System</th>
<th>Annuity Tax Collected</th>
<th>Pay Back Period</th>
<th>Present Value (Tax Free)</th>
<th>Annuity (Tax Free)</th>
<th>Return on Capital</th>
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<tr>
<td>No Tax</td>
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THE CASE FOR THE PROSECUTION

The case for the prosecution, Ladies and Gentlemen, is simple: As shown in Table 1, the present system of progressive taxation so distorts the true profitability of, at least some, farm development programmes, that they will simply not be undertaken by individual farmers, even though they are extremely profitable to the nation as a whole.

If we continue with progressive taxation in its present form, we must expect very many farms to continue to produce at about 50 per cent capacity, because as much as five-sixths of the benefit of increased production goes in practice to the Inland Revenue.

More liberal tax deductions and the abolition of death duties would improve the situation, but basically progressive taxation is incompatible with providing incentives for increased agricultural production.

THE CASE FOR THE DEFENCE

A case for the retention of the present tax system could be developed on the basis of any of the following three arguments:

(i) Maybe we don't need increased agricultural production at all, or

(ii) The particular case cited is exceptional, and other farms show a much closer relation between private and national rewards, or

(iii) It is impossible to devise a better tax system.

I trust that no one who has listened to the Minister of Agriculture this morning would feel inclined to argue that increased production is not needed.

Rebuttal of the second defence would need far more research resources, than we can expect at Massey whilst gifts for agricultural education and research continue to be taxed.

Accordingly, I will now attempt to rebut the third defence by the presentation of a better tax system.

THE FACTOR TAX IN BRIEF

Briefly, the factor tax proposes that each farm should be assigned an "effective acreage of an appropriate land class." An appropriate tax per acre would be derived for each land class, and a farmer's tax liability would merely be his acreage multiplied by the appropriate tax per acre.

That is, tax liability would be divorced from actual production on individual farms.

This divorce would mean, of course, that increased production, and increased income could be achieved without an automatic increase in a farmer's tax liability. And, by the same token, a farmer with a low level of production, and low income, would be taxed as if he had average production and average income.

Let's make no mistake, I am proposing a fundamental change in the tax structure. If introduced, it would allow an efficient and progressive farmer in a backward district, to become a very wealthy man in a relatively short time. Looking at the other side of the coin, we see that a farmer who has in the past been operating a large
holding at a fraction of the intensity of his neighbours (and by virtue of low income has incurred little tax), would find himself forced either to increase the intensity of his farming, or sell out. It is quite conceivable that some backward farmers would find their tax liability exceeded actual farm profits.

The proposed factor tax would provide incentives to increased production, both the carrot of retaining all the profits from above average efficiency, and the stick for inefficient farmers of being taxed as if they were average.

I should perhaps emphasize, at this stage, that I am attempting merely to put the case for a factor tax to you. I think the case is a strong one. Whether it is strong enough depends mainly on how badly the country wants increased agricultural production.

ADMINISTRATION OF THE FACTOR TAX

Any number of variants of the above basic proposal can be put forward. For what it is worth, I propose the following general scheme. The steps to be taken in introducing the tax would be:

1. **Definition of “Soil Productivity Classes.”** These productivity classes would be related to soil type, topography, and climate. The aim would be to include at least 100,000 acres in each productivity class, and 250,000 to a million acres would be preferable. Potential productivity classes which suggest themselves would include “South Taranaki—Undulating,” “Wanganui Hill Country,” and “Central Plateau Volcanic Ash.”

2. **Definition of “Effective Farm Acreages.”** Actual farm acreages within each soil type could easily be obtained. An assessment would then be needed on each farm to see if there were any reasons it could not be expected to produce as well as good farms on this soil type. Particularly bad contour, erosion problems, and low inherent fertility are the main reasons that come to mind for assigning a farm an “effective acreage” less than its actual acreage. There would, of course, have to be provision for “appeal” against assessed acreage.

3. **Calculation of “Average Profit per Acre.”** To calculate “average profit per acre” farm accounts would be collected from all farmers on each soil productivity class. Ignoring interest payments, this would allow the calculation of an “average profit per acre” over all the “effective acres” in the soil productivity class.

4. **Calculation of “Standard Farm Profit.”** Standard farm profits would be defined as:

   Standard Farm Profit: 
   
   \[
   \text{Standard Farm Profit} = (\text{Effective Acres} \times \text{Average Profit per acre}) - \text{Interest Payments}.
   \]

   That is, it is the average profit per acre, for the soil productivity class, multiplied by effective farm acreage, with a deduction for any interest payments actually made.

Having defined the Standard Farm Profit, we may then opt for either of two schemes “A Factor Tax with Progressive Income Tax” or “A Factor Tax In Place of Progressive Income Tax.”

SCHEME A: A FACTOR TAX WITH PROGRESSIVE INCOME TAX

This is very simple; the farmer fills in his income tax return, essentially as at present, but in place of his actual farm profit (used at present) he puts his standard farm profit.
SCHEME B: A FACTOR TAX IN PLACE OF PROGRESSIVE INCOME TAX

In the case where a farmer has no other income, this system is also simple. The standard farm profit is simply multiplied by the appropriate tax rate (a rate set for agriculture as a whole, say 4/- in the £).

Where the farmer has other sources of income, Scheme B appears rather more complicated. We take the standard farm profit plus other income, and use this total (with the normal progressive tax tables) to calculate "a standard tax liability." Actual tax liability is then this "standard tax liability," multiplied by the fraction which "other income" represents to total income, and added to "standard farm profit," multiplied by the appropriate tax rate.

This is better seen with the aid of an example.

EXAMPLE: Consider a farmer with,
An Actual Farm Profit of ......... £2,000
A Standard Farm Profit of ......... £1,000
Other Income of ................. £500

Then under our present system he pays progressive tax on £2,500 (i.e. Actual Profit plus other income).
Under Scheme A he would pay progressive tax on £1,500 (i.e. Standard Profit plus other income).
Under Scheme B, we would first calculate the progressive tax on £1,500 (i.e. on Standard Profit plus other income), and call this "standard tax liability." Then his Actual Tax Liability would be:

\[ \text{Actual Tax Liability} = \left( \frac{\text{£2500}}{\text{£1,500}} \right) + (\text{Flat Rate} \times \text{£1,000}). \]

EFFECTS OF THE FACTOR TAX

The immediate effect of the factor tax would be to transfer income from inefficient to efficient farmers.

It would certainly hasten the decision of some older farmers to retire, and might force some inherently inefficient men off their farms.

Unproductive land, in productive areas would fall in price, since it would become a serious financial liability.

Unproductive land in unproductive areas would probably increase in value since anyone developing it, would be assured of a tax free income until the rest of the area was developed.

With the recognition that large profits would be made, there would probably be an influx of a new type of young, aggressive and well-trained men into the industry, either as managers or owner operators.

Under scheme A, a farmer would have a big incentive to farm his land well, though acquisition of additional land would increase his tax liability progressively (though no doubt less than at present). Under scheme B, the incentive to acquire additional land would be the same for farmers of all sizes. There would be no falling off of incentive as scale was increased.

DIFFICULTIES

A number of real difficulties exist with this proposal. Questions which will come to your minds probably include:

(a) What about re-assessment of effective acreage?
This should only be necessary infrequently. Land valuation
depends on technical change, and prices. Since prices move continu­
ally, land valuations have to be constantly revised. Effective acreage
on the other hand would only need to be re-assessed on the basis of
technical changes—and technical changes which affected some, but
not all, farms on a soil productivity class. The introduction of aerial
top-dressing has, for instance, reduced the difference in productivity
of ploughable and unploughable hill country. This sort of technical
change might necessitate revision of effective acreages. But these
revisions would take place in response to particular, specified, changes
in ways of farming.

(b) What about changes in average farm profit?
As the inefficient are forced to leave farming or improve, the
whole level of farming efficiency should rise. Farmers would feel
themselves under a continual gentle pressure due to the improvements
they, and their neighbours were making. This I think is a thoroughly
good thing!

(c) What about changes in the flat rate tax Scheme B?
As total agricultural output expanded, we might expect Govern­
ment to wish to increase the total tax take from the industry. In this
case the setting of the appropriate tax rate would be a major politi­
cal decision (as are decisions with respect to any tax rates!) We
may note that this difficulty does not arise under Scheme A.

(d) What about the sort of tax concessions currently available to
farmers undertaking development?
I hope I have shown that the value of these concessions is not
great. These concessions appear great, during the development
period since tax is often not paid at all for several years. But this
is at the expense of penal tax rates once the development has been
completed.

In fact, I believe the factor tax would make it easier for a young
and able man to become established in farming. The increased tax
on unproductive land would force this type of land on to the market,
and the increased supply would tend to reduce prices. Farmers
would tend to retire earlier as they found they could not stand the
pace, and the long run profits from successful development pro­
grames would justify more adventurous lending policies to young
and able men than are currently usual.

**OBJECTIONS**

A number of objections can be raised against the factor tax.
I will try and deal with the more obvious of these:

1. **This would involve treating agriculture differently from the
rest of the economy.**

That is dead right. The objective is to get increased agricultural
production; the factor tax will help. In any case we expect to treat
different sectors of the economy differently, take the export incentive
scheme, where firms get a proportion of their net profit tax free, in
relation to increased export sales to total sales. Apply this to agri­
culture and you get all taxation on increased production wiped out at
once!

2. **The derivation of "Effective Acreage" would be arbitrary,
to some extent.**
This is true, but so is the assessment of income tax at the present time. There is no reason to believe that major errors would be made frequently. In any case, to some extent these errors would be self-correcting. Farms where the effective acreage had been set lower than its "true" value would tend to sell for a higher price. A new entrant into agriculture could buy a relatively expensive farm, with a relatively low effective acreage or a cheaper farm with a correspondingly higher tax liability. That is, to some extent, any errors in assessing effective acreage would be self-correcting.

3. The Whole Scheme would be Politically Unacceptable.

I am tempted to respond to this argument with simple abuse and say that the alibi of "political unacceptability" is the instinctive reaction of people who do not understand what is proposed, see nothing wrong with the status quo, and have no intention of understanding the past or the future.

But more seriously, as to whether either scheme would be politically acceptable depends on the one hand on how badly we want extra agricultural production, and on the other hand on the relative strength of traditionalist and progressive attitudes in the farming community.

Obviously the members of this audience are better qualified to tell whether the factor tax would be "politically acceptable" than I am. You are as the American's say, "the grass roots," or, as we say, you have the votes.

FINAL THOUGHTS

My own views on "political acceptability" may be put as follows: I believe we will eventually abandon the auction system for wool—when the Wool Commission holds £20,000,000 worth of wool.

I believe we will introduce the factor tax, Scheme A, when we have borrowed £20,000,000 from the International Monetary Fund, and I believe both of these events will take place at about the same time, say between two and six years from now.

In the meantime we should be studying what we will put in place of the auction system, and the best method of administering a factor tax.

Finally, let me make it clear that:
I don't say the factor tax is a perfect tax.
I don't even say it is a good tax, but
I do say, that from the point of view of increasing agricultural production, it is from 300 per cent to 500 per cent better than the present method of taxation.
Mr D. G. Tomlin:

Mr Roberts and I are going to talk about a farm which I and my two sons—Lester and Max—have been developing at Whitecliffs over the last three years. I am going to tell you how we bought the farm and what we did over the first year. Then Mr Roberts of the Lands and Survey Department is going to tell you how he was able to help us through Marginal Lands finance. Finally, I will tell you how we used this money to continue of development plans.

In 1961 the family came up from Lumsden to look for a farm. We had sold nearly everything. I was a barber but I had a small 30-acre farm. Lester, who is married with two children, sold his house. He was a shearer and contract fencer. Max has done all sorts of jobs from contract baling to casual farm work. Then I have another son still at school.

We formed a company and pooled our funds which came to £11,000 plus three cars, a truck, a crawler and a baler together with a selection of dogs. We searched for a farm which came within our capital limits. We also wanted one that was reasonably handy and one that had room for development. I have had a keen interest in sheep dogs having once been a high country musterer, so we had to have a hill place to keep the dogs right.

Fortunately we found a 1335-acre farm at Whitecliffs. It had two houses which we needed for the two families and there was a good shed and yards. The farm was bought for £19,000 as a going concern. It carried 600 ewes, 125 hoggets, 10 rams and 13 mixed cattle. We took over in May, 1961.

The farm was mostly in tussock and poor grass when we took it over and much of it still is because we have only scratched the surface so far. There are 842 acres in the back block in poor tussock with scattered gorse and manuka. The tussock on the first block was slightly better and there were a few acres of fair grass near the homestead. This is clay downs country and about half is ploughable. I am told the soil is known as Glenroy silt loam. The rainfall is about 40 inches and the winter is hard and long because the altitude is between 900 and 1500 feet. In fact this is much like Southland where we came from.

What did we do first? With the T.D.6 crawler brought up from down South we ploughed 33 acres in two blocks. Ten acres were sown back to grass and oats in the first spring to give us a cut of hay for much-needed winter feed. The remaining 23 acres were sown in swedes on the ridge.

We were told that it was no use trying to grow swedes. However, Southlanders may be Scotsmen by ancestry but they are not mean when it comes to putting on fertilizer. The climate seemed much the same so we put on 2cwt of borated super before sowing, together with 3cwt of reverted super which was sown with the seed. The swedes are first-class. When the swede paddocks go back to grass we sow another 3cwt of super and this then gets followed by 1cwt every
year afterwards. I do not think this is luxury rate; in fact, I believe we could profitably use even more fertilizer.

To get back to our story. We had to shift a quarter of a mile of fence to give a suitable block for ploughing. The three of us built one mile of new fencing together with a bridge, culverts and three-quarters of a mile of track. Lester sheared that season bringing in £800 while Max went south for lambing and brought back a cheque for £200.

As you can see, this kind of programme costs a great deal of money. There was just not the income coming in from this store sheep property to keep the three of us and to finance the improvements we wanted. So we went and saw Mr George Watt, Commissioner of Crown Lands, and applied for a Marginal Lands loan of £5,000 for fencing, grassing, aerial topdressing and plant.

Mr Roberts:

I first met Mr Tomlin and his two sons in May, 1962. As a Field Officer with the Lands and Survey Department, part of my job at that time was to make reports on farms where there was an application for Marginal Lands loans. After my report, the local Marginal Lands committee inspects the farm. This committee consists of the Commissioner of Crown Lands or his representative, an experienced local farmer and a Farm Advisory Officer of the Department of Agriculture. They discussed my report and the farm and in this case they agreed to recommend the loan to the Board in Wellington who make the final decision.

Mr Tomlin's case will make it clear the kind of requirements the Board needs before it will help. The Field Officer looks at these factors—the farmer, the farm, the financial position and the proposed development plan.

The Farmer: The farmer is the most important factor determining success or failure in land development. If we don't think he has the enthusiasm, the experience, the ability to stick at it and the managerial capacity then we do not lend. The diagnosis was quite easy to make on the Tomlin's farm. After a day with them I saw they had these characteristics from what they had already achieved. Further Max and Lester had been prepared to work off the farm to bring in much-needed finance.

The Farm: Mr Tomlin has already described the farm and the improvements made in the first year. Obviously the property was marginal at the time but there was scope for development. It had never been cultivated, oversown or topdressed except for a few small areas yet it had a good range of buildings. With cultivation, topdressing and oversowing, subdivision and water supply I estimated that it could carry 2,500 ewes and replacements together with 80 cattle.

Financial Position: I valued the property, stock and plant at £23,000. The indebtedness was £10,000 leaving an equity of £12,000. This was a fairly good margin of security for a Marginal Lands loan. I also estimated that after two years of development the property, stock and plant would be worth £28,000. The indebtedness would have risen to £14,000 leaving a £14,000 equity.
Proposed Plan: Together we discussed the development programme which the Tomlins had in mind for the next two years. In the first year they planned to sow 40 acres in swedes out of tussock and sow down 40 acres in grass. They also planned to topdress and oversow 80 acres with the aeroplane. They needed a new Fordson diesel tractor and a second-hand drill. In the second year a further 50 acres of tussock would be put into swedes and the previous year's 40 acres would have to be sown into grass. In the programme we planned for two miles of fencing material. The cash cost was £2,000 in the first year and another £1,000 in the second—a total of £3,000. We also worked out the costs of a further two-year programme along the same lines. The Tomlins could apply for another loan of £1,000 per year if they wanted it and if the Marginal Lands Board thought further finance for development could not be obtained from income. We also granted an additional loan of £320 for two small haybarns.

After my inspection, I could see that the four factors I have mentioned were satisfactory—the farmer, the farm, the financial position and the proposed development plan. I considered that the loan would be in the interests of the Tomlins and in the interest of the national economy. Before Mr Tomlin tells you how their proposed plan worked out, I should like to say something about terms of Marginal Lands finance. There are many misconceptions. Some farmers come to the office with the idea that loans are interest-free. Others think that we will lend money to purchase a farm. We don't, but we can assist farmers to buy extra land where their present holding is uneconomic. In general we lend for development.

Terms of Marginal Lands Loan:

1. Marginal Lands loans are not available to farmers who can obtain finance elsewhere. We are not competing with other lenders. All we are doing is to lend money to those who can't get it elsewhere. We are the full-backs.

2. Like any other lending institutions we lay our hands on any security we can. For instance, we took a second mortgage over the Tomlin's land and improvements, a second Bill of Sale over the stock and plant and a first Bill of Sale on the diesel tractor and the second-hand drill acquired with Marginal Lands finance. There was more security here than on many Marginal Lands cases.

3. The loan is not granted in one lump sum but is paid on accounts which result from the work done. The Tomlins send each account to me as their field officer and I pass it for payment. We pay the firm for the materials purchased and charge this against Tomlin's Marginal Lands account. I have to see that the amount set aside for each item is not overspent and check that the Tomlins have completed this work. However, sometimes we have more variations in the farming plan to suit seasonal conditions.

At present the interest charge is 5 per cent if we have a first mortgage or 5½ per cent for second and subsequent mortgages. This current account system means that farmers do not have to pay interest until money is actually spent, which is an advantage.

4. Once development has been completed or has reached the stage where the farm can stand it, the loan is converted to an Instalment Mortgage with interest rates at 5 or 5½ per cent as for current
account. The Board decides the terms of the mortgage. The term varies from farm to farm but is often twenty to twenty-five years.

Marginal Land finance is for development. Often we lend with very little security. Consequently we have to get more facts before we lend than others because we are charged with taking greater risks than any other lending organisation. Our security is the man and future production he will achieve.

Mr D. G. Tomlin:

With Marginal Lands help we carried on developing the farm which otherwise would have been impossible. Over the last two years we have sown down over a hundred acres of grass. We sow in the spring using a bushel of perennial ryegrass, half a bushel of H1, half a bushel of winter grey oats together with 2lb of cocksfoot, 1lb of timothy, 1lb of dogstail, 4lb of Montgomery red and 4lb of white clover. This is sown in 3/4-inch coulters. The diesel tractor has been most satisfactory. It has dual steel wheels and allows us to work safely on country which would normally be thought of as being only suitable for a crawler. We got the idea out of the “New Zealand Farmer.”

Most of the sidelong paddocks are too steep to plough so we topdressed 80 acres in the first year under Marginal Lands and a further 80 acres this year. These areas get 2cwt of molybdic super the first year, 2cwt of ordinary super in the second year and we plan a 1cwt dose per acre thereafter. Fortunately Mr Austin Ebert of the Department of Agriculture had completed trials on our sidelong paddocks before we came so we have had excellent local information to go on. It was he who put us on to molybdenum as a substitute for lime and he also told us that sulphur was probably not necessary. He will be following this up with further trials.

The oversown sideling paddocks get special treatment. First of all we bare them down in the winter by using them as a run-off from the swedes. This opens up the pasture and consequently there is a most satisfactory take of clover when the plane flies on seed and super in the spring. We have used up to 10lb of “thirds” clover to the acre.

Over the two years we have carried on with the fencing at the speed of one mile per year and put up the two haybarns with Marginal Lands’ help. Lester continued shearing and Max learnt. Between them they brought in £1,000 per year.

So far we have concentrated on the pasture rather than the stock. The flock had too many old sheep in it when we took over and we bought four-year-old sheep one year, because of shortage of money, which has not helped matters. Wool weights are around 7lb and the lambing percentage is only 80 per cent. The hoggets have been troublesome and losses have been high until we got on to selenium. This year they are doing well.

The ewes are being bred to Romney-Lincoln rams this year to get a more open fleece which perhaps will be more suitable for this wet climate. They will be crossed back to the Romney later on.

Whitecliffs has a tough winter and a late spring. The feed at this time limits the stock numbers we can carry. With a good summer rainfall and extensive tussock areas in the rough there is no
feed shortage in the summer. So far for every extra 40 acres sown in new grass we can feed an extra 300 ewes at lambing time. This means that instead of 600 ewes the farm now carries 1,500 ewes, 450 hoggets, 18 cows, 19 yearling heifers, 50 rams, 40 old ewes for dog tucker and 50 wether lambs for the house. This is a threefold increase in stock numbers in the three-year interval. Debt with the stock firms has increased by £2,000 to buy extra sheep.

Has it been worthwhile? Mr Roberts tells me that the farm is now worth about £34,000. Our indebtedness is now up to £15,000: on paper the value of company assets is about £19,000. You will remember we had £11,000 to start with so we have made a gain of £8,000 in three years. We could only have made a gain of £4,000 over three years in Southland, so roughly speaking and on paper we have made £4,000 gain in assets. However, this is only theoretical. In practice we have been doing what we wanted to do. We have got our farm and we are developing land.
FARM DEVELOPMENT IN SOUTH CANTERBURY

J. L. Steel, Farmer, Pleasant Point.

The property of 3,033 acres known as Langley Downs, was purchased in June 1948. It is situated in the Levels County of South Canterbury about 16 miles from Pleasant Point. It varies in altitude from 500ft at the lowest to 1800ft at the highest point, which overlooks the downlands and plains of Canterbury towards the east, and Fairlie district towards the west. The property could best be described as long rolling downs cut by gullies.

In June 1948 the property, carrying 1,400 ewes, 650 hoggets and 150 breeding cows was most unattractive. It was bleak and desolate, as a farming proposition, it was heavily infested with gorse and what could be termed pasture, was basically browntop and fescue. With the exception of 25 heifers bought in in 1951 the stock, both sheep and cattle at the time of purchase were used as the nucleus of the present stock on the property.

The improvement, naturally, has been brought about by the use of bought-in rams and bulls.

The soil types are Kakahu, Opuha and Rapuwai silt loams, all responsive to lime phosphates and sulphur. Excellent results have been obtained from sulphur super in the presence of lime and molybdenum, therefore no difficulty has been experienced in getting the scheme going, occasioned by fertilizer problems.

There was no higher thought of the good of the country or the welfare of the community, in the aims and ambitions for the future of this property. It was bought simply to make a living, and something had to be done about it, but in those first four years we wondered how we would ever get round it. After the third year we could see definite possibilities and we then thought that if we could get the property developed we could carry the equivalent of 10,000 ewes. The previous owner had limed one paddock with obvious results and our experience with lime in Southland gave an indication that herein lay its definite possibility and since then we have spread over 9,200 tons.

A small wheel tractor was the only tractor on the property, but with the addition of a D2 crawler we managed to get all our work done for the first four years after which we got a bigger wheel tractor and a blade for the crawler and from this point the development was easier and really went ahead.

We started ploughing 100 acres a year for winter feed, but gradually stepped that up getting as high as 200 acres one year, but now it ranges between 120 acres and 160 acres depending on the size of the paddocks. To begin with, the paddocks were selected from those having the least amount of gorse and to clear as much as we could we mounted a Vee-prong on the back of the crawler to root out the big old-man plants that dotted the areas to be worked, but after we got the blade we worked out from the homestead.

Our rotation, which is a simple effective one, and consequently inflexible, is from the gorse and browntop to swedes and turnips with 2 tons of lime spread before, and 3cwt reverted super at sowing. This is followed by rape and grass with another 2 tons of lime and 3cwt
reverted super. Then an increase in stock to turn the extra grass grown into meat and wool. For the first ten years we made it a habit to increase our stock by four ewe equivalents for every acre of grass sown. At the moment we've got two years to go before we finish breaking in the original, except for the many dirty corners and steepish faces that were left on the first time round, when we hadn't the time or the machinery to do them.

As most of you will be aware you have to start the second round to maintain good pastures. This has meant a slowing down of the breaking-in programme, but it has also resulted in better swedes and turnips.

Originally new pastures were topdressed annually with 1cwt super; nowadays with 1cwt fortified super followed with 1cwt super the next year. Some people will argue that we don't require the super the following year, but that's the way I like to do it. Initially we use the highest rate of sulphur but this will be reduced to the lower rate subsequently. Each year we use at least 130 tons of various forms of super and we have oversown and topdressed 150 acres of rough, stony out-crop at the back of the property with excellent results. Up till now we've put on 9,200 tons of lime and 1,200 tons of super.

The fencing on the property was, as you could imagine, poor to bad, but for the first two years we used willow posts. We couldn't afford anything else, and besides, willows grow on the property. Since that early period we've started into concrete with eight-wire concrete cattle posts and are now getting the fencing problem solved.

The water supply generally wasn't too bad, creeks flowing through the property could normally handle the requirements of the stock. The drought of 1956 convinced us of the need to supplement the normal supply with storage dams strategically placed. In the altitude regions 1,000ft to 1,200ft where the homestead and houses are, water is short, so we put in a pumping scheme from a bush creek which supplies water to the houses and paddocks, and we have reaped the benefit this year.

The original stock on the property was:

- 1,400 ewes
- 450 hoggets
- 30 rams

**2,080 TOTAL SHEEP** and **150 BREEDING COWS**.

This year we will go into the winter with:

- 5,300 ewes
- 1,800 ewe hoggets
- 240 wether hoggets
- 120 rams
- 120 wethers

**7,580 SHEEP** and **560 CATTLE** including **200 COWS**.

As I said this flock has been bred up from the original taken over with the property. Our policy was to hold on to all ewe lambs. Except for the first year when we sold store wether lambs our policy has been to fatten the wether lambs, all ewe lambs are wintered and what
we don't require are sold at the two-tooth fair and the ewes are sold in an annual draft at the fairs.

We are getting more and more lambs fat off the mothers this season, getting 1,900 this year. In 1961 we bought in 2,000 lambs to fatten, having had an exceptional crop of rape and grass and we'll continue this policy as conditions permit.

Since 1957 all cattle have been fattened; before then we sold calves and this year we sold 70 calves owing to the shortage of enough suitable winter feed.

It would be appropriate here to give you some indication of wool production over the years.

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<th>Year</th>
<th>Sheep Shorn</th>
<th>Lambs Shorn</th>
<th>Bales</th>
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<th>Wool per acre</th>
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</tbody>
</table>

It would be very hard to give sheep and cattle sold this way, as the surplus for sale depended entirely on the number one was increasing the flock and herd.

Therefore probably the best way to give you an indication of the profit would be to indicate the percentage return on capital based on Government valuation of the land and book values of stock and plant. But I had better mention that the Government valuation has increased by 500 per cent since the property was purchased.

<table>
<thead>
<tr>
<th>Year</th>
<th>Return on Capital (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949</td>
<td>-7.9</td>
</tr>
<tr>
<td>1950</td>
<td>1954 15.5</td>
</tr>
<tr>
<td>1951</td>
<td>-1.5 1955 10.9</td>
</tr>
<tr>
<td>1952</td>
<td>23.3 1956 9.5</td>
</tr>
<tr>
<td>1953</td>
<td>11.7 1957 21.2</td>
</tr>
<tr>
<td>1954</td>
<td>7.7 1958 9.8</td>
</tr>
</tbody>
</table>

Having managed properties in Southland for 13 years, by 1948 my wife and I decided to have a go ourselves and settled on Langley Downs and were able to meet just about 50 per cent of the value of land, stock and plant. Before buying we formed a trust for our three children and purchased the property for my wife, myself and the trust.

You will all agree that when you have limited resources in a venture like this, you've got to consider every avenue which will give you access to cold, hard cash in the early development years. As the children were under 16, the trust allowed more income for development and it split the income tax load. My children paid for their own schooling, etc., and in effect were financially independent of me. This I think was probably the most important action taken at that time.

When negotiating for finance to go into Langley Downs we never received much encouragement. The area was not regarded as a very loan-worthy district. I had not been in South Canterbury for two months when talking to a leading figure in one of the stock firms about what I hoped lime would do to the country, he said to me, "Look, Steele, you have bought one of the worst properties in South
Canterbury. I know, because we lost £7,000 in the property next door." However, you will agree that our faith in this property was justified.

Great encouragement! But nevertheless we took over a small mortgage that was on the property and my stock firm financed me for the remainder. This mortgage fell due two years after purchasing and it was at this stage we ran into some difficulty re-financing. We went to a leading lending institution and were turned down flat. Under no circumstances would they lend money on the property. But after much talking and seeing our first two years' work they relented and agreed to give us a 25 years' table mortgage and at this point the worst of our financial worries were over.

However, before re-financing worries struck us, we were faced with the inevitable necessity to employ labour and reached the decision that married personnel was far more satisfactory. Having arrived at that decision we were faced in 1949, with converting an old cottage which had been used for storing chaff into livable quarters. That cost £700 and like everything else at that time went on to the overdraft with the firm.

In 1953 again faced with the problem of married quarters we took out an additional mortgage. This situation was again repeated in 1959. But since then these mortgages have been repaid, the last this year.

The woolshed we extended two years ago, and can now hold 800 sheep and the new wool room has 1,400 sq ft which makes working much easier and pleasanter than the old one.

In the first year we had better winter feed; in the second year we had better grass. Besides better winter feed we had increased our stock, we had an increased income, and so the process snowballed. Like everyone else in this game we ploughed back every penny we could afford in stock increases and development.

Well, this sounds very nice, but we have had our rough spots as in 1952 when we lost just on 300 hoggets. We were pre-lamb shearing and as was my custom when we finished the ewes we started the hoggets. It was beautiful weather and we got 350 done the day we finished the ewes, but woke next morning to eight inches of snow and a bare 50 hoggets still walking about, but no loss with the ewes. Then in 1955 we lost 120 ewes in a smother on a 200-acre paddock of turnips when nobody was there. In 1963, the winter of which you all have vivid memories we lost 700 ewes—a big proportion due to sleepy sickness. So we've had our setbacks but we're still in the game.

It has given us great pleasure in doing this job, a job which started from gorse, to winter feed, to improved pasture and finally more stock, but we've also been able to find the time and the money to take a couple of trips abroad.
For progress to be made in the development of new herbage plants the breeder must have variability in the plant characteristics that are important for any particular objective, and this variability may be either natural or induced.

Natural Variability

At Grasslands Division we are continually collecting plants or seed from various localities within New Zealand and introducing from overseas both bred varieties and seed collections for assessment under our conditions. As an example of this phase of our work I propose to outline our programme in Prairie grass.

Prairie Grass (*Bromus unioloides* H.B.K.)

In the summer of 1960-1961 following the studies of B. R. Watkin at Grasslands Division, Lincoln, we commenced the collection and introduction of this grass. Mr Rumball has been assessing in the field 36 introductions from overseas and 154 pasture and roadside collections from throughout New Zealand made for us by the Department of Agriculture. This last group covers a range of climates, soils and farming practices in 31 districts. All are being assessed at Palmerston North and smaller numbers at the Grasslands Division substations at Kaikohe, Lincoln and Gore. We are not yet prepared to forecast the extent to which Prairie grass can be improved but large differences exist in tiller density, habit, coarseness, yield and flowering behaviour. It should not be difficult to produce selections with well recognised and stable characteristics for large-scale grazing trials.

Induced Variability

Two main processes are being used at Grasslands Division, firstly recombination by hybridization within or between species or between genera, secondly by the induction of tetraploids.

Hybridization Within Species

At present Grasslands Division has programmes in ryegrass (selections within ARIKI for quality); in *Lotus pedunculatus* (*L. major*) (crossing New Zealand Lotus with a Portuguese winter-active Lotus); in red clover (crossing Cowgrass with a Moroccan winter-active form); in cocksfoot (crossing Grasslands cocksfoot with winter-active Mediterranean cocksfoot); in white clover (crossing New Zealand white clover with Mediterranean winter-active forms); and in tall fescue (crossing New Zealand tall fescue with palatable and often winter-active Mediterranean fescues).

As examples of this type of programme some recent white clover results are presented, an outline is made of the tall fescue improve-
Programme and studies in ARIKI ryegrass on quality of feed are reported.

**White Clover**

In 1957-58 a Spanish winter-growing introduction was crossed with elite New Zealand plants and selected plants of the resulting F1 Hybrid were backcrossed to elite New Zealand plants in summer 1959-60. In summer 1962-63 selected backcross plants were polycrossed and the new progenies planted out spring 1963. Table 1 compares the present varieties (New Zealand and Spanish), the bulk of the backcrosses (1960 Hybrid) and the new selection (1963 Hybrid) derived from the backcrosses for production in selected winter and summer periods.

**TABLE 1**

**White Clover Production, Palmerston North. Single Spaced Plants.**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Summer 1961</th>
<th>Summer 1964</th>
<th>Winter 1961</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1960 Hybrid</td>
<td>89</td>
<td>104</td>
<td>200</td>
</tr>
<tr>
<td>1963 Hybrid</td>
<td></td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>53</td>
<td>77</td>
<td>275</td>
</tr>
</tbody>
</table>

In 1961 New Zealand was about twice as good as Spanish in summer but only about one-third as good in winter. The 1960 Hybrid intermediate in winter production between New Zealand and Spanish. In summer the 1960 Hybrid was nearly as good as New Zealand.

In summer 1964 the 1963 Hybrid outyields all others while both the 1960 Hybrid and the Spanish are improved in relation to New Zealand compared with 1961. Results this winter will determine whether large scale field trials of the 1963 Hybrid are warranted.

**Tall Fescue**

In 1958 a comparison was made as single spaced plants at Palmerston North of 20 Introductions including Aberystwyth S170 and Oregon 1000 and 20 New Zealand collections. The introductions as a whole proved more palatable than the New Zealand lines which, though good in growth especially in the summer, were tough and harsh. For total growth 24 lines were 20 per cent or more better than S170, for summer growth 20 lines and for winter growth 17 lines. It seemed clear that it should be possible to breed a vigorous tall fescue with good palatability and wide seasonal growth that would be an improvement on S170 for New Zealand conditions. Accordingly 43 crosses were made between the best plants out of the best progenies and these were planted out autumn 1960. Table 2, from data compiled by Mr McNeur, compares production of certain of these crosses with a standard New Zealand line and with Oregon 1000 for selected winter and summer periods.
### TABLE 2
Tall Fescue Production, Palmerston North. Single Plants.

<table>
<thead>
<tr>
<th>Progeny</th>
<th>Origin</th>
<th>Winter 1961</th>
<th>Summer 1962</th>
</tr>
</thead>
<tbody>
<tr>
<td>T98</td>
<td>Oregon 1000 x Oregon cross</td>
<td>165</td>
<td>105</td>
</tr>
<tr>
<td>T96</td>
<td>&quot;x Israel</td>
<td>152</td>
<td>90</td>
</tr>
<tr>
<td>T95</td>
<td>&quot;x Australian</td>
<td>144</td>
<td>100</td>
</tr>
<tr>
<td>T73</td>
<td>&quot;x New Zealand</td>
<td>136</td>
<td>124</td>
</tr>
<tr>
<td>Oregon 1000</td>
<td>American x Algerian</td>
<td>135</td>
<td>90</td>
</tr>
<tr>
<td>T93</td>
<td>Oregon 1000 x Australian</td>
<td>133</td>
<td>136</td>
</tr>
<tr>
<td>T85</td>
<td>&quot;x New Zealand</td>
<td>129</td>
<td>134</td>
</tr>
<tr>
<td>T100</td>
<td>Oregon cross x Australian</td>
<td>118</td>
<td>140</td>
</tr>
<tr>
<td>N.Z.</td>
<td>ex Tokomaru</td>
<td>(100)</td>
<td>(100)</td>
</tr>
<tr>
<td>T91</td>
<td>S170 x Australian</td>
<td>98</td>
<td>123</td>
</tr>
<tr>
<td>T107</td>
<td>Australian x Australian</td>
<td>77</td>
<td>73</td>
</tr>
</tbody>
</table>

| d.05    |                                       | 18          | 20          |

Certain progenies are superior both winter and summer (e.g. T100, T85, T93 and T73), some only superior in winter (T96), some only superior in summer (T91) and others poor in both seasons.

Further selections from these progenies have now been made, some with New Zealand origin included, others without any New Zealand origin so that if the toxic substance known to cause "fescue foot" is still present in selections including New Zealand, it may be avoided. The next phase if results warrant would be to proceed to detailed pasture and animal trials.

**Quality Studies in ARIKI Ryegrass**

Chemical analyses (Bailey) of pastures used in animal production trials carried out at Palmerston North by combined Massey University and D.S.I.R. research group have indicated that the efficiency of various ryegrasses as fattening feeds is strongly associated with their cellulose content. Short-rotation ryegrass with relatively low cellulose was more efficient than perennial ryegrass with relatively high cellulose. This is now being used as a criterion for the further improvement of ARIKI ryegrass. Wilson at Grasslands Division has found a wide range in cellulose content in ARIKI and has initiated studies to obtain an estimate of the hereditability of this characteristic. Agronomically good types have been screened so that breeding for low cellulose can commence this spring provided the hereditability figures hold out promise of good genetic advance.

**Hybridization Between Species**

Induced tetraploids of *L. pedunculatus* (syn *L. major*) pollinated with *L. corniculatus* (a natural tetraploid) develop small viable seeds, but it has been possible to dissect the immature embryo from these seeds three weeks after pollination and culture the embryo under sterile conditions on nutrient agar. The majority of the resulting plants set seed when intercrossed and some 4,000 F2 plants have been
compared as single spaced plants with the parent species. It is hoped a hybrid variety combining the drought resistant and palatability of \textit{L. corniculatus} and the competitive ability of \textit{L. pedunculatus} may be bred from this material.

**Hybridization Between Genera**

Both natural and induced 28 chromosome hybrids between tall fescue 42 chromosomes and ryegrass 14 chromosomes were obtained by Mr. Anderson at Grasslands Division a number of years ago, but were all sterile. With the aid of embryo culture and early colchicine treatment 56 chromosome hybrids have been obtained which have some fertility. It is hoped that it may be possible to produce a completely fertile hybrid with better agronomic characteristics than those of tall fescue but with much greater potential under dry conditions ryegrass.

**Induction of Tetraploids**

The drug colchicine may be used to induce tetraploidy, that is plants with double the usual chromosome number. In tetraploids, apart from a frequent increase in size of plant parts, there are greater opportunities for accumulating, by selection, desirable genetic factors. In addition greater seed size usually results in increased seedling vigour. Biochemical constituents such as soluble carbohydrates may be increased with resulting increased efficiency for fattening livestock. Grasslands Division have produced tetraploids in a number of species including \textit{Lotus pedunculatus} (syn. \textit{L. major}), red clover, and various ryegrasses. As an example of this type of work details are presented for \textit{Lolium multiflorum westerwoldicum} ("Westerwolths"), the extreme purely annual Italian-type ryegrass.

**Westerwolths Tetraploids**

In recent years the Dutch have been supplying a range of tetraploid ryegrasses to the United Kingdom market and these have apparently become very popular with farmers. We have tested a number of Dutch tetraploid ryegrasses at Grasslands Division but they are rather lacking in vigour compared with New Zealand diploid material. However, it seemed interesting to find out how New Zealand tetraploids produced from New Zealand diploids would perform. Accordingly in the winter of 1962 seedlings of Grasslands diploid "Westerwolths" were treated with colchicine solution. In the summer of 1962-63 23 pair-crosses were made between identified tetraploid plants. The resulting progenies were planted in the field in 1963 and Miss Newman made comparisons with the Grasslands diploids and the Dutch tetraploid "Billion." As single spaced plants the New Zealand tetraploids appeared to be superior in many ways to both of the other grasses, and a breeding programme was initiated to produce a new variety for field tests. In December, 107 pair-crosses were made between unrelated plants and these have been planted for single plant progeny tests at Grasslands Division, and for seed multiplication at Flock House. Overall, there are indications that the New Zealand tetraploid plants are definitely superior to the diploid, in winter growth at least, and greatly superior to the Dutch tetraploid in both winter and spring growth. The plants are lush and strong-growing, with very wide glossy leaves which are a darker green than those of
Grasslands diploid. The plants are of a more open type as fewer tillers are produced, and there seems to be pronounced resistance to the lodging so frequently found in the diploids. Little information is yet available on seed-setting but the following mean 100-seed weights have been obtained:—

<table>
<thead>
<tr>
<th>Variety</th>
<th>Mean Weight (gms) ± SE</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.Z. diploid</td>
<td>0.188 ± 0.002</td>
<td>20</td>
</tr>
<tr>
<td>N.Z. tetraploid</td>
<td>0.456 ± 0.007</td>
<td>101</td>
</tr>
</tbody>
</table>

The larger seed size gives the tetraploid an advantage in seedling vigour. How this new tetraploid will perform in swards will not be known until field trials are sown in the autumn of 1965.

It should be clear that Grasslands Division, while continuing the breeding of Lolium species, white clover and red clover, are also active in many other grasses and legumes including Prairie grass, tall fescue, cocksfoot and lotus sp. In addition Paspalum collections and introductions are being assessed at Kaikohe and a wide range of Phalaris introductions have been obtained for assessment. The wider possibilities of producing improved herbage varieties through interspecific and intergeneric hybridizations and through the induction of tetraploidy are being examined.

Acknowledgements

The author wishes to express thanks to Mr A. C. Glenday, Applied Mathematics Laboratory, for statistical analyses, to members of the Plant Breeding Section, Grasslands Division for release of information on current plant improvement programmes, and to Dr R. W. Bailey, Plant Chemistry Division, for information on cellulose.
A FERTILIZER MIXTURE FOR STIMULATING THE GROWTH OF LUCERNE

P. B. Harris, Senior Scientific Officer and W. R. Lobb, Superintendent, Winchmore Research Station, Ashburton.

Introduction

Perhaps there is no more appropriate place to discuss any aspect of lucerne production than at the Farmers' Conference at Lincoln College. It would be no exaggeration to say that the place and value of lucerne in the farming economy of Canterbury, and in the areas of lower rainfall generally, has had its staunchest advocates at Lincoln. Not only have they strongly recommended lucerne as a fodder for quantity production on the light lands, but of more importance, the emphasis on its value as a quality feed in prime lamb production has recently been stressed.

Aspects of lucerne production under investigation at Winchmore are concerned with varietal performance, nodulation, management and fertility requirements. This work is being done partly under dryland and irrigated conditions. In the former case, as more lucerne will be grown on dry land than under irrigation, and in the latter, because there is a growing school of opinion which underestimates the value of lucerne under irrigation. Because of its potential to produce high yields of good quality fodder, however, one cannot accept this opinion without fully examining the problems of lucerne production on the irrigated farm.

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From the work already done on the varietal, managerial, and fertility aspects of the crop, one must take a much more optimistic view of the place of lucerne under irrigation. Whereas at one time it might have been the policy to grow lucerne on those parts of the farm which could not be irrigated, it might now well be advocated that lucerne should also receive the benefits of irrigation. Its total production, from a lesser amount of water supplied, may be much greater than pasture, and its maintenance may not be any more difficult on dry land.

The Fertility Requirements of Lucerne

It is proposed in this paper to deal in some detail with the fertility requirements of lucerne on the Lismore soil type, particularly under irrigation. Before doing so, two things must be made clear. Firstly, all the fertility interactions are not yet being studied, notably the relationships between lime and molybdenum, and between lime and soil pH, in their influence on lucerne growth, nor the true value of phosphate to the crop; and secondly, that very little, if any, information is yet available as to the fertilized responses likely to occur on this soil type, when a lucerne stand is either grazed, or used as a run-off, or on to which is fed some or all of the hay produced. This at once limits the value of the information on fertilizer responses, which is presented hereafter.

However, as lucerne is customarily used as a source of hay only, on many farms, and as it has often been subjected to varying degrees
of mis-management, due to its very ability to produce when pastures don't, then the aspects of its fertility requirements to be described must be applicable to a great part of the lucerne areas on this soil type, particularly those under irrigation, at the present level of lucerne utilisation.

The Lismore soils, which cover a considerable part of the Canterbury Plains, are generally deficient in phosphate, sulphur, molybdenum and they respond to lime. Their pH is low at 5.3 and this may be considered as being too low for lucerne, but to what extent is not certain. This is because we are not fully aware of the part molybdenum might play at the low pH, and we are not yet fully conversant with all the techniques which might be used to nodulate the lucerne plant efficiently, in the absence of lime. We can say, however, that it has been possible to establish lucerne with lime-pelleted seed in poor soil conditions on dry land, without applying lime to the soil, and to grow it productively thereafter. Anyone driving past the Station will see the results of one example of this in the lucerne strips on the side of the road. Molybdenum has been observed to give a response under such conditions.

Lime then and/or possibly molybdenum, are necessary to provide the right conditions for the lucerne plant to grow at its best, but more work needs to be done on the optimum counts of these materials required, on their times and methods of application and on the effects of sowing pelleted seed.

Considerable attention has been paid to the relative positions of sulphur and phosphate in pasture responses. In by far the majority of cases on the Lismore and allied soils, the beneficial effect of superphosphate on pasture is due to the presence of both these substances, and it can be said that if one were used without the other, the result would be negligible. This would appear to be the case for both the grass and clover constituents of the pasture.

The same situation occurs in the lucerne crop. In trials at Winchmore, responses have been obtained to both phosphate and sulphur in the total yield from a lucerne stand. It is also apparent that where these two substances are applied together, as they are in superphosphate of course, their combined effect appears to be even greater than when applied separately and a consistent positive interaction has been recorded increasing total yield, i.e. including grasses, weeds and other species that have invaded the lucerne stand.

When the yield of pure lucerne alone is considered, this also is increased by applications of phosphate and sulphur, but there is some indication from these trials that the beneficial effect of the phosphate may be less in this case, and may be reduced further by its stimulation of growth of other species. It appears that this is more likely to occur where heavy dressings are applied to older stands, particularly in spring and autumn, when the grasses are in their phase of maximum growth, and the legume is not.

The following table of average results for the first cut in the fifth year of an irrigated trial at the Station, shows this effect. Here all herbage has been removed after cutting, as in a hay making system.
Effect of Superphosphate (Yield in lbs dry matter per acre)
First cut 1959-60

<table>
<thead>
<tr>
<th>Yield</th>
<th>Relative</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>1,100</td>
<td>100</td>
</tr>
<tr>
<td>2cwt per acre</td>
<td>1,450</td>
<td>96</td>
</tr>
<tr>
<td>4cwt per acre</td>
<td>1,420</td>
<td>129</td>
</tr>
</tbody>
</table>

Although the superphosphate dressings have increased the yield of lucerne, the heavier dressing has given no additional response. The lucerne percentage has been lowered, particularly by the heavier superphosphate application; and it is thought from other work that this is mainly due to its phosphate content. This would indicate that if a lucerne stand is beginning to decline, under these conditions of complete removal of hay, and grass and weeds are taking control, it may not be the best thing to try to renovate it by applying a good dressing of superphosphate. In fact, it is likely that this would be the worst thing to do and would probably only aggravate the condition.

It appears rather paradoxical that application of superphosphate both encourages the growth of lucerne and its decline, but it is considered from work already done at Winchmore, that the solution lies in the potash supply available to the plant. Where this is sufficient, superphosphate continues to be beneficial; where it has become deficient, applications of superphosphate may be detrimental to the stand by aggravating that deficiency.

On the Lismore soil type, a yellow-grey earth, zonal soil, formed on sedimentary parent material, potash is being released continually by natural processes. This usually is sufficient for the nutrition of pasture plants, and possibly lucerne also, under grazing conditions, where the potash is largely being returned to the soil by the animal. When, however, all herbage is removed from a paddock, as it is when made into hay, and when the amount removed is increased by applications of superphosphate and/or by irrigation in particular, a serious drain on the available potash takes place and it is considered that a deficiency may occur, not an absolute deficiency, but a deficiency in the amount available to the plant, so that potash becomes the limiting factor in growth. It has been calculated that with a potash level in the dried herbage of 2.5 per cent, the equivalent of 4cwt of muriate of potash is lost when a yield of 4 tons of dry matter per acre, rather low for irrigated lucerne, is removed as hay each year.

That this supply of potash to the plant is not sufficient when such losses occur, can be seen from a trial at Winchmore on lucerne at present five years old. It receives annually an overall basal dressing of phosphate equivalent to that supplied by 3cwt of superphosphate and is limed to a pH of around 6.5. It compares three rates of sulphur application and three of potash, both alone and in combination, the potash being applied in four dressings, one after each cut. Results to date show, briefly, that all rates of sulphur, 28lbs per acre, 56lbs per acre and 329lbs of gypsum per acre, give a similar increase in yield. In other words, when superphosphate is applied at 3cwt per acre, the level of sulphur supplied is satisfactory.

The potash applications, however, show an increasing yield response, especially in yield of pure lucerne, and an increasing lucerne
percentage with the heavier dressings. This is shown in the following table:

**Responses to Potash (Yields in lbs dry matter per acre)**

<table>
<thead>
<tr>
<th>Irrigated—Hay Removed</th>
<th>1962-63 Annual Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lucerne Yield</td>
</tr>
<tr>
<td>No potash</td>
<td>7,390</td>
</tr>
<tr>
<td>2cwt per acre</td>
<td>9,290</td>
</tr>
<tr>
<td>4cwt per acre</td>
<td>9,960</td>
</tr>
<tr>
<td>8cwt per acre</td>
<td>10,570</td>
</tr>
</tbody>
</table>

The potash applied is muriate of potash. The additional response with the higher rates can be seen to be also a diminishing response. These results are average of the treatments given and it appears from these that the most economic application would be 2cwt of muriate of potash applied with 28lb of sulphur plus the basal phosphate dressing. In other words, with 3cwt of superphosphate applied per acre per annum, 2cwt of muriate of potash would give the most economic response in terms of lucerne production. Probably, at this level, it could be applied in one or at the most two dressings with much the same effect.

This beneficial effect of potash on the growth of lucerne will be seen from the following slides of this trial, taken on the 4th February this year, just before the third cut and 12 days after irrigating.

The first shows the control plot receiving phosphate only. The lucerne is not very vigorous as judged by the foot-rule by the board. Next, is phosphate plus 28lb sulphur, i.e. approximately the equivalent of 3cwt of superphosphate applied each year. This would represent usual farm practice; as considered at present, good farm practice: with the lime applications to keep up the pH. More lucerne growth is apparent here but grass is still prominent. Next, the same treatment plus 2cwt muriate of potash. The lucerne is here much more vigorous and obviously on top of the grass.

Views of another trial on the Station, also irrigated with hay removed, but this one in its ninth year, show similar effects. Firstly, receiving sulphur, phosphate and lime—the usual farm treatment. Next, receiving the same as before plus potash, in this case 4cwt per acre per annum, muriate of potash, ignoring the boron and magnesium dressing shown on the board, which have given no responses in this trial. The beneficial effect of the potash is again seen here with the vigorous growth of lucerne definitely on top of the grass. The next slide shows that phosphate may not be necessary as here the lucerne is as vigorous as before and yet is receiving only sulphur, lime and potash, again ignoring the minor elements. As mentioned earlier, however, more work needs to be done on the value of phosphate to lucerne to ascertain its true position.

It is of interest in connection with this induced potash deficiency as described for lucerne that workers in America, namely Drake and others1 in studying the cation exchange of plants roots, found that root capacities of dicotyledons plants were roughly double the value for monocotyledons. From this they argued that in grass/legume associations at low levels of soil potash, the grasses are able to
obtain much more of what is present than the legumes and yield and persistency of the latter may, in this way, be seriously reduced. If accepted, this may explain the situation described for lucerne, and it seems obvious that, under such conditions, in order to maintain the crop in a state of high production, the potash in the soil must not be reduced to too low a level, as it may be where high yields of herbage are being produced and removed as hay.

Although the trials mentioned so far, the slides and tables shown, consider the return to the lucerne of a fertilizer, such as muriate of potash, as a replacement for the potash lost, this may not be necessary. It is to be hoped that it is not, as costs of production would be raised further thereby. But by simply putting the hay back where it came from, the loss of potash is made good, and no fertilizer application is required, as far as we know at present. In another trial at Winchmore, the last we wish to mention this afternoon, this is carried out by feeding the hay back in the winter on to the stand from which it was removed.

The practice adopted in this trial, which is now five years old, is to feed back all the hay in mid-winter when the lucerne is quite dormant, the sheep being set stocked on the area until all the hay is consumed. Further investigation is necessary on the amount of hay fed back as it seems likely that where all of it is returned, as under this system, the stand may be opened up too much; and also on the possibility of obtaining the same effect by using the lucerne as a run-off only. Besides the return of nutrients, particularly in the way of potash in the hay, in this manner, the treading of the sheep has a cultivation effect which kills out much of the grass that has invaded the stand during the year.

Another treatment in this trial, which deals with the management of the lucerne crop and includes a comparison of irrigated and non-irrigated lucerne, is a spring application of 2,2DP to kill out the grass in the stand. It has been found that feeding back the hay is as beneficial in getting rid of the grass, as the herbicide, and this is shown in this final table which gives the average results for the 1962-63 season on irrigated lucerne under a hay production system.

**Irrigated Hay Production (Yields in lbs dry matter per acre)**

<table>
<thead>
<tr>
<th>Lucerne Yield</th>
<th>1962-63 Annual Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lucy per cent</td>
</tr>
<tr>
<td>Hay removed</td>
<td>7,630</td>
</tr>
<tr>
<td>Hay removed plus Herbicide</td>
<td>8,230</td>
</tr>
<tr>
<td>Hay fed back</td>
<td>10,900</td>
</tr>
<tr>
<td>Hay fed back plus Herbicide</td>
<td>11,310</td>
</tr>
</tbody>
</table>

No herbicide was actually applied in the spring of 1962, as it was considered on inspection to be unnecessary, the effects of the previous years' spraying being still apparent, as can be seen by the increase in lucerne yield and particularly lucerne percentage under the two treatments. However, the hay fed back treatment is as good and does not check the lucerne growth in the first cut, as has occurred on occasion after applying the herbicide.
These treatments showed even greater responses on the dry land in the same season as may be seen from the following slides. These were taken in early October 1962 showing the spring growth before cutting or irrigating. This stand was then in its fifth year. The first is not irrigated and has the hay removed. Lucerne growth is here very poor and grass is becoming dominant. Next is the same, but with the herbicide applied the year before. Very little grass is present and growth of lucerne is rather more vigorous. Finally, irrigated lucerne with hay fed back. There is as little grass here as where the herbicide was applied, and the growth of lucerne is even more vigorous.

It may be that this same effect in returning the potash will be obtained by grazing the lucerne stand, possibly for the first and last cuts of the season only, when hay is difficult to make anyway, even if hay from the other cuts is removed, but this requires further investigation, as does the case where the lucerne is used purely for grazing. It is likely that, in the latter case, no potash response will occur, as most of that available would be returned by the animal. In this connection it should be emphasised that grazing should be hard enough to ensure that any grass present is eaten down as well as the lucerne, especially early and late in the season, otherwise it may become dominant.

SUMMARY
To summarise this paper it can be said that on the Lismore soils, lucerne requires lime and possibly molybdenum, sulphur and probably phosphate to grow well. In other words until more information is available from further work, the lucerne grower should continue to lime his land to raise the pH and apply superphosphate to fertilize the crop. Where the lucerne stand is being used purely for hay, which is then all taken off the paddock, and particularly where high yields of lucerne are being produced by heavy superphosphate dressings and/or irrigation, care should be taken to maintain adequate reserves of potash in the soil. This may be done by applying a potassic fertilizer, and where 3cwt of superphosphate is being applied per acre per medium and lime is adequate, 2cwt of muriate of potash would probably give the most economic return; or by feeding back the hay in the winter on to the stand from which it was removed, in which case the treading of the sheep will also have a beneficial effect. The position where the lucerne is wholly or partly grazed is not known but it is likely that then there is less risk of an induced potash deficiency occurring.

It is realised that the necessity of potash for lucerne is not unknown, but it is thought and hoped that this paper will be of interest and value to growers in much of Canterbury in pointing out to them a situation which may occur in lucerne under the conditions described. The gaps in this study of the fertility requirements of the crop have been outlined and it is hoped that they will be made good in time.

ACKNOWLEDGEMENT
Finally we wish to make acknowledgements to Mr Bruce Lauder and Mr John Lammerink, formerly of this Station, who laid down the trials referred to, and also to the members of the staff at Winchmore who have carried out the work involved.

REFERENCE
1 Mr Drake, J. Vengries W. G. Colby. Soil Sci. 72, 139, 1951.
CONTROL OF PASTURE PESTS UNDER THE NEW REGULATIONS

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The following remarks apply to what will happen after the Agricultural Chemicals (Insecticides) Regulations 1964/1 come into operation on 1st July 1964.

The main purpose of the Regulations is to protect our meat and dairy produce markets by ensuring that residues of insecticides are either absent, or so low that they would not worry overseas purchasers.

In broad terms the Regulations allow the use of any insecticide no matter what form it may take—be it a fine dust or spray or as pellets—to be applied from any air or ground equipment, provided farmers can secure a permit from the Director-General of Agriculture, or the consent of the Minister of Agriculture.

The intentions behind the Regulations however, make it quite clear that the use of hydrocarbon insecticides such as DDT, lindane and dieldrin as dusts or dusts mixed with anything else, will be banned for application by air, ground spinners or air blast sprayers.

Under a rigid permit system sprays could be used for control of such crop pests as the diamond-backed moth and clover casebearer caterpillars, and the decision whether or not to issue a permit would be based on likely residues and withholding periods; air treatments would not be sanctioned.

If field tests show that any preparation and its method of applications results in no, or very low residues on pastures, the way is open for the proprietors to apply for Gazetting of that product as not requiring a permit. This has been done with DDT prills and so far this is the only material that may be applied without a permit.

Now the question is: What are farmers able to use after 1st July to control grass grubs and Oxycanus?

I. Without a permit farmers will be able to use only DDT prills—not just any DDT pellets or granules the same size and appearance of DDT prills, but the product of one firm only—because that firm proved to the satisfaction of the Agricultural Chemicals Board that its DDT prills gave a very low pasture residue. Use of DDT prills will have the following effects:

(a) If they are applied on a three-year rotation basis to prevent infestations of grass grubs and Oxycanus it is unlikely that there would be any big difference between DDT prill and DDT wetmix-treated paddocks.

(b) Application of DDT prills against low average infestations of grass grubs and Oxycanus (about 6 and 1 per square foot respectively) would mean that the first year there would be an approximate 19 per cent reduction of pasture cover as compared with DDT wetmix-treated areas, and this difference would persist into the second year.

(c) DDT prills applied to paddocks heavily infested by grass grubs and Oxycanus (population of 20 and 10 and over per square foot respectively) would result in Canterbury in an approximate 67 per cent loss of pasture in a year of well distributed rainfall, and leaf
length of the remaining pasture would be not longer than 2 inches compared with 6 to 8 inches long and a 11 per cent loss on DDT wetmix super areas.

II. With a Permit: (a) If farmers can persuade the Department of Agriculture to issue permits for use of DDT wetmix super for application beneath the soil surface in areas carrying both grass grubs and Oxycanus, the grubs would be controlled, but the majority of the Oxycanus caterpillars would remain to destroy the pasture.

(b) If farmers can secure permits for use of DDT wetmix super on heavy grass grub and/or Oxycanus infestations by box top-dressers, with approved aprons at front and rear of boxes, at low wind velocities (not more than 10 m.p.h.), and in absence of stock, the loss of pasture would be approximately 11 per cent in pasture plants, and leaf length would be between 6 and 8 inches in the autumn and winter months in a year of good rainfall distribution.

(c) Use one of the DDT pelleted materials of which there are several under trial. Some of them are DDT concentrates, prepared either in New Zealand or America, and designed to be applied either as pellets or for mixing with superphosphate. At least one preparation is in the form of granulated wetmix DDT super. In current and past tests some of these preparations are giving good results, and Fertilizer Research Station trials indicate that pasture residues are not significantly different from those of DDT prills. At the moment, however, longer withholding periods will be retained till they have proved themselves further. All could be applied by spinners or from planes at winds up to 15 m.p.h.

Since there is no doubt whatsoever that pelleted materials give lower residues than sprays or dusts, the position is that we should encourage preparation of more such pellets and granules. They not only give low residues but can be applied in winds of up to 15 m.p.h. whereas at that wind speed most of the sprays and dusts would be lost. They could be applied also by planes and spinner ground equipment of suitable types. The fact that the Gazetted DDT prills are slow in giving pasture protection does not mean that all pelleted materials are slow, because some tested DDT pellets give reasonable pasture protection, and some of the other pelleted hydrocarbons and organophosphates were as fast in action as wetmix DDT super.

In regard to replacement materials for DDT, there are other hydrocarbons which give satisfactory control of both grass grubs and Oxycanus, but none of them is as safe as DDT and the Regulations restrict their use in the same manner as for DDT.

So far, none of the organophosphates has been fully registered by the Agricultural Chemicals Board and only one (diazinon) has a provisional registration up to a maximum usage of 10,000lbs. This means that the organophosphates cannot be used on a widespread farm scale at this stage, and I feel that the Board would be very unwise to give organophosphorus chemicals full registration till side effects are clarified.

There is at the moment a world-wide move to replace DDT and other hydrocarbons with organophosphorus insecticides, because the latter do not leave detectable residues in either plant or animal tissues for any length of time. My personal opinion is that this move is a premature one as we do not know the long-term effects on plants and
animals. In Canterbury trials over the past two years, for example, two organophosphates (diazinon and thimet) had a severe effect on pastures one year after application of a single dosage of 2lb a.i./acre. It is fair to note, however, that the same materials did not have this effect in Nelson trials on soils of higher humus content.

Some organophosphorus preparations have a high human death rate record at the user end on a world basis, whereas DDT has been used now for 22 years on a very large-scale annual usage over millions of acres of malarious country, and not one case of acute or chronic injury from correct usage has been recorded in that time.

As regards effectiveness against grass grubs and Oxycanus, however, some organophosphates gave good pasture protection: Against grass grubs, diazinon, dipterex, methyl parathion, gusathion and lebaycid as pellets all gave effective control of grubs present at time of treatment at a rate of 2lb a.i./acre.

Against Oxycanus diazinon, dipterex, methyl parathion and thimet as pellets all gave good pasture protection at dosages of 2lb a.i./acre, last year, and as sprays or pellets in current Canterbury trials diazinon at 1lb and 2lb a.i./acre, methyl parathion at 3lb, and dipterex at 0.8lb a.i./acre gave excellent control of very heavy infestations.

None of these organophosphate preparations lasts long enough in the soil to protect pasture against reinfestations by either grass grubs or Oxycanus, as has happened each year in Canterbury trials.
OUT OF SEASON SHEARING WITH REFERENCE TO WOOL QUALITY

A. E. Henderson, Professor of Wool Science, Lincoln College.

The practice of shearing more than once in a year is comparatively new to New Zealand. But it is something that has been done extensively and for a long time in some other countries. It has been traditional in New Zealand to think that the ideal is a fleece of twelve months' growth. Australian producers have thought and acted in the same way. Much South African wool is shorn after eight to ten months' growth and in Continental countries where some sheep are housed in winter it is apparently common practice to shear twice in the year. It is difficult to find any common reason why sheep in these countries are shorn at six to eight month intervals. The practice is obviously part of the sheep management pattern and markets for the short stapled wool have been established a long time.

The comparative newness of twice a year shearing in New Zealand, the extensive growth of the practice and the very large volume of short wools that we now market successfully are rather remarkable. It has meant an upheaval in sheep management practices and a radical change in the nature of a substantial part of our wool clip. The purpose of this paper is to discuss the effects frequent shearing has on the wool clip.

These effects can be divided into different categories. There are direct effects on the fibre, there are effects connected with the relationship of the fleece and the environment and there are indirect effects on wool growth arising because of physiological adjustments within the sheep made according to the state of growth of the fleece.

Of the direct effects, possibly the most controversial—and probably also one of the least important—is the question of whether the simple act of cutting, or in this case frequent cutting, has an effect on the fibres. I know of no evidence which shows that it does. A wool fibre is made of hard fibrous tissue, it is not alive in the popular sense of the word and it has a remarkably constant composition along its length. It is therefore difficult to believe that cutting or the way it is cut would have any effect.

By far the most important direct effect concerns the place at which the fibre is cut. This is brought about by the different rates of growth of fibre in different months of the year.

Some years ago Story and Ross (N.Z. J. Agric. Res. 3) made detailed measurements of month to month wool production of Romney breeding ewes running at the Invermay Research Station. The kind of fibre grown by these sheep, which are similar to most of the sheep that are shorn more than once in the year is shown in Fig. 1.

There is a number of points of interest convey by Figure 1. Firstly if production in the months for which two sets of production figures are available, that is September to February, are compared, it will be noted that relative monthly production rates vary from year to year. The main causes of this will be feed supplies, climate and the number of lambs being reared. The second thing to note is the very different wool production rates from month to month. Note that the highest production occurs close to the month of February and that the lowest production is close to the month of August.
GROWTH RATE OF WOOL FIBRES

1954

Sept.
Oct.
Nov.
Shearing
Dec.

1955

Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Shearing
Dec.

1956

Jan.
Feb.

Fig. 1

% Years Clip
10.9

46%
Length 3"
Diam. 41.0 H
36s Quality

10.9

54%
Length 4.6"
Diam. 34.3 H
46s Quality

9.7

= 100

8.6

7.9

4.3

3.5

3.8

6.2
Highest production is almost three and a half times that of the lowest production. A similar pattern of wool growth in crossbred and Corriedale ewes in Canterbury has been described by Coop (J. Agric. Sci. 43), and Hart (Proc. N.Z. Soc. Anim. Prodn. 15). For these sheep slightly less extreme maximum minimum ratios of approximately 3 to 1 were found.

If twice yearly shearing is to be done the farmer has the choice of almost any month during which he can shear. However it is of some importance to note that his choice of months will have a very considerable influence on the shape of the fibre, its average fineness, its length and proportion of the year's clip that is taken.

For example if sheep are shorn at the end of November and again at the end of March almost 46 per cent of the clip will be taken. The staple will be comparatively short (3 inches) and will be the coarsest part of the year's growth (41 microns). By contrast the other half of the clip will be more than half as long again as the first lot (4.6 inches) and it will be considerably finer (34.3 microns).

It is quite apparent that choice of shearing times has a profound influence on the clip obtained. But times of shearing seem to be dictated more by management factors than ambition to have a particular kind of wool to sell. The commercial significance of the above differences cannot be reasonably determined. It is quite possible, and indeed probably that these two clips would be used for different purposes and would fetch the same price.

A further point which has some significance since we sell most of our wool in the greasy state is that the clean scoured yield of the summer clip would probably be slightly less than that of the winter clip. This is mainly because a good deal of the fatty fraction of yolk will usually be washed out of the fleece by winter rain.

Another direct effect which only occurs with some sheep and which is associated with the time of shearing is coarse hairy tip. This will only occur in sheep with an inherited ability to produce medullated fibre. This is the so-called hairy fibre which typically has a central core of large spongy cells. In most sheep able to produce this kind of fibre, hairy fibre is produced only in months of high wool growth or if some other powerful stimulus is provided. This being the situation we are likely to find that it is the wool growth from December to March that is affected. Unless there is a high percentage of this kind of fibre there is no price discrimination against it and if carpet wool supplies are in demand it may even be worth a premium.

A similar but very much shorter production of medulla may be brought about by the very act of shearing. This more correctly is an indirect effect brought about by physiological adjustment within the skin. It is apparently provoked by lowered temperatures because it does not happen if the skin is immediately covered so that it is kept warm. A combination of this effect and the marked stimulation of wool growth that occurs about November is often sufficient to cause marked harshness of the tip in fleeces grown after November shearing. Remember, however, that this only happens in sheep with the inherited ability to produce medullated fibre. It certainly does not happen in all sheep.

The occurrence of some stimulation of wool growth after shearing raises another point over which there is much argument. There
is a popular conception that frequent cutting of hair or of wool will stimulate growth. The evidence is that the first time it happens there is probably some stimulation but it is very small that it can not be measured and it therefore is of no practical significance.

Lack of direct response to shearing must be reconciled with the common experience that sheep frequently grow more wool after shearing or following repeated shearings. But they sometimes grow less and we must look for some indirect causes of this.

The most simple explanation is that the changes in wool growth result from changes in the amount of food consumed and in the demands made on this food following shearings.

Immediately after shearing several fairly profound physiological adjustments have to be made by the sheep. Since the fleece is a very good insulator, and it need be only just more than half an inch long to provide more than three-quarters of the possible insulation of a full fleece, shearing with machines which leave something like one-fifth of an inch of wool will very substantially increase the chance of heat loss from the body. This is accentuated by wind and rain with wind being the more important of the two. However low air temperatures will of course increase the deficit. The significant point is that food requirement for maintenance will rise following shearing and if temperatures are low, food requirement will be greater.

Some notable adjustments are made to combat this heat loss. For example the skin thickens immediately after shearing. The physiology of this is not very well understood, but a noticeable thing about it is that shivering lessens as the skin thickens. Secondly, and more important, there is an immediate increase in appetite. At its peak a few days after shearing this may be 40 per cent to 50 per cent more than before shearing, but this elevated appetite only persists for a short time and has disappeared in approximately four weeks (Wodzika-Tamasewska, Proc. Ruakura Farmers’ Conf. 1963).

At this point it is appropriate to recall three important principles of wool growth. One is that a sheep will still produce wool but in lessening quantity as it is losing weight. The second is that the more surplus food there is above the maintenance requirement the greater the quantity of wool that will be grown. And thirdly, there is the fact that wool growth responds very quickly to changes in the level of feeding.

If these principles are considered together with the physiological stresses associated with shearing and which are accentuated by bad weather the conclusion must be reached that, except in the very hottest months of the year and during good weather, newly shorn sheep must be allowed to eat more simply in order to maintain wool production rates. If they are expected to show an increase in wool production after shearing then they must be allowed to fully satisfy their temporarily high appetite. This appears to be higher than is required for increased maintenance so that there can be some surplus for body weight gain and increased wool production.

In the few detailed trials of twice yearly shearing some have shown that more, and some that less, wool is grown than if the sheep had only been shorn once. Feeding in the month immediately after shearing would appear to be the chief cause of this variation and of course cold or bad weather provides a complication which would
reduce the effects of good feeding and accentuate the effects of mediocre or bad feeding.

Before leaving this point it is well to recall that if sheep are machine-shorn during the months of naturally low wool production length growth rates are so low that it takes much longer for the fleece to reach a length sufficient to provide reasonable insulation. If there is to be no following loss of production it seems imperative that sheep be shorn with a snow-comb or with blades in these months.

Turning now to the interaction that occurs between the fleece and the environment. There are several obvious advantages of the short fleece. One is that the extent of weathering is much less because the maximum time any wool is exposed to the damaging effects of sunlight is perhaps seven or eight months. Usually loss of wool by weathering is substantial on open woolled sheep such as the Romney and particularly in districts with frequent rainfall and intense sunlight. Twice yearly shearing in these districts will certainly produce a less damaged fibre and will also ensure that less fibre substance is lost over the course of the year. A similar saving action is performed by covers.

The most important aspect of fleece-environment interaction is wetting and drying behaviour. It is well known that many wool faults, particularly staining, are caused by prolonged wetness of the fleece and it is obvious that the shorter the staple the more quickly a fleece will dry. Rates of wetting and drying of fleeces are complex things to explain because of the variable nature of rainfall and drying conditions and no one situation can be claimed to be ideal.

However, it is worthwhile to describe several typical situations. Although pink tip appears not to be a very important wool fault it nevertheless draws attention and is associated with wool damage and loss. It seems not to occur unless there is at first damage to the fibre tip and subsequently the weather is both damp and cold. Normally double shearing does not allow sufficient initial fibre damage for the fault to develop. The same may be true also of black fungus tip.

A fault of great importance in New Zealand wool is what is commonly called canary yellow. This is a diffuse and unscourable stain which occurs only when the fleece is wet, temperatures are high and there are highly alkaline conditions within the fleece. All three conditions must be satisfied. Nothing can be done about rainfall or air temperatures, but if the fleece is short a reasonably high proportion of alkaline substances are washed out of the fleece by rain and the fleece will normally dry fairly quickly. In addition the temperature gradients within a short fleece are liable to be rather different from those in a long fleece. These conditions in the short-stapled fleece are nearly always sufficient to prevent canary yellow staining.

On the other hand there are some situations in which the short fleece is at a distinct disadvantage. Being short it wets to the skin very easily and quickly. If for nearly a week or more there is no opportunity for it to dry a number of things may happen. A superficial inflammation of the skin may develop. Following this an exudate is produced and frequently there is extensive multiplication of micro-organisms within the exudate. In any case a band of yellow-ish material will appear in the fleece and while the condition is active it may be slimy and foul-smelling. Sometimes colour-producing bacteria may be present and if so the fleece may be stained in bands
of green or brown and much more rarely, blue. The occurrence of bands of exudate is much more common than the green or brown stains but neither can be considered typical of short wools. In general, considering the relationship of double shearing and high rainfall, the evidence favours double shearing. In some circumstances it can cause trouble but in most it provides for faster drying and less fleece damage.

There is another important factor through which indirect effects may be produced in the fleece. A fleece three inches or more in length will, when wet, hold a considerable weight of water and there is no doubt that a heavy, wet fleece is an encumbrance. The thrift of sheep subjected to these conditions is liable to suffer and there is a consequent effect on wool growth. Under difficult conditions whether these be caused by climate or topography, and provided there is no undue stress at the time of shearing, it is common experience that more wool and wool of a better style and colour is produced if sheep are shorn at approximately half-fleece.

So far no special mention has been made of shearing at eight-month intervals. In flocks that have a very high individual production, and these are most often stud flocks, shearing at about eight months' growth provides a very acceptable kind of wool often equal in staple length to the average 12 months' fleece. It should be remembered that it is possible to have wool overgrown and in this state the fibre length is greater than required and the fleece is very subject to faults associated with dampness.

There is no doubt that eight-month shearing is acceptable if wool is well grown. But if practised in low-producing flocks it may result in the clip being rather out of line with market requirements.

**SUMMARY**

**Advantages**

1. The actual effects of cutting are not important but in sheep able to grow medullated wool shearing during the months of high wool growth rate will accentuate the fault. This is not important providing the wool is to be used for carpet manufacture.

2. Choice of time of shearing has a considerable effect on the nature of the clip produced.

3. Shearing at intervals of substantially less than a year will lessen the amount of tip damage and associated faults such as pink tip. It will also effect a saving of wool.

4. Shortness of staple allows the fleece to dry easily and this will lessen the chances of bacterial staining.

5. The high appetite immediately after shearing may be capitalised to give a slightly greater amount of wool.

6. In difficult conditions a light fleece is a distinct advantage and indirectly there may be increased wool growth associated with greater thrift.

7. Shearing at eight-month intervals is an advantage in high wool-producing flocks.
Disadvantages

8. A short fleece during continuous light rain can wet so easily that the faults associated with prolonged wetness can occur.

9. Unless a newly-shorn sheep is allowed to eat more immediately after shearing there may be loss of production.

10. In the colder months or during bad weather a closely-shorn sheep is generally unable to eat enough extra food to maintain itself and there can be consequent loss of wool production.
OUT OF SEASON SHEARING WITH REFERENCE TO FARM MANAGEMENT

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I believe that it will be extremely difficult to cover all the management features involved in the consideration of out of season shearing, in the twenty minutes allotted to this paper. To make the best use of the time available the paper will therefore be restricted to the major management considerations.

In-season shearing is generally regarded as meaning shearing between the beginning of October and approximately the end of January. Out of season shearing is assumed to be shearing outside this "normal" period and involves several relatively common practices. These are, for ewe flocks, pre-lamb shearing, double shearing and eight-monthly shearing. To some extent it may also be prudent to include late February-March shearing as this practice has declined and is now considered by some people to be out of season. Pre-tupping shearing of two-tooth ewes will be considered separately as will single and multiple lamb shearings.

The advantages or disadvantages of each system are numerous and their suitability for any particular farm or farmer extremely varied. Particular out of season shearing practices which suit some properties admirably may be entirely unsatisfactory on adjoining properties. Where the change to another shearing practice could confer only one or two major advantages, this may be sufficient to make the practice well worth while. Advantages of some out of season practices which may be regarded as merely trivial by some farmers may be of extreme importance to others and likewise with the disadvantages. Consequently it would be foolhardy to disregard any of the advantages or disadvantages, but in this paper we will be limited to the major factors.

The advantages of any form of out of season shearing can be summed up in one word—flexibility; however this requires further elaboration. The advantages can be broadly grouped into three factors. Firstly, productive factors such as lambing performance, deaths and foraging ability; secondly, direct flock management considerations (managerial flexibility) and, thirdly, liquidity flexibility or working capital benefits. The disadvantages may be grouped into flock management problems and factors reducing returns. Increased risk of deaths or parasitism may be grouped into either of these categories.

In order to clarify some of the more pertinent advantages or disadvantages of the various shearing practices, these will now be considered separately.

1. Pre-lambing Shearing

This is probably the predominant out of season shearing practice at present applied in Canterbury. However its relevant importance in relation to total sheep shorn, does not concern us as much in this paper as the particular advantages or disadvantages it may confer.
(a) Advantages:

Firstly factors improving productive performance. Many people have observed that pre-lamb shorn ewes will seek shelter more readily than woolly ewes at lambing and this may be assumed to increase lamb survival during lambing storms.

Secondly, factors improving managerial flexibility. Ewes tend to become cast less frequently at lambing when shorn and on some properties shepherding has been reduced considerably since the introduction of pre-lamb shearing. Pre-lamb shearing may also confer an advantage through spreading the labour requirement in the spring-summer period, particularly on mixed cropping farms where the peak labour requirement is reached over the period coinciding with in-season shearing. In many districts shearsers are more readily available at this time of the year than later. On properties subject to early droughts, early sale of cull ewes is particularly important and although we can not be certain that the sale of woolly sheep is an unsound practice in all circumstances, the majority of farmers are much happier selling ewes out of the wool. Pre-lamb shearing certainly enhances the possibility of early culling of ewes. On high country, pre-lamb shearing obviates one full muster of ewes with lambs at foot. Pre-lamb shorn ewes need only be re-mustered at weaning. Holding paddocks grazed heavily at normal shearing times are very slow to recover compared with paddocks grazed out in the early spring.

The third factor—liquidity flexibility—is of less importance as compared with other forms of out of season shearing but is still a comparatively important advantage of pre-lamb shearing. Pre-lamb shorn wool is normally sold in October or November or even earlier and consequently the proceeds will be deposited in the bank and in most cases before the peak overdraft level is reached. Consequently pre-lamb shearing may confer a very real benefit to the liquid cash position by overcoming this restriction.

(b) Disadvantages:

Firstly, flock management problems. One of the most commonly-voiced disadvantages of pre-lamb shearing is the increase in feed requirement after shearing. Casual farmer observations have indicated that the increased requirements may be as high at 35 per cent; however, this will vary considerably depending on air temperatures, wind velocity, pasture length and other environmental factors. However, the problem does exist and is accentuated by the fact that the increased feed requirement occurs at a time when feed shortages usually reach their most critical level. A second management disadvantage is that it is very difficult to determine the condition of pre-lamb shorn ewes over the summer period, particularly between weaning and tupping. Ashley Dene trials involving body weights have indicated that eye appraisal of body weight can be well astray on half-woolled ewes over this period even among experienced men. Consequently correct feeding of ewes over the summer period may be extremely hard to judge especially in summer droughts and if mismanaged a resultant drop in body weight may occur. Pre-lamb shearing also complicates dipping procedure. Ewes are dipped out of the wool pre-lamining and again in the normal autumn dipping period. The longer wool in the autumn generally reduces the effectiveness of
the dip and may result in a higher incidence of parasitism as well as an increased dipping cost. Further, the combination of dusty conditions, dip and long-woolled sheep often results in unattractive, dirty wool and may severely reduce the price—this is the first factor responsible for reducing returns through pre-lamb shearing. The stock loss risk is increased during this period through the increased incidence of snowfalls, tighter feed restrictions and the generally colder conditions, the risk may be minimized but rarely completely overcome. Cast for age ewes pre-lamb shorn are generally sold with the wool on. I believe this may often be a disadvantage if the ewes are well-grown and in good condition, but it may be advantageous if the ewes are in poor condition. On top of this there is the very big question of yield and price already covered by Professor Henderson.

2. Double Shearing

Ewes are shorn twice a year, the timing of the interval depending on staple length, but, generally speaking to obtain two even clips the summer period between shearings is from five to five and a half months and the winter interval from six and a half to seven months. The most common choice of months is early to mid-November or mid to late April. As a general rule a minimum staple length of approximately three and a half inches is required and for average-framed Romney ewes this is practicable with total fleece weights of approximately 10½ pounds per head. However this should be treated with some reservation as yield, quality number and body weight will all affect the relationship of wool weight per head to staple length.

Occasionally ewes are shorn as late as July to obtain some of the pre-lambing shearing advantages with a comparable movement of the other shearing back into the summer.

(a) Advantages:

Firstly, factors improving productive performance. Once again these factors depend on casual observations. On dirty properties infested with dense manuka, gorse or blackberry, that I have been associated with, wool weights have improved by as much as one pound per head through a change from normal to double shearing. The increased fleece weight occurs through an improvement in the sheep’s foraging ability. Long-woolled ewes are unable to forage in second growth as easily as shorn sheep and the improvement in utilization of existing feed can often be quite marked following a change to double shearing. There is also some evidence to indicate that where wool weights exceed 12 pounds per head approximately, on hill country a slight gain in weight may be obtained through double shearing due probably to an improvement in the animal’s foraging ability.

Managerial flexibility may be improved particularly on dirty properties where log stain problems occur as usually this may be confined to one six-monthly period of wool growth instead of staining an entire fleece.

The major advantage of double shearing, and this usually far outweighs all other considerations, is the benefit conferred in liquidity flexibility. Most sheep farmers reach their overdraft peak between November and March, consequently if half the total wool income is received six months earlier than under normal shearing conditions the overdraft peak may be reduced by almost the entire amount. Thus if a farmer has a maximum credit restriction of £2,000 at the bank
which he normally reaches in December and he sells an annual wool clip worth £3,000 per year, he could conceivably reduce the overdraft by £1,500 by double shearing. However, when shearing costs are taken into account and the gains from interest saving on the overdraft are assessed this amount will fall a further £50 approximately. A disadvantage which must be mentioned at this stage is that in the initial swing to double shearing, the normal summer shearing date is advanced into the spring to allow sufficient staple length for the autumn shearing. Consequently approximately sixteen months' total
wool may appear on the balance sheet for taxation purposes and if double shearing is commenced in a high profit year, the initial liquidity advantage may be lost through the higher rate of taxation imposed. If on the other hand double shearing is commenced in a low profit year the initial increase over the normal twelve months wool weight may not be lost through imposition of high rates of taxation. My own belief is that the explosion of double shearing in the North Island was triggered off by just these circumstances. Profits were falling and accelerated rapidly in 1958-59. On top of this trading banks and stock firms imposed further credit restrictions forcing farmers to turn to double shearing as one of the most obvious means of sustaining liquidity levels. Many farmers had already had experience of double shearing in the 1951 wool boom and were quite happy to swing back into it.

(b) Disadvantages:

Firstly there are two shearings instead of one per year. On top of this it is still often necessary to crutch the ewes to clear wool from the udder. As far as the price of the wool is concerned there appears to be little or no disadvantage when compared with neighbours' wool prices and prices received for full length wool shorn off sheep on the same property at the same time—certainly for the last few years.

Another less obvious disadvantage is created if a farmer wants to return to normal shearing, through the resultant delay in income and loss in liquidity.

3. Eight-monthly Shearing

Eight-monthly shearing is a variation of double shearing often practised when staple length is too short to allow double shearing or secondly where a farmer is not prepared to swing completely to double shearing and compromises with this system. Usually the months chosen are April, December and October, the cycle repeating itself every two years.

Advantages and Disadvantages:

These are somewhat similar to those relating to double shearing. Productive and liquidity advantages are reduced but still exist and managerial flexibility can be improved on dirty country.

Unfortunately eight-monthly shearing or three times every two years involves two important complications. Firstly, if hoggets and two-tooth ewes are shorn at times outside the shearing dates for the bulk of the flock there may be four major and minor shearings per year and if lambs are shorn as well there will be five. The second complication involves income. The pattern of eight-monthly shearing results in a comparative imbalance of wool income between years. Alternate years' balance sheets will show for taxation purposes one and a third and two-thirds of a normal clip and the same problem exists when overdraft restrictions are considered. If all other income and expenditure items remain static, overdraft levels could only be compared on a two-year cycle and unfortunately most bank managers are more inclined to look at individual year's credit restrictions separately.

4. Pre-tupping Shearing of Two-tooth Ewes

Where double shearing is practised this is often directly incorporated in the autumn shearing. However on many properties using other shearing systems it is practised separately.
Advantages and Disadvantages:

The major advantages of this system have been well covered by speakers at previous Farmers' Conferences throughout New Zealand. Briefly the advantage lies in the improved lambing percentage, particularly from Romney ewes and increases of up to 25 per cent have been recorded. Other advantages and disadvantages are similar to those relating to double shearing.

5. Late February-March Annual Shearing

Although this may still be considered to be in-season shearing in several South Island districts, in others its practise confers particular advantages which are worth considering.

Advantages:

From a managerial aspect, late summer shearing allows better integration of labour requirements. In mixed cropping districts the bulk of harvest and main summer work will be finished allowing shearing to be fitted in much more conveniently. On irrigated mixed cropping farms, the inconvenience of normal in-season shearing may be more extreme than most other types of farming. The second factor is that shearers are more readily available at this time of the year.

Disadvantages:

The major disadvantage is reduced liquidity resulting from the delayed wool income. On some farms delayed shearing may push overdraft levels to higher peaks. Secondly, long wool through the summer may increase discoloration from dirt and the risk of parasitism.

6. Single Lamb Shearing

Lambs are shorn in mid-summer when they may be expected to clip approximately 2½ lb wool per head or more.

Advantages and Disadvantages:

On most properties the major advantage of lamb shearing lies with the resultant increase in thrift of the lambs following shearing. Lambs appear to be much more lively and more thrifty after shearing especially in districts with high summer temperatures. There is also an advantage through advancing part of the lamb wool income by eight months and reducing the death risk in blackberry and lawyer.

There appear to be few disadvantages except that it may not be prudent on properties which normally produce a particularly good line of full-length hogget wool. The reduction in staple length may reduce the price per pound disproportionately, to the disadvantage of the seller.

7. Double Lamb Shearing

This is becoming increasingly common in more northern North Island districts. Lambs are shorn in November or early December and are re-shorn in early April.

Advantages and Disadvantages:

Without doubt the major advantage through increased thrift depends on high temperatures lasting well into the late autumn. Its advantages and disadvantages are similar to single shearing of lambs. It is doubtful that this practice will ever have a consistent place under South Island climatic conditions with lower humidity and cooler autumn nights.
To summarize, out of season shearing is an extremely important and complex subject and deserves much more time and consideration than I have taken. Thirty per cent of New Zealand's wool is shorn out of season, ten per cent eight months' wool and twenty per cent double shear. The factors associated with each particular system are mainly observations and for this reason should be weighed up carefully if a change in shearing time is being considered. I believe that out of season shearing can be a particularly useful managerial consideration if applied correctly and its practise (particularly double shearing) may be expected to increase further in the South Island within a few years.
Selection in one or other of its many forms is the most important tool available to the breeder in his attempts to raise the level of productivity of his stock. The two operations involved in selection—choosing which rams to use in the flock, and deciding which ewes should be culled—have to be carried out year after year by all breeders. In turn, the effectiveness with which they are undertaken is an important factor in controlling the present and future productivity of the flock. Consequently, any method which will increase the efficiency of selection deserves careful consideration.

The aim of this paper is to discuss the principles of selection as they apply to sheep improvement and to elaborate methods which can be used within the present framework of the sheep-breeding industry. While the principles are general in their application, most of the details given will be pertinent to the Romney breed. Moreover, a great deal of the discussion will be devoted to methods which can be used in stud flocks, although some comment will be made about modifications which can be used in commercial flocks. Although the basic problems of selection are the same in the two types of flock, the applications are often simpler in stud flocks where individual identification of ewes and rams is necessary.

Three General Aspects of Selection

In planning a selection programme, one must answer three questions:

1. What characteristics are to be considered in the selection programme and how important is each of these characteristics?
2. How can they be measured and recorded?
3. What is the best way of using these records in deciding which sheep to keep for breeding?

Although these questions are easily stated, it is not so easy to answer them.

The first question is concerned with defining what should be the aim in improving the flock or breed with which the breeder is working. In attempting to answer it, there are two points which are of fundamental importance. First, the greater the number of characteristics of the sheep which one sets out to improve, the weaker is the selection for each one of them and therefore the slower the progress in changing each characteristic. It is therefore essential to keep the objectives as simple as possible. Indeed, it is often advantageous to over-simplify the objective in the interests of faster progress. Secondly, however much the objective is simplified, it is still necessary to select for several characters. In these circumstances, it is necessary to decide on the relative importance of the characters which one wants to improve. One needs to know, for example, how important improvement in fleece weight is in comparison with fleece grade? In effect, a ranking of the characteristics in the order of their importance is required.
One way of approaching this problem is to ask the question: "To what extent does a change in each character increase the financial return from the sheep?" To answer this question requires information on market prices for differing quantities and qualities of wool and lamb over a period of years. Several studies using this procedure have been made of the relative importance of characters of the Romney breed. In general, they all indicate that over a wide range of conditions fertility ranks highest on the list of traits, followed by fleece weight which, in turn, is more important than fleece grade, while conformation makes a relatively insignificant contribution to economic merit.

This approach has the advantage that it is directly related to the financial return that the commercial producer receives. It is one-sided in the sense that it gives no measure of the importance of such characteristics as "hardiness" or longevity. Also it does not take into account the efficiency of conversion of feed to wool and lamb. Its main justification is that it does give immediately useful information to act as a guide to selection while more basic information is coming to hand.

It has been noted that fertility and fleece weight are the two most important traits in the Romney breed. Methods of selecting for these two traits will now be considered.

Selection for Better Fertility

First of all, it is necessary to outline how fertility can be measured on the individual ewe. Although there are many ways in which this can be done, there are only two methods which can be used with comparative ease, at least in stud flocks. They are:

(i) The number of lambs reared by a ewe. A ewe will rear, none, one, two or, very occasionally, three lambs in any given year. Sometimes this can be subdivided further; for example, distinction can be made within the ewes having no lambs, between the true dry ewe and the ewe which has lost her lamb. This is the simplest measure of lamb production and the information on each ewe should be available in the records normally kept in a stud flock.

(ii) The total weight of lambs weaned by the ewe. This measure is a refinement which requires weighing the lambs at weaning. It includes the information given in (i) above but, in addition, the weights of the lambs give information on the ability of the ewe to milk and rear the lambs.

Most of the discussion will be devoted to the number of lambs reared but the same general principles apply to weight of lamb weaned per ewe.

From the viewpoint of improvement by breeding, it must be noted that both number and weight of lambs weaned are characteristics of the ewe and can only be measured on the ewe. No direct information is available on the ram, the only indications of his likely ability to breed daughters with high lamb production coming from the performance of his female relatives. This feature of lamb production must be strongly emphasised because it differs markedly from most other characteristics of the sheep which can be measured on both the ewe and the ram and therefore can be selected directly in both sexes.
A further point to stress is that, in talking about a ram being good or poor for lamb production, it is meant that he will pass on to his daughters a good or a poor inherent ability to produce lambs. The statement does not refer to the ram’s ability to get lambs from the ewes to which he is mated, this being an entirely different characteristic. To avoid confusion, the term “breeding value for lamb production” will be used to describe the ram’s ability to pass on lamb production to his daughters. In effect the breeding value of the ram would be equal to the average lamb production of a very large number of his daughters.

The problem of breeding for increased lamb production is thus, primarily, the problem of how to assess the breeding value of rams or ewes for lamb production, so that the best can be selected for flock replacements.

Selection of Rams

As mentioned earlier, the main information on which an assessment of the breeding value of a ram can be made, comes from the records of lamb production of female relatives. For example, some or all of the following types of information can be available in a stud flock:

(i) The lambing performance of daughters of the ram.
(ii) The number of lambings the dam has had and the number of lambs she has reared.
(iii) The number of lambings and the number of lambs reared by one or both of the granddams.
(iv) The lambing performance of the half-sisters of a ram.

The accuracy and use of all these sources of information have been discussed in detail by the writer (Sheepfarming Annual, 1963, p. 167). Here reference will be confined to the lambing performance of the dam.

The main problem in ram selection is that of selecting the two-tooth ram. As the dam is the closest female relative, her lamb production is the most useful information in assessing the breeding value of her son. It is important therefore to have a simple way of using this information.

The problem is indicated by the following example:

Two-tooth ram A: His dam reared 5 lambs in 4 lambings.

Two-tooth ram B: His dam reared 3 lambs in 3 lambings.

Two-tooth ram C: His dam reared 2 lambs in 2 lambings.

How can one rate these rams from the point of view of their breeding value for lamb production?

An accurate answer is available. Because of the way in which fertility is measured, it can be reduced to a table which is simple to use. The comparisons are given in Table 1, where an index representing the breeding value of the ram can be read off from the number of lambs produced by his dam in a given number of lambings. It should be noted that the index is merely a figure which ranks the breeding values of rams whose dams have differing numbers of records. It cannot be interpreted in terms of lambing percentages or number of lambs. While it would be informative to have a figure
that could be thus interpreted, to do so would spoil the simplicity of
the table.

Adjustments have been built into the table to allow for the fact
that two-tooth and four-tooth ewes normally have a lower lambing
percentage than do ewes of older ages.

Since this table was published in 1958, a considerable amount
of experience has been obtained it its use, and the conclusion has
been reached that in the main it does a satisfactory job of ranking
rams over a wide variety of conditions.

Selection of Ewes in Stud Flocks

There are a number of aspects to this topic and a variety of
things that can be done but often little real information on the
comparative advantages of different methods.

Rising two-tooth ewes have not yet had the opportunity to have
lambs; hence, in the absence of other information, the production of
their dams is the best basis for assessing their likely performance.
Consequently, Table 1 can also be used for assessing the breeding
value of two-tooth ewes as well as two-tooth rams. Information on
other relatives of the ewe will not usually be worth taking into
account.

As far as the older ewes are concerned, the main question is
whether to keep or cull the dry ewes.

The dry two-tooth ewes are the most important group. There
is a considerable amount of information available in New Zealand
about the subsequent performance of the dry two-tooth. For example,
Edgar (1958), in an investigation at the Whatawhata Hill Country
Research Station, found that ewes which were dry as two-tooths
were just as likely to lamb as four-tooths as those which had lambed
as two-tooths. On the other hand, both Barton (1947) and Wallace
(1958) found that the later performance of dry two-tooths was dis­tinctly poorer than those which had lambed. To reconcile these
results, Wallace (1958) suggested that one could think of dry two­
tooths as being of three kinds: (i) infertile, (ii) inherently poorly
fertile, and (iii) temporarily infertile because of environmental and
management effects. The first group will have no lambs at later
lambings; the second group will have poorer performance than those
which had lambs as two-tooths and, in general, the third group will
perform as well as those which lambed as two-tooths. In general, it
appears that the last group will represent a large proportion of the
total dry two-tooths when on average the two-tooths are poorly grown
at tupping. Under these circumstances, the percentage of dry two­
tooths is also likely to be large.

This picture is further complicated by differences between ewes
which are born as singles and those which are born as twins. Again,
a number of studies of this difference has been made. The situation,
as it appears from studies made on flocks run under differing condi­tions at Massey University can be summarized in the following way:

(i) Under poor hill-country conditions, the ewe born as a twin
has a poorer lambing performance, as a two-tooth, than the ewe born
as a single, although her performance at later lambings is better.
Under these conditions, it is common to find that at tupping the twin­
born two-tooth ewe is still smaller on average than the single-born
ewe, i.e. she has not yet overcome the handicap of being born and
reared as a twin.
(ii) Under better conditions, it has been found that the ewe born as a twin has on average the same weight as the ewe born as a single at tupping. In this case, there is usually little difference between the lambing performance of the two types of ewe.

(iii) Under good conditions, the twin-born ewe can overcome its handicap at less than 12 months of age and, in these circumstances, it is usual to find that the twin-born ewes have an average a better two-tooth lambing percentage than the single-born ewes.

Thus, it is apparent that the decision as to whether the dry two-tooth should be kept or culled, must vary from flock to flock. The summary given above, however, would suggest the following courses of action:

(a) Where the two-tooths are poorly grown and the proportion dry is large, either retain them all and cull only those which are dry as four-tooths, or cull the ewes which were born as singles and retain those which were born as twins. The latter method seems to be preferable, especially in a flock where emphasis is being placed on breeding for higher fertility.

(b) Where the two-tooths are adequately grown and only a small proportion are dry, then cull all the drys.

It would appear reasonable that dry ewes at older ages should be culled as well, although there is little information on this point.

Selection for Fleece Weight

Selection for fleece weight and fleece characters is in some senses easier than selection for fertility because these characters can be measured directly on both ewe and ram.

Measurement of fleece weight by the use of a suitable set of scales, or a special wool table with a weighing device incorporated, presents no particular difficulty in a stud flock. Fleece weighing can probably be limited to the ram and ewe hoggets and the selection decisions made on the basis of these weights. If one wishes to include fleece grade and quality number in the selection plan, then grading of the fleeces by eye for these traits will need to be undertaken.

Selection for Both Characters at the Same Time

As mentioned earlier, the practical problem is to select for both fertility and fleece weight and possibly additional traits at the same time. There are two ways of doing this:

(a) By the use of a total score or index which automatically balances the different characters so that the best prediction of the breeding value of each animal can be made. This method will not be discussed because it is quite complex and the breeder would usually need computational assistance in its use.

(b) By selecting, on fertility, a greater number of animals than needed for flock replacements and then selecting for fleece traits within this group. For example, in ram selection, one would first of all eliminate all sheep with faults such as jaw and feet abnormalities. Then, if ultimately five rams were required, select say fifteen whose dams have the highest fertility records as shown by Table 1 and then select the five with best fleece characters from these fifteen.

This second method is less efficient but somewhat easier to carry out without assistance.
Selection in Commercial Flocks

Some brief comment will be made on problems of selection in commercial flocks where detailed information is not available.

(a) Selection of Rams. To the sheepfarmer who is keen on improving the production of his flock and who appreciates the important part that the ram must play in doing so, there seems to be very little to offer in the way of useful information. In purchasing rams, there would appear to be two important points:

(i) Choosing the stud flock from which to purchase. Choosing the stud from which to buy is probably more important than the choice of the ram from within the stud since, in general, the flock ram purchaser will be getting rams which are nearer the average of the stud. The objective should be to choose a stud where the breeder is consistently endeavouring to breed for higher production.

(ii) The purchaser can seek information from the breeder on the performance of the dams of the rams placed in front of him and can use this information to help in his final selection. The point needs to be made that this information will tell much more about the breeding value of the ram for lamb production than any amount of scrutiny in the yards. If information on fleece weights is also available, then this can also be used.

(b) Ewe selection. The extent to which selection can be practised in the commercial flock depends entirely on whether or not a practical method of identification can be undertaken. In this case, it is not a question of identifying individual ewes but of identifying classes of sheep within the flock that differ in their lamb production potential.

(i) Dry ewes. This is the simplest group to identify from the viewpoint of the work involved, and the usual method adopted is the insertion of coloured ear tags. The discussion of the dry two-tooth problem given earlier is pertinent here. Two courses of action can be taken. Where the two-tooths are not well grown and there is a large number of them, keep them for a further lambing and cull the twice drys. The main way of improving lambing percentages in these circumstances will be by nutrition rather than by breeding. Where the two-tooths are well grown at tupping, then cull those which are dry.

(ii) Twin lambs. Identification of twin ewe lambs by ear mark is more difficult in terms of the work involved. The fact that a ewe is born as a twin gives two useful pieces of information. First, in selecting two-tooth ewes, it allows emphasis to be placed on selecting twin ewes to enter the flock. Secondly, it indicates that the lamb has had a handicap to overcome and due allowance can be made for this handicap in assessing what to do about the dry two-tooth ewe. That is, it allows one to retain the dry two-tooth which was born as a twin, while culling the single-born dry two-tooth.

(iii) Ewes with above-average lamb production. There are various groups of ewes in the flock which will be above-average in their lamb production. Providing that these ewes are lambed separately so that it is easy to mark all ewe lambs from them, they
can make a positive contribution to raising the production of the flock. For example, if dry ewes are identified by coloured ear tag, then it is possible to select from among the six-tooth ewes and older, the ewes which carry no tag. One will then have a group of ewes which, as a minimum, will have at the time they are picked out—reared two lambs in their first two lambings. If the ewe lambs from this group are identified, they can be given preference at the time of selecting two-tooth ewes to enter the flock.

Another elite group of ewes in the flock are the twin-bearing ewes. There is more work in identifying them but preliminary studies would suggest that there is a substantial advantage in doing so. Ewes which have twins at both two-tooth and four-tooth lambings not only have more lambs in their own life but also daughters which are up to 15 per cent better in lambing percentage than those which produce only singles or are dry at these two lambings.

Selection for wool will largely be carried out at hogget shearing. Methods of fleece weighing have been developed for commercial flocks but their use depends on the extent to which the flock owner is willing to take trouble over the selection of his sheep.

Discussion

The general outline given above of the practice of selection is enough to indicate the philosophy behind modern methods of selection. The basic requirements of any plan for breeding improvement are: (i) simplification of the objective in breeding to two or three characteristics which have major importance in controlling economic merit, (ii) measuring and recording the performance of the individual animals, and (iii) appropriate analysis of the records in order to make selection decisions. The application of these three requirements has achieved marked success in the breeding of dairy cattle, poultry and pigs. It is thus important to consider whether the present structure of our stud-breeding industry is such that it can utilize this approach.

The main essential in such an approach would be the development of a performance-recording service to assist the breeders with the problems of measurement and recording, to organize the analysis of the records (not a difficult problem with modern data-processing methods), and to present the records in an appropriate form for the making of the selection decisions. The service would also help in the interpretation and follow-up analyses of the information obtained. It should be noted that such a service could be able to utilize more complex selection procedures than those outlined in this paper. In effect, I have outlined a "do it yourself" procedure, but there are many ways in which this procedure can be made more effective. In effect, the service would supply the sort of assistance which the dairy industry has had for the last 30 years.

In conclusion, it must be stressed that we are passing out of a leisurely era of agricultural evolution into a period where rapid and sustained progress must be made. It is clear from developments overseas that our present organization of pedigree breeding just cannot cope with the demands which will be placed on it, and that the obvious first step towards coordinated effort is the development of a recording system along the lines mentioned above.
TABLE 1
The Lamb Production Index Based on the Dam's Records
(corrected for age)

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</table>
Administration

The Wool Research Organisation is an autonomous body which was formally inaugurated by its registration as an incorporated society in January 1961.

The control of the organisation is in the hands of an executive which consists of four members appointed by the Wool Board, namely, Messrs Bethell, Briscoe-Moore, Chapman and Callaghan, and three members appointed by the Minister for Scientific and Industrial Research, namely, Mr Hilgendorf, Mr Duncan of the Department of Agriculture and Dr I. K. Walker, director of the Dominion Laboratory. An ex-officio member of the executive is the permanent head of D.S.I.R., namely, Dr W. Hamilton. I was appointed as director in December 1961, and took up duty on a full-time basis in June 1962. There have been no changes in the executive except that during the last twelve months Mr Hilgendorf has found it increasingly difficult to attend meetings, and resigned, and his place has yet to be filled.

Mr Bethell has been our decisive and vigorous chairman, so that delays have been cut to a minimum. The rest of the executive, and all other members of the Wool Board, have also been very cordial and helpful in many ways so that we have had a smooth development.

Budgeting for Staff and Facilities

The nominal income of the organisation is £100,000, made up of two grants each of £50,000—one from the Wool Board and one from the Government. In addition, these bodies have each granted towards the cost of the building a further £25,000 during the two financial years 1964-65, 1965-66, i.e. a further £100,000 in toto. They have expedited development considerably, as the financial basis of the organisation was such that money for buildings and initial equipment had to be saved out of income during the early years.

It will still be some years, however, before our research activities reach the full potential possible within the limits of our present income. This can be seen from the accompanying graph of our annual budget for the first ten years. In the graph, the level of expenditure on salaries and consumable supplies for research staff is a guide to the level of research output. It will be seen that salaries and supplies do not reach their full share of the budget till 1969. In the early years the major allocation is to the laboratory building, and had we not had the additional grant for the building, the building expenditure would have had to be pruned and staff build-up further delayed.

The gradualness of staff recruitment indicated by the budget is only partly due to the need to save money for buildings. In the long run the value of research output is determined by the calibre and field of training of your staff. The world demand for high calibre research staff is increasing faster than the supply of them. More-
Grants to Massey and Lincoln Colleges

Annual Expenditure in £1,000's

- Building Fund
- Research
- Fellowships
- Equipment
- Administration
- Salaries
- Consumable supplies

Years: 1962 to 1970

Expenditure reaches £150,000 p.a.
over, for the research projects we have in mind, only certain fairly specialised types of post-graduate training are a suitable preparation. It was, therefore, decided to secure some of our professional research staff by awarding nine generous research fellowships to outstanding graduates of New Zealand Universities to enable them to obtain training to the doctorate level in overseas universities in the special fields required. A condition of the award is that these graduates return and work at our direction for at least two years.

The nine Fellowships have now been awarded. Four Fellows are at present training in the U.S.A., four in England, and one, Dr Wickham, has returned, and is working at Lincoln. The budget graph shows the finance provided for the Fellowships passing through a maximum this year and then tapering to zero by 1966-67.

A detailed list of the equipment required has been made and its total value is about £100,000 and it is estimated that annual purchases after the building is fully equipped will probably be at a level of about £16,000 p.a. Only about one third of the equipment can be purchased by the time the laboratory is to be available in mid-1966. The remaining two thirds of the equipment is budgeted for purchase in the next two years. This delay is somewhat unfortunate and a good deal of thought will probably have to be given to priorities in selecting the equipment to be available in the first year of operation. It may not be as serious as it may seem at first, as the exact brand of some types of instrument can only be decided after research projects have been decided in detail, and this will probably take the newly returned Fellowship holders some time to do. Some of them will probably start with surveys of the literature, evaluations of the benefits of various alternative projects, and preliminary work making some use of equipment in other laboratories. Subscriptions to the main research journals were commenced last year and reprints of relevant papers from earlier journals are being collected, so that a fairly good library will be available when the laboratory opens. One of the serious gaps in the libraries of this area, i.e. of Lincoln College and D.S.I.R. is the lack of Chemical Abstracts. Chemical Abstracts is the premier abstracting service for chemical and physical research, but its price has been raised successively in the last ten years. At the concession rate to Universities it is now £180 p.a. Lincoln subscribed for some years then terminated because of the cost. D.S.I.R. Lincoln carried on the subscription for a few more years and then terminated when there was another price increase. The Wool Research Organisation has made grants to Lincoln to buy the back numbers missing from the combined sets of the College and D.S.I.R., to purchase the quinquennial index, and subscribe for a few years—about £1,000 in all. These abstracts will remain College property. We hope the College and D.S.I.R. will eventually share with us the cost of the subscription.

The budget provision for administration costs is made up of three-quarters of my salary, my secretary's salary, travelling expenses for executive meetings, accountancy charges, advertising, etc., etc.

Buildings

The laboratory building will be a high quality one by world standards. Its general appearance is indicated by the photograph of the model. Many features in the design are very similar to those of
the Meat Industry Research Institute at Hamilton, and it has been designed by the same architect, Mr Philip King. We could have developed some research projects more rapidly by purchasing an existing building, and fitting it out with laboratories. This is much more expensive in the long run. Sometimes the purchase or erection of temporary buildings is the correct procedure—for instance in wartime. But as many of you know from personal experience, temporary buildings can become an almost permanent eyesore and limitation.

The contract for the construction of the laboratory was signed with John Calder Ltd. on 3rd February this year for completion by 3rd April 1966 at a cost of £339,472. Bulldozing of the area to be occupied by the two wings has been done, and pouring of concrete for the foundations of the southern wing was commenced on March 12th. So far the rate of progress is quite pleasing.

Research Programme

Part of our research expenditure is by way of grants to other institutions. For example, the organisation is now the vehicle for continuing certain grants formerly made to Massey and Lincoln by the D.S.I.R. and Wool Board.

At Lincoln these grants pay the salaries of about four technicians and one postgraduate student in the Department of Wool Science, the salaries of two technicians in Microbiology assisting in research in fleece discolorations, the salary of a research officer working on factors determining wool prices in the Department of Agricultural Economics, and they have been used for the purchase of surgery equipment for the Johnstone Memorial Laboratory.

At Massey they pay the salaries of technicians assisting in sheep breeding and husbandry projects, and the salary of one permanent Research Fellow Dr F. R. Cockrem.

£15,000 per annum is provided for these grants. For research within the W.R.O. laboratory, about £85,000 p.a. is therefore available. Now, about £5,000 p.a. is required to support a professional officer engaged in bench-type research. This allows for his salary, supplies, and the usual ratio of laboratory, clerical and other assistance. We can thus calculate that seventeen professional officers, i.e. sixteen in addition to the director can be supported with the £85,000 per annum.

It has been decided to allocate eight of the sixteen to basic research. This is aimed at obtaining a deeper understanding of materials and processes that are of importance to the industry. Eight people will be devoted to applied research projects, each of which will be aimed at producing some particular benefit to industry. It is advisable to have at least two, and preferably more than two professional people in any field of research so that they can criticize one another’s ideas, and collaborate for faster progress on projects that promise large rewards. As there will be only eight professionals in each research field, it follows that we should attempt to develop not more than three or four fields in basic research, and not more than three or four fields in applied research.
A good deal of thought has been given to the selection of these field, and they have decided as follows:

The fields of basic research will be:

1. **Fibre structure as revealed by a study of the biosynthesis of the fibre in the follicle.** In spite of the very large amount of research that has been carried on for over thirty years into the chemical structure of the wool fibre, this is still not completely known. Two scientists have obtained Nobel prizes for methods developed for analysing the fibre, and a great deal has been established, but the molecule of which the fibre is composed probably consists of thousands of atoms so that the task of establishing the exact positions of all the atoms is a tremendous one. Until this constitution has been completely established, however, methods of modifying the wool fibre for dyeing, mothproofing, mildew resistance, shrinkproofing, improved abrasion resistance, altered water absorption, or mechanical properties are to a greater or less extent trial and error. If nothing was known about the chemistry of the wool fibre, it could well be expected that a person could spend several lifetimes on end, unsuccessfully, in attempting to produce some of the modifications required. We are going to attempt to contribute to the knowledge of the chemical structure of the fibre by studying the chemistry and biological features of the synthesis of the fibre in the follicle of the skin. This line has been chosen partly because it represents a new approach to the problem of determining the fibre structure, partly because it takes advantage of the available people trained in wool biology at Massey and Lincoln Colleges, and partly because it also takes advantage of the availability of animals through our location at Lincoln.

2. **Fibre Modification.**—This will have the ultimate object of stiffening or softening, straightening or crimping, strengthening or mothproofing of fibres. It will ultimately be largely an applied field, but in the early stages is best undertaken as an extension testing of knowledge built up in the structure group.

3. **Wool Water relationships.**—This field will be developed because control of these in commerce, processing and clothing comfort still leaves much room for improvement.

The fields for applied research are:

1. **Materials handling of greasy wool from shearing floor, to stores, sale, ships and eventually into the scour of the mill abroad.** The first project to be developed in this field will be that of denser dumping for export. The Dominion Laboratory have done some preliminary work in this field and this will now be taken further by the Wool Research Organisation.

2. **The materials handling of slip wool.**—The first project to be developed will be improved methods and chemicals for removing wool from sheepskins. This work will, initially, at least, be carried on in conjunction with the Leather and Shoe Research Association.

3. **Carpet manufacture and carpet wool.**—Research in carpet manufacture will be directed initially at determining optimum methods.
of manufacturing carpets with large percentages of New Zealand wool. The manufacturer, and evaluation of tufted carpets with a short dense pile is the first project.

The imparting of additional crimp to New Zealand wools, and ways of reducing the incidence of discolorations in our wool, and of bleaching or stabilizing these discolorations to eliminate present colour-fade troubles are also contemplated.

**Denser Dumping**

The project that seems to offer the biggest rewards in the reasonably near future, is that of denser dumping.

Many factors enter into the cost of transporting goods by ship, including the pattern of trade, design of ships in use and so on, but a study of the freight rates at present charged, suggests that the cost of transporting wool should eventually be reduced, or the tendency to increase arrested, if wool was exported as a denser cargo. This is not a suggestion that bales should be made heavier, but that, if of the same weight as at present, they should be made smaller, i.e. the density, expressed, if you like, as the number of pounds per cubic foot, should be increased. This is quite possible because 80 or 90 per cent of the volume of an ordinary bale of wool is just air.

![Graph showing freight rate variation with density](image)

The way in which some freight rates at present vary with density is indicated in the accompanying graph. The general cargo rate from New Zealand to Europe on 3rd April, 1964, was 335/- per sea ton. A sea ton is the actual weight in tons, or the number of cubic feet occupied per ton weight divided by 40, whichever is the greater. For example, if a ton of the cargo occupied 40 cubic feet or less, the freight rate is 335/- per actual ton of weight, but if a ton occupied 80 cubic feet, the freight would be 670/- per ton. If
a ton occupies 80 cubic feet, there are 28lb in each cubic foot, i.e. its
density is 28/ft³; and if the freight is 670/- per ton this is equiva-
lent to 3.6d per pound. By assuming various volumes to be occupied
by a ton weight, the graph of freight per pound has been calculated.

The freight rates for greasy, slipe and scoured wools (2.714,
3.075 and 3.45d/lb respectively) are also shown on this graph, plotted
against the average densities found for these type by one dump, viz.
24.5lb/ft³, 22.0lb/ft³ and 18.41lb/ft³ respectively. Greasy, slipe and
scoured wools compress to different densities because the main resis-
tance to compression comes from the wool fibre alone. They therefore
compress in the dump till they have about the same density in clean
fibre per cubic foot, and the extra grease and dirt in greasy and slipe
wool results in a greater total density for these wools. It will be
seen that the freight rate for the different types of wool varies with
density in much the same way as the general cargo rate, but that
wool enjoys a lower rate overall; presumably because of the volume
of it, and its comparatively easy handling and stowage. It appears
from this graph that if one were to increase the density of dumped
greasy wool from 24.5lb/ft³ to 27lb/ft³ the freight cost should drop
about 8/- per bale, and £600,000 annually over the whole clip. If,
therefore, we can increase the density from 24.5lb/ft³ to 27.0lb/ft³
with an added cost of much less than 8/- per bale, say 2/- per bale,
there should still be a good chance that even if the shipping costs
do not decrease quite as fast as shown, there ought to result a net
annual saving of more than the whole annual cost of the Wool
Research Organisation.

The Dominion Laboratory and C.S.I.R.O. have both looked into
the question of the amount of extra strapping that would be required,
to hold the wool at greater densities under various pressing conditions.
It appears that in New Zealand a 10 to 20 per cent increase in
density of single dumped bales, which comprise about a quarter of
the clip, could be obtained using existing dump presses with no more
than one extra wire, provided the wires could be secured when taut
around the bale. The reduction in volume obtainable is indicated by
this slide. To develop a technique of taut-banding in a fast and
economical manner, is our first objective. We have only just started
on this ourselves. An engineer, Mr Alan Barker, joined our staff
on the 10th February. He has been familiarizing himself with the
work of the Dominion Laboratory and tonight moves down to Christ-
church to establish himself in quarters being loaned by the Engineer-
ing School here.
AIMS OF BEEF CATTLE SELECTION AND METHODS OF ACHIEVING THESE AIMS

R. A. Barton, Senior Lecturer in Sheep Husbandry, Massey University of Manawatu.

In New Zealand, the profits from raising beef cattle have usually been low and indeed in some years financial losses have been made. Sheep production, cropping and seed sowing have all shown higher returns per acre than those obtained from beef cattle alone. Yet, in spite of this, the numbers of beef cattle are steadily climbing and at the present figure of 3.5 million head, they now exceed by 500,000 the number of dairy stock in New Zealand. The number of beef cattle in the South Island is 563,000 or only 16 per cent of the national total.

It is probably true to say that cattlemen in the South Island are less hampered by tradition than their North Island counterparts. They are more ready to experiment and try out new methods. This attitude augers well for the future as cattle breeding and management practices must be subject to change if the enterprise is to be made more profitable and the final product is to become more acceptable to the consumer.

At the outset, it will be as well to state the goals in beef cattle breeding and production. The following goals will be purposely at a high level in order to stretch the skill and resources of the individual producer wishing to achieve these.

1. Attain a herd calving percentage of at least 95, including heifers calving for the first time at two years of age. There must also be a complete absence of calving troubles.

2. Achieve a weaning weight of at least 450 pounds for heifer calves and 500 pounds or more for steer calves when weaned at about seven months. Due allowance should, however, be made for age of cow and age of calf at weaning.

3. Establish a growth rate after weaning which enables the steers to be ready for slaughter at 16 to 18 months and yield a carcass of 550 to 700 pounds.

4. Select cattle with a conformation that is compatible with structural soundness and carcass desirability.

5. Produce animals that yield a carcass with weight in the high-priced back and hindquarter regions having a large proportion of red, attractive meat covered with an optimum amount of white-to-creamy-coloured fat. The beef, when cooked, must be satisfying and therefore tender, succulent and flavourful.

6. Ensure that the animals have a temperament that makes their handling a simple and pleasant task.

7. Retain breeding stock that live and produce efficiently at a highly-productive level until an old age.

8. Insist on a total absence of hereditary conditions such as horns and dwarfism, or defects of the feet, jaws, udder, eyes and reproductive tract.

9. Cattle which have all these qualities will be those that best suit your farming conditions and will give you the highest net return.

These goals should be now be considered in detail:
High Calving Percentages

The influence of heredity on reproductive performance or fertility seems to be low and consequently progress resulting from selection will not be great. Fertility is a complex character with calving percentages depending upon many factors. Obviously there are many chance environmental influences that can affect fertility, and these operate from the start of the mating season right through until the calf is weaned. There is, however, no doubt that fertility is of major importance and hence attention must be paid to it in selection.

There are a number of practical steps that can be taken in breeding for higher fertility. In selecting bulls, choose only those out of cows with good fertility records and by sires with high fertility. The selected bulls themselves must also be highly fertile as determined by a semen examination.

In selecting replacement heifers to go into the herd, attention should be paid to the fertility record of their cows; those out of shy-breeding cows should not be chosen. The heifers too must be well grown, as large size is an indicator of fertility, growth rate and probably of potential milk production, too.

A cow which fails to get in calf, or one that does not wean a calf, or one that has a late calf, should be culled. Maximum fertility is the aim so there is no opportunity to give cows a second chance.

Pregnancy diagnosis is a simple and valuable aid when attempting to breed for higher fertility. This test can be accurately carried out from 60 days following mating. It involves restraining the cow in a crush. The person making the examination feels the ovaries and uterus through the wall of the rectum and can determine whether the cow is in calf and whether it will calve early or late in the season. With this knowledge the breeder can cull those cows which are empty and, if he wishes, he can also cull those which are going to calve late. Pregnancy diagnosis provides early information which can be obtained later at calving time. Its advantage lies in being able to cull before the winter, thereby making management of the herd easier.

The cow which gets in-calf late is an inefficient one, simply because it has had a longer-than-normal interval from calving to first heat or because it has experienced more heat period and hence services before it has become pregnant. The aim is to have all cows settled at their first service. Among other things, this ensures a compact calving which, in turn, leads to greater uniformity in the size of calves at weaning.

A heifer ideally should be mated first as a yearling and calve down without difficulty as a two-year-old. To achieve this the heifer must be wintered so that it gains weight at the rate of a pound a day and weigh at least 600 pounds at mating. Early breeding has the decided advantage that it adds another calf to the total the cow will have during its lifetime. In addition, it is known that if body fat amasses in the udder before the first lactation, this may adversely affect the level of milk production. This situation, however, is hardly likely to be of any consequence in heifers calving at two years of age.

Freedom from calving difficulties is an essential feature of any herd. It is true that the incidence of calving troubles in beef herds is low but nevertheless no cow should be retained in the herd if she
has had assistance at calving. By culling her, it is assumed that the condition is inherited and/or likely to be repeated at subsequent calvings.

**Heavy Weaning Weights**

There is a trend towards slaughtering cattle at younger ages; therefore growth before weaning tends to make up a greater proportion of the animal's total growth. Accordingly, weaning weight becomes an increasingly important character. The nursing or mothering ability of the cow is reflected in the weaning weight of her calf. It is true that the calf's own genetic make-up for growth contributes to its weaning weight but, in any case, half of what it has inherited comes from its mother.

Mothering ability of cows can be evaluated reasonably accurately by the weaning weight of their calves. Furthermore, cows tend to repeat their performance at subsequent calvings; thus those cows weaning heavy calves one year are very likely to do so in succeeding years.

Most farmers, and many stud breeders, will not have scales suitable for weighing calves. This should not, however, deter them from culling cows with light-weight and poor calves. A simple method of doing this is to separate off the poorest calves at weaning time and, after a few hours, let them find their mothers. This will identify the poor-producing cows and these can then be rounded up and marked for culling.

Adjustments can be made to the weaning weights for age of calf, age of dam and sex of calf, as each of these non-hereditary factors affect weaning weight. These adjustments will make comparisons between animals more accurate.

From overseas studies it has been established that something like 30 per cent of the variation in weaning weight due to hereditary causes. This figure is the heritability estimate for weaning weight. It gives an indication of the expected response to selecting for heavier weaning weights. For example, if the average weaning weight of the animals selected to go into the herd is 30 pounds above the average of all the calves weaned, then the progeny of the selected animals can be expected to be nine pounds heavier than if no selection had been practised for this character (30% x 30lb = 9lb). The heritability estimate of the character gives an important piece of information and largely determines what selection methods should be employed and whether progress in the improvement of the character is likely to be made.

The birth weight of the calf naturally contributes something to its weaning weight. A heavy calf at birth will consume more milk, will be stronger in its early life and therefore more likely to end up with a high weaning weight. Birth weight, too, is strongly inherited. There is a danger, however, if calves are too heavy at birth that this might contribute to calving difficulties. The aim should be an optimum birth weight of, say, 80 to 95lb, depending upon breed, age of cow and sex of calf.

**Rapid Growth Rate**

Growth rate and economy of gain are closely related, so selecting for one means, in effect, selecting for the other. The more rapidly
cattle grow and fatten, the sooner they can yield a profit. Economy of gain takes into account the efficiency of converting feed into live-weight and hence beef.

It is known that growth rate is strongly inherited and therefore capable of being improved by selection. Bulls which have been weighed at specific intervals and shown to have high daily rates of gain should be selected as herd sires. It is indeed gratifying that beef cattle breed societies in New Zealand are now informing their members of the availability of mobile weighing scales and a scheme for the recording of the weights of their cattle. In the future, increasing numbers of beef bulls should be offered for sale on the basis of their liveweight gains, together with other important production details. Those with the best records should be keenly sought after as these are much more likely to leave offspring of superior performance.

Heifers could also be selected for breeding on the basis of their liveweight gains. They should be fed to gain, not at maximum rates but rather at a rate of about one pound a day during their first winter. If they are full fed on grass and concentrates at this age, their reproductive performance and subsequent mothering ability may be affected adversely. In any case, since a high proportion of heifers are required to go into the herd there is not much opportunity to select for growth rate on the female side.

Fast-gaining cattle are usually those with more red meat and less fat in their carcasses than slow gainers. As this is a desirable situation, they should be preferentially selected as future breeding animals. When the fattening stage is reached, the animal is unable to make rapid liveweight gains as it takes about two-and-a-half times as much food to produce a pound of fat as it does to produce a pound of lean. This similarly applies when making comparisons between animals of any age; some are prone to produce higher proportions of fat, rather than lean, and these tend to be the slow gainers.

Animals light at weaning may subsequently make more rapid daily gains in liveweight than heavy calves. This is called compensatory growth and can occur at any time following a period of under-nutrition. If weaning weight is not taken into account, when assessing rates of gain following weaning, it is possible than animals may be selected from cows which have poor milking ability.

Final mature size is important and this is, as would be expected, related to liveweight gains. Large size in cows has been shown to be a significant factor affecting calving percentage. For instance, in a New Mexico study it was shown that large-type Hereford cows had a calf crop which was 12.2 per cent higher as compared with compact Hereford cows. It was also found that the large cows were better adapted to the rigorous range of conditions and were therefore able to maintain higher reproductive rates. The same general finding emerged from a study of conventional and comprest cows under Colorado range conditions in that the conventional cows had an 8.4 per cent higher calf crop.

Conformation, Structural Soundness and Carcass Desirability

In the breeding of stud cattle at the present time, a great deal of attention is paid to type and body conformation; indeed these dominate the stud cattle-breeding scene. How really important are they?
Type is clearly of little or no importance as far as beef is concerned. It is thought to be important by the breeder as an advertisement of his breed of cattle—this is particularly true in the case of colour markings and type of coat.

Conformation should be mainly concerned with structural soundness which may contribute to longevity and ease of movement and to beefiness, particularly in the region of the high-priced cuts of the back, loin, rump and round. If conformation is mainly concerned with the shape of head, development of brisket, tail setting, and the like, then it is unlikely to contribute much, if at all, to improved beef potential of the selected animals.

Yield of Meat and Eating Qualities

A high yield of red meat, especially from the expensive cuts, is the goal. Yield of red meat can vary considerably between animals from the same herd and raised together. Identification of the high yielders must be the aim of the breeder. These will be the cattle with long, wide bodies, lacking a little in smoothness and having no great depth of body. They will also be free from excess accumulation of wastey fat and they will be found among the fastest-gaining animals.

The eating qualities of the beef are of major importance. There is no known relationship between the appearance of animals raised together, of the same sex, age and condition, and the eating qualities of their meat. This can be appraised effectively only after the meat has been cooked under standard conditions, tested mechanically or chemically, or eaten by persons trained to discriminate between several grades of the various palatability factors.

Tenderness is the most important factor that all consumers want in meat. There are large differences between animals in the tenderness of their meat and some of the variation is due to hereditary factors within and between breeds of cattle. It is known that nutrition and management, age of the animal at slaughter, length of the ageing process after slaughter, freezing and storage practices, and cooking methods, will all affect tenderness and perhaps other qualities of the meat. Certain cuts from the same carcass will also be more tender than others. Considerable research effort is being directed at this most important attribute of meat and various procedures have been evolved to artificially tenderize meat, none of which will make all meat equally tender. This means that it continues to be necessary to produce animals with tender meat.

As tenderness is highly heritable, rapid improvement ought to be possible. In America, samples of muscle are removed from living bulls and those with tender muscle are retained for breeding as they should sire offspring with tender meat. Another approach is to appraise the tenderness and other eating qualities of meat from a sample of each of several bulls’ progeny and those bulls whose progeny produce the most desirable meat are kept for further breeding. This progeny test is slow because of the long intervals from mating until the offspring are finished and slaughtered.

Other palatability factors, such as flavour and succulence, are related more to age of the animal, the amount of fat in the meat, and to the cooking methods than they are to hereditary factors.
One carcass trait that is sought after, at least in America, is size of the ribeye. This is the red meat in the wing rib and its area can be measured on the carcass. The largest ribeye areas are usually associated with minimum amounts of covering fat and younger cattle. The ribeye area is a highly-heritable characteristic and therefore selecting for it should produce worthwhile improvement in carcass desirability. This train, however, is difficult to evaluate on the live animal without special ultrasonic equipment. It can, of course, be assessed in the carcasses of the progeny bulls, and those whose progeny excel in this feature should be used widely.

Temperament

Docile cattle are known to fatten more readily, they are much easier to handle and they cause less damage to gates, fences and yards. Bulls which have a nervous, wild temperament should never be used and cows which are difficult to handle should be culled. Management practices are important in quieting cattle and every opportunity should be taken to train them; nevertheless, there will be a proportion that fail to respond to this treatment. These are the ones to cull; if they stay in the herd they will only upset the remainder and they may also beget their kind.

Longevity and Efficient Production

The higher the proportion of old cows in the herd the lower the proportion of heifers that have to be added to maintain herd numbers. This has several advantages, the most important of which are: culling of heifers can be more severe and calving percentages will be higher because of the small number of young cows in the herd.

Under good conditions, cows will continue to perform satisfactorily up to and, in some cases, beyond the age of twelve. A cow is certainly not too old at nine years for most farming conditions and, unless she has deteriorated seriously in condition, or in her movements and in her production, she should be retained for further breeding.

As far as bulls are concerned, there are definite advantages in using them for only two or three years. With a short life in the herd, they will not mate with their own daughters and they will be more active. This practice will also achieve a quick turnover of generations on the bull side which is an important factor in obtaining maximum rate of genetic gain.

Hereditary Defects

Fortunately among New Zealand herds hereditary defects appear to be rare. A few dwarf calves have been born in stud herds of the three beef breeds but their incidence is fortunately much lower here than in America. Most hereditary defects are simply inherited; when they occur in stud herds both the bull and the cow should be culled even though they may be high-priced animals.

The modern, world-wide trend is towards polled cattle. Horns can easily be bred against by using true-breeding polled animals, but if the progeny of horned animals crossed with polled animals are bred together, even though polled themselves, about half the offspring will be horned.
A reasonably-common eye trouble, mainly of Herefords, known as cancer eye, has been found to be quite highly inherited. This means that the condition can be avoided by breeding from cattle which never develop cancer eye. If Herefords are selected with pigmented eyelids, these will have a lower incidence of cancer eye than those with unpigmented eyelids.

Some defects of the cow's reproductive tract and its udder, have an hereditary basis and cows with these should be culled. Undershot and overshot jaws and weak feet and legs may also be inherited.

**Conclusion**

In order to make progress in breeding more productive cattle, considerable effort will be required to weigh, record, analyse, and interpret the findings. A major problem, too, as the one of accurate identification of cattle so that records can be easily and reliably obtained. A further difficulty lies in the attitude of the cattle breeder towards the task of breeding more productive animals. He will have to jettison some long cherished ideas and perhaps cull some show winners but, in doing so, he will be contributing much to the future of the whole beef-cattle industry.

The commercial run cattle breeder has a significant role to fulfil too. He has to be sure of his goals and insist on the stud breeder producing bulls that will more nearly meet his targets. He too has a problem of identifying individual animals for culling purposes and this will involve him in special branding or tagging and the keeping of certain records, together with the determination to use these records wisely.

There are a few herds where all this is practised and in which the results speak for themselves. The need of the future is to increase the number of such herds until it becomes universal practice to breed for greater productivity. The present-day financial rewards for beef are good and there are large and valuable markets available. Now is the time to get on with the job and use the considerable body of scientific information to guide you in this task.
THE PROFITABILITY OF IRRIGATION IN CANTERBURY

J. D. Stewart, Acting-head of Farm Management and Rural Valuation Department, Lincoln College, and D. A. R. Haslam, Farm Management Department, Lincoln College.

1. Introduction

During the summer of 1962-63, at the request of the Irrigation Development Association of the Ashburton-Lyndhurst Irrigation scheme, the Farm Management Department of Lincoln College undertook a survey of irrigation and dry land farming in Mid-Canterbury. The objective was to obtain information on the comparative profitability of irrigated and non-irrigated farms. This information was required by the association as a basis for the negotiation of new contract rates for irrigation water, as the existing contracts were then due to expire at the end of the 1962-63 season.

Physical and financial data for the three production years 1959-60, 1960-61 and 1961-62 were obtained from 130 farms. Of these, 108 were on light land (Lismore series). This paper is concerned with these farms only, the remaining 22 being on better class cropping soils. Of the 108 farms, 65 were being irrigated from the Ashburton-Lyndhurst scheme, under varying levels of watering intensity. This was a comprehensive sample of irrigation farms over 200 acres. The remaining 43 farms which were non-irrigated were located outside the boundaries of the scheme, but under similar environmental conditions.

The results of the survey* have been fairly widely publicised. They gave quite clear indications that after due allowances had been made for different farm areas and for their correspondingly different levels of investment, irrigated farms were showing a margin of profit no wider than non-irrigated farms. There was in fact some indication that the opposite applied. We have been led to believe that opponents of irrigation in other districts, where the results do not necessarily apply, have used the survey to support their opposition. The survey has even been called a "national disaster." We know that there are quite a number of people who genuinely feel that further development of irrigation on the Canterbury Plains has been put back many years by the publication of the survey results.

We would share the concern of those who feel that the results have been interpreted too generally. But we could not have been more specific in designating the area to which the research applied, and in describing its physical environment. We were careful to point out in the conclusions to the survey that they related to "the class of land and climate covered by the survey . . . the type of farming generally practised . . . and the existing technological conditions.” Having taken this care we believed that it was our obligation to publish the facts which the research uncovered, even at the risk of unpopularity in some circles. It should also be emphasised that the research was specifically aimed at determining the capacity of irri-

gated farms to meet increased water charges. It was not primarily concerned with the wider aspects of irrigation economics.

2. Relative Profitability of Dry and Irrigated Farms

In an attempt to understand the survey results, we investigated the financial and physical features of 11 dry land and 13 medium irrigated farms of Table 1.

TABLE 1
Financial Results on Light Land Farms
300-499 acres

<table>
<thead>
<tr>
<th></th>
<th>(a) Non-Irrigators</th>
<th>(c) Medium Irrigators</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Number of farms</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>(2) Average area in acres</td>
<td>425</td>
<td>374</td>
</tr>
<tr>
<td>(3) Average acre/feet water per acre</td>
<td>—</td>
<td>0.64</td>
</tr>
<tr>
<td>(4) Average total farms capital (£)</td>
<td>23,118</td>
<td>28,446</td>
</tr>
<tr>
<td>(5) Average Owner's Surplus (£)³</td>
<td>1,328</td>
<td>1,064</td>
</tr>
</tbody>
</table>

We aggregated and averaged the relevant data for these farms and the results are presented in Table 2. (Details of this table are given in Appendix 1).

1. Stewart (op. cit.) Table 5 p. 10.
2. Farmers who used between 0.4—0.79 acre feet of water per acre of the farm, as an annual average over the three survey years.
3. Owner's surplus is the residual of income available to the farmer as a reward for management, after meeting all working expenses including depreciation, and interest at 6 per cent on the total farm capital.

Table 2 shows that when compared with the average 300-499 acre medium irrigated farm the average 300-499 acre dry land farm has heavier investment in land, stock and plant, with the result that total farm capital is some £5,000 greater. Secondly these irrigators are carrying only half a sheep per available acre more than the dry land farmers. In particular, both these average farms carry the same number of breeding ewes and the extra stock unit is composed of dry sheep and cattle.

Therefore it is not surprising to find the total farm income is only £400 greater on irrigated farms and farm expenses are also greater.

The survey results showed that the average irrigation farmer was making at least no more profit than the average dry land farmer, and in fact indications were that the opposite applied. Table 2 shows that the extra half a sheep per grazing acre carried by the irrigation farm is not sufficient to sustain the additional £5,000 capital investment.

However, we wish now to emphasize that we have never suggested that irrigation can not be made to pay. Indeed there are clear indications that some irrigators are earning high rates of return on the additional capital they have invested in irrigation. On the other hand, very efficient dry land farmers are earning high rates of return on their properties. Some critics have been inclined to accept our results but to argue that irrigation farmers in general are not using the water efficiently. This may be so, but it may also be
argued that dry land farmers in general are not using lucerne very effectively. (Only 10 per cent of the area of the dry land farms in the survey was in lucerne.) There seems to be no ground for arguing that a sample of irrigation farmers, as widely representative as our survey group, is any less competent than any other group of farmers. However, it is arguable that we have yet to see major advances in irrigation technique that will change the economics of irrigation farming. I understand that Mr Lobb will be discussing some of these innovations and that he will suggest that recent work at Winchmore on the mechanics of border-dyke irrigation will lead to advances in the design of future irrigation schemes on the Canterbury Plains.

### TABLE 2

**Average Physical and Financial Data 300-499 acre Farms**

**Dry and Medium Irrigated**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Average of 11 Dry Land farms (with per acre averages in brackets)</th>
<th>Average of 13 Medium irrigated Farms (with per acre averages in brackets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (acres)</td>
<td>425</td>
<td>374 (170 border-dyked)</td>
</tr>
<tr>
<td>Land Utilization (percentage of total area)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Cash crops</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>(2) Small seeds</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>(3) Winter feed</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>(4) Lucerne</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>(5) Grass</td>
<td>62</td>
<td>68</td>
</tr>
<tr>
<td>Labour units</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Capital (£)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Land U.V.</td>
<td>10,814 (55.4)</td>
<td>10,735 (34.0)</td>
</tr>
<tr>
<td>(2) Land V.I.</td>
<td>5,946 (14.0)</td>
<td>8,217 (22.0)</td>
</tr>
<tr>
<td>(3) Land C.V.</td>
<td>16,760 (39.4)</td>
<td>20,952 (56.0)</td>
</tr>
<tr>
<td>(4) Plant (Book Value)</td>
<td>1,666</td>
<td>1,861</td>
</tr>
<tr>
<td>(5) Stock</td>
<td>2,924</td>
<td>3,748</td>
</tr>
<tr>
<td>(6) Working capital</td>
<td>1,766</td>
<td>1,884</td>
</tr>
<tr>
<td>(7) Total farm capital</td>
<td>23,118 (54.4)</td>
<td>28,446 (76.0)</td>
</tr>
<tr>
<td>Stock (numbers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Breeding ewes</td>
<td>1,085</td>
<td>1,100</td>
</tr>
<tr>
<td>(2) Others</td>
<td>184</td>
<td>336</td>
</tr>
<tr>
<td>(3) Cattle</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>(4) Stock units/available acre</td>
<td>3.3</td>
<td>3.9</td>
</tr>
<tr>
<td>Financial Performance (£)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Total farm income</td>
<td>5,413</td>
<td>5,830</td>
</tr>
<tr>
<td>(2) Total farm working expenses</td>
<td>2,698</td>
<td>3,059</td>
</tr>
<tr>
<td>(3) Interest on T.F.C.</td>
<td>1,387</td>
<td>1,707</td>
</tr>
<tr>
<td>(4) Owner’s surplus</td>
<td>1,328</td>
<td>1,064</td>
</tr>
</tbody>
</table>

In the meantime farmers in the Ashburton-Lyndhurst scheme are left with their own particular problem, of how to make the investment they have made in irrigation, and the long hours of tedious work involved in their conventional irrigation systems, pay off.

We have carried our research a little further. We attempted to isolate those characteristics of the management of irrigation farms which appear to be associated with success. Our interest to this stage has been only in current management practices as revealed
by the survey farms. We have not attempted to explore the economics of innovations, such as automatic irrigation, because of inadequate information.

3. The Pattern of Farming

The production possibilities under irrigation farming on the light soils are quite wide, even though these soils can not be very heavily cropped. Our first interest was in the production patterns of the highest performance farms. We wished to see whether these farms exhibited a constant or even similar pattern of farming. Some of the principal characteristics of these farms are shown in Tables 3 and 4, Table 3 being for irrigated farms under 500 acres and Table 4 for irrigated farms over 500 acres. (Details of these tables are given in Appendix 2.)

**TABLE 3**

<table>
<thead>
<tr>
<th>Area (Nearest 10 acres)</th>
<th>Owner's Surplus (£)</th>
<th>Index of Irrigation level</th>
<th>% Crop</th>
<th>Stock units per available acre</th>
<th>Lamb meat per available acre (lbs)</th>
<th>Wool per available acre (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm 1 490 2,342 35 32</td>
<td>3.5 120 32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm 2 450 2,153 19 8</td>
<td>3.5 83 44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm 3 370 2,029 128 7 5.8 67 69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm 4 430 3,864 32 33</td>
<td>4.1 142 43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm 5 370 1,746 71 —</td>
<td>4.1 83 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm 6 370 1,603 78 4</td>
<td>4.4 81 41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is evident from these tables and also from Tables 5 and 6 (details of which are given in Appendix 3) which give additional information on the management policies of the same ten farms, that there is little consistency amongst them. For example, in the small farm group (Table 3) the range of owner's surplus is only £700, yet among the six there are two heavy croppers, three light croppers and one zero cropper, there are two farms carrying 3.5 ewe equivalents per acre and one carrying 5.8, and there is a farm using scarcely any water at all and one an intensive irrigator. Similarly there is a large range in lamb meat and wool production per available acre, and in the stock policies practised.
TABLE 5
Alternative Management Policies of Six High Performance Irrigated Farms
(Results from farms below 500 acres)

<table>
<thead>
<tr>
<th>Farm</th>
<th>Area (Nearest 10 acres)</th>
<th>Owner's Surplus (£)</th>
<th>Index of Irrigation Level</th>
<th>% Cash Crop</th>
<th>% Small Seeds</th>
<th>Beef Cattle per 100 Breeding Ewes</th>
<th>Dry Sheep per 100 Breeding Ewes</th>
<th>Bought-in Stock per 100 Lambs sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>490</td>
<td>2,342</td>
<td>35</td>
<td>32</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>430</td>
<td>2,153</td>
<td>19</td>
<td>3</td>
<td>5</td>
<td>1.4</td>
<td>44</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>370</td>
<td>2,029</td>
<td>128</td>
<td>7</td>
<td>—</td>
<td>1.4</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>430</td>
<td>1,864</td>
<td>32</td>
<td>30</td>
<td>3</td>
<td>—</td>
<td>8</td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td>370</td>
<td>1,746</td>
<td>71</td>
<td>—</td>
<td>—</td>
<td>4.8</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>370</td>
<td>1,603</td>
<td>78</td>
<td>4</td>
<td>—</td>
<td>1.6</td>
<td>29</td>
<td>12</td>
</tr>
</tbody>
</table>

TABLE 6
Alternative Management Policies of Four High Performance Irrigated Farms
(Results from farms 500 acres and above)

<table>
<thead>
<tr>
<th>Farm</th>
<th>Area (Nearest 10 acres)</th>
<th>Owner's Surplus (£)</th>
<th>Index of Irrigation Level</th>
<th>% Cash Crop</th>
<th>% Small Seeds</th>
<th>Beef Cattle per 100 Breeding Ewes</th>
<th>Dry Sheep per 100 Breeding Ewes</th>
<th>Bought-in Stock per 100 Lambs sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>750</td>
<td>3,935</td>
<td>90</td>
<td>—</td>
<td>—</td>
<td>8.8</td>
<td>35</td>
<td>—</td>
</tr>
<tr>
<td>8</td>
<td>1,000</td>
<td>3,519</td>
<td>6</td>
<td>11</td>
<td>5</td>
<td>2.3</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>1,000</td>
<td>2,531</td>
<td>52</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>32</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>870</td>
<td>2,239</td>
<td>12</td>
<td>3</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

4. Case Farm Studies

Carrying the examination a little deeper we now give further details of the management of three of these ten farms, which in our view are of particular interest.

(i) Farm 1. The area of this property was approximately 490 acres of which nearly two-thirds could be irrigated, one-half by border dykes, and the balance by wild flooding. Automatic irrigation was used and a man was not needed full time on watering. However, over the survey period the volume of irrigating was only 0.35 acre feet per acre of the farm. 1,100 Corriedale breeding ewes were run, replacements were purchased and an average of 160 acres of cash crop was grown each year. Two men worked the farm entirely, except for shearing by contract.

Stock: The farm carried 3.5 stock units on the available grazing and produced 120lb of lamb meat and 32lb of wool per acre. The ewes lambed down 115 per cent survival-to-sale, 50 per cent of which were sold fat off the mother. Replacements were bought in as two-tooths and approximately 200 wether lambs were purchased, shorn, and fattened each year. The ewes were wintered on 80 acres of autumn saved pasture, 3,000 bales of lucerne and meadow hay, 80 acres of lupins and 10-15 acres of turnips.
Cropping: The cash crops grown included principally 80-100 acres of wheat and 60-80 acres of barley. Linseed had also been grown in the past. All harvesting was in bulk, carried out by farm labour.

The farm’s high earning capacity was ascribable to:

(a) High gross output, 45 per cent of which came from cash crops, 25 per cent from wool and 25 per cent from stock. Crop yields and stock performances were good.

(b) Low costs, especially on wages and contract work.

(ii) Farm 3. This property of approximately 370 acres was one of the most heavily stocked in the survey. It carried 1,350-1,400 Romney ewes, plus replacements and 120 head of cattle. Over the three years, only 6 per cent of the farm had been in cash crop. Two men worked the farm and contractors did all the normal contract work, including heading and baling, but not topdressing.

The ewes all went to the white-faced ram and all ewe lambs were kept. Between 300 and 350 surplus two-tooths were sold annually. The farm was stocked at 5.8 stock units per available acre and produced 69lb of wool and 67lb of lamb meat per acre. The wool production figure was exceptional for the area and the lamb meat figure was good considering all ewe lambs were kept.

The ewes were wintered on 2,600 bales of hay, 180 acres of autumn saved grass and 15 acres of swedes. Lambing was quite good —110 per cent—and no lambs were sold off the mother. All lambs were shorn before drafting.

The property was one of the heaviest irrigated in the scheme and used 1.3 acre feet of water per acre each year. The entire farm could be watered.

The management features of this farm were:

(a) High stocking through heavy watering.
(b) Resultant high wool production per acre.
(c) A breeding replacement policy, involving the sale of surplus two-tooths.
(d) Late fattening and shearing of wether lambs.
(e) A little diversification in the form of cash cropping and a few cattle.

The gross income was high, while low vehicle and machinery costs, together with moderate other expenses, conferred on this farm its high financial performance.

(iii) Farm 7. The area of this very high performing farm was 760 acres. It carried 1,900 Romney breeding ewes, 600 ewe hoggets, 85 breeding cows and 80 yearlings. No crops were taken and no winter roots grown.

The labour complement, for the size of farm and the stock numbers, was low, two men doing all the work. However, there was no harvesting or cultivation work involved. Contractors were only employed for shearing and crutching.

The farmer was a heavy irrigator and used 0.9 acre feet of water per acre of the farm. Between one-quarter and one-third was bordered and a similar area could be wild flooded, so that almost one-half
the farm was irrigated. This means that the level of watering on
the irrigated portion was very heavy.

Stock: The ewes averaged 115 per cent lambing survival-to-sale,
and one-third of the total lambs were sold off the mother. Only
enough ewe lambs for replacements were kept. Seventy pounds of
lamb meat and thirty-six pounds of wool were produced per available
acre. Including the cattle, 3.9 stock units per available acre were

The property carried a relatively large number of cattle and was
one of the few with breeding cows. The cattle were all Aberdeen
Angus and the surplus heifers and all steers were sold fat as rising
two-year-olds.

The property was an all-grass farm and the stock was wintered
on approximately 10,000 bales of meadow hay and 600 acres of
autumn saved grass, some of which was carried over into lambing.
The cattle played a vital role in utilising lower quality meadow hay
cut from irrigated grass.

The high performance of this farm was attributable to a low cost
farming system, particularly with respect to labour and machinery.
But output per acre was high, due to high carrying capacities on
grass, and to the supplementation of income by cattle which fully
utilized rough grazing and lower quality hay.

5. The Synthesis of Irrigation and Management Policies

If investment in irrigation is to be worthwhile, the irrigation
farmer must outproduce in value terms his dry land equivalent by
the extent of all the running costs associated with irrigation, plus
interest on the extra capital invested in irrigation facilities. Our
survey indicated that this was not in fact the case. Indeed it appeared
that many farmers adopted the now well established principles of
successful dry land farming. These involve early lambing and wean­
ing, drafting at light weights and summer destocking. Irrigation on
these farms becomes merely a drought insurance rather than an
income earning investment.

The ten farms tabulated, of which three have been described in
more detail, have quite different patterns of management yet each
is a highly successful financial unit. It might be concluded therefore
that the pattern of management and production is not very relevant
to variations in the level of financial success, and that what is really
important is the level of managerial skill with which these various
patterns are implemented. Management has three components, plan­
ing, execution and control. It appears that under irrigation farming
wide differences in management plans may be possible, and that
results will depend more heavily upon skilful execution.

But closer appraisal of the high performing farms indicates that
they tend to have one factor in common. They have adjusted their
pattern of output from conventional dry land farming methods to
suit the change in their environment conferred by irrigation. We
are convinced that profitable irrigation farming depends on their
making this change. This pattern could conceivably involve the irri­
gation of crops, which is the basis of profitable use of irrigation in
other countries. But the influence of water on mixed arable farming
in Mid-Canterbury is not so clear. There are indications that farmers
can achieve success with the irrigation of linseed, barley, cocksfoot and white clover seed. This appears to be the reason for high profits on some survey farms. On the other hand the survey results show that some very high performing farms have no crops at all. Nevertheless they have adapted their pattern of output to suit their changed environment.

A valid question would be “What form should summer utilization of irrigation take?” We can suggest a number of alternatives for consideration and many of you will know of others. The list has been divided into two sections. Group A concerns products with a world-wide market and Group B includes alternatives with a local or New Zealand market only.

Group A The World Market
(1) Increased wool production:
   (a) Dry sheep with a high per acre production.
   (b) Shearing of bought in store lambs.
   (c) White-faced lamb production, shearing all lambs not sold off the mother and subsequent sale of surplus stock as ewe lambs, ewe hoggets, or two-tooths.

(2) Increased Meat Production:
   (a) Purchase of store lambs for fattening.
   (b) Late fattening of heavyweight lambs.
   (c) Fat cattle production.

(3) Crop Production:
   (a) White clover seed.

Group B—The Local Market
(1) Meat Production:
   (a) Butchers’ market for fat stock.

(2) Crop Production:
   (a) Cocksfoot seed.
   (b) Linseed.
   (c) Barley.

Each of these alternatives to be successful, requires directly or indirectly the continuous efficient use of irrigation water throughout the irrigation season. These are only some of the alternatives open to the irrigation farmer. We are at present investigating the relative profitability of these with the help of computer programming.

6. A Comparison of Two Management Systems under Irrigation

Finally we selected two management systems of irrigation farming and examined their relative profitability. These were (1) all-grass farming, (2) mixed-arable farming. We selected these because they represent two opposed schools of thought prevalent in Mid-Canterbury. We established a hypothetical farm of 310 acres. The farm capital, the amount of border dyking, the carrying capacities and stock performances, and the crops grown and their yields, were based on information collected during the irrigation survey. They are therefore as accurate and faithful a representation of the actual situation practised in Mid-Canterbury, as we could interpret. We assumed that management efficiency was similar on the grassland farm and on the mixed cropping farm. The grassland farming system carries the stock for twelve months of the year on pasture and hay
alone. No winter supplements are grown. We allowed a pasture life under irrigation of fourteen years with renewal through a summer fallow. In fact farmers practising this system consider that pasture life under prudent stock management, could be indefinite. On the cropping farm, we harvested linseed, wheat, barley, rye grass and white cover seed, and grew forage crops for wintering the stock. The stock policy on the grassland farm involved the use of white-faced rams, rearing replacements, and the sale of surplus two-tooth ewes. On the mixed cropping farm, replacements were purchased as two-tooths and all ewes were put to the Down ram.

On the basis of these two programmes, we established the land utilization, and using the carrying capacities experienced during the survey, we calculated the number of stock to be carried. We then budgeted the two alternatives, using 1963-64 prices and costs. A summary of the land utilization and comparative budget is shown in Table 7. (Details of these are given in Appendix 4.)

TABLE 7
Alternative Management Systems under Irrigation
Land Utilization and Comparative Budget for a Grassland, and a Mixed Arable Farm.

Area: 143 acres border dyked
      52 acres wild flooded
      105 acres dry land
      10 acres waste
      310 acres

<table>
<thead>
<tr>
<th>Item</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Land Utilization (acres)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Spring-summer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Irrigated grass</td>
<td>182</td>
<td>40</td>
</tr>
<tr>
<td>2) Dry land grass</td>
<td>72</td>
<td>48</td>
</tr>
<tr>
<td>3) Lucerne</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>4) Autumn saved grass</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>5) Cash crops</td>
<td>42</td>
<td>75</td>
</tr>
<tr>
<td>6) Small seeds</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>7) Winter feed</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>8) Fallow</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>9) Rape, new lucerne</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>(b) Winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Winter forage</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>2) Cash crops</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3) Small seeds</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>4) Autumn saved grass</td>
<td>48</td>
<td>55</td>
</tr>
<tr>
<td>5) Pasture</td>
<td>206</td>
<td>83</td>
</tr>
<tr>
<td>6) Lucerne</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>7) Fallow</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>8) New grass</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

87
This table illustrates that on the assumptions made, a low cost system of grassland farming is more profitable than a more costly mixed cropping system. The essence of the former system is its low cost structure in relation to the total income. In particular wages, and vehicle and machinery expenses are very low. Moreover this system is utilizing irrigation during the summer for the production of late fattened, shorn lambs, and to carry all ewe hoggets. Critics may argue that we have unduly penalized the mixed cropping system by using lower crop yields than one might expect. We can only remind them that these yields are based on information obtained from a large sample of farms during our survey. While individuals may be obtaining much better performances we can only interpret those of the average farmer. Moreover it is equally arguable that we have penalized the grassland farmer by using lower carrying capacities than some people are achieving. Again we have interpreted the performance of the average farmer.

We hope to have illustrated that a mixed arable system involving high expenses, requires physical performances to be high, and probably better than the average irrigation farmer on Lismore soil can expect. On the other hand, a grassland farming system efficiently executed, with a low cost structure appears to be a very profitable one. Indeed, our experience with farmers operating under this system have verified this.

APPENDIX 1. DETAILS OF TABLE 2

1. Capital
(a) Land and buildings at the 1961 Government revaluation.
(b) Stock: The stock numbers were obtained at the field inspection. The values used were a standardized estimate of market values appropriate to the whole period. These values are listed below. Any wether lambs on hand at balance day were not valued, unless rearing of wether hoggets was practised. Stock bought in and fattened were ascribed a value proportionate to the length of time on the farm.
### Breeding ewes

1. **Romney mixed age**  50/-
2. **Romney 4 and 5 year**  35/-
3. **Corriedale mixed age**  45/-
4. **Corriedale 4 and 5 year**  30/-

### Ewe hoggets

1. **Romney**  50/-
2. **Corriedale**  45/-

### Wethers

- 40/-

### Wether hoggets

A fraction of 40/- depending on the time on the property.

### Rams—all breeds

- 100/-

### Stud sheep

1. **Ewes**  80/-
2. **Ewe hoggets**  60/-
3. **Ram hoggets**  100/-
4. **Rams**  160/-

### Beef breed cows

- £25

### Rising 2-year heifers

- £20

### Rising 1-year heifers

- £15

### Bullocks

- £30

### Rising 2-year steers

- £20

### Rising 1-year steers

- £15

### Bulls

- £50

### Dairy cows

- £25

### Dairy heifers

- £25

### Dairy yearlings

- £15

### Sows

- £12

### Weaner pigs

- £5

### Plant and Machinery:

This was determined by taking the opening book valuations for 1959, 1960 and 1961 and the closing valuation for 1962 for all the plant and machinery, except the motor car, and averaging these entries. Depreciation was standardized at 20 per cent per annum for motorized plant and 10 per cent for non-motorized. No special depreciation was allowed. Where machinery was sold during the three-year period and the sale price differed from the book value, the sale price was taken as the book value, and the preceding valuations were recalculated from this. Hence any gain or loss on sale shown in the Profit and Loss Account was eliminated.

### Working Capital:

An allowance for liquid cash necessary to run the farm. This was estimated as one-half the average annual sum of all cash expenses, excluding outlays on stock, rent, interest, development, and depreciation reserves, but including an allowance for owner-occupier drawings. (The latter was calculated as 675 plus 1 per cent of the total capital involved in land and buildings, stock and plant).

### Total Farm Capital:

The sum of land and buildings, stock, plant and estimated working capital.
2. **Stock units per available acre**

The carrying capacities of the farms were calculated on the following basis:

<table>
<thead>
<tr>
<th>Stock Category</th>
<th>Stock Units per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Romney ewes</td>
<td>1 stock unit</td>
</tr>
<tr>
<td>Corriedale ewes</td>
<td>0.9 stock unit</td>
</tr>
<tr>
<td>Hoggets</td>
<td>0.67 stock unit</td>
</tr>
<tr>
<td>Trading stock</td>
<td>Part thereof—as per time on the farm.</td>
</tr>
<tr>
<td>Breeding cattle</td>
<td>6 stock units</td>
</tr>
<tr>
<td>Cattle (rising 2-year)</td>
<td>4 stock units</td>
</tr>
<tr>
<td>Cattle (rising 1-year)</td>
<td>3 stock units</td>
</tr>
</tbody>
</table>

The figures for each farm were expressed as stock units per acre available for grazing or feeding. Where an area was available for grazing for part of the year only, as for example with white clover, allowances were made.

3. **Total farm income**

The sum of the average gross profits on sheep, cattle, wool, grain, seeds and produce and any other farm income.

4. **Total farm working expenses**

The sum of wages, vehicle and machinery expenses, contract and cartage, repairs and maintenance, farm purchases (including lime, fertilizer and seeds), overhead expenses (including rates), irrigating charges, and depreciation, but not including rent, interest paid, developmental expenses.

5. **Interest on total farm capital**

Charged at 6 per cent.

6. **Owner's surplus**

\[(\text{Total farming income}) - (\text{Farm working expenses} + \text{Interest on total farm capital})\]

**APPENDIX 2. DETAILS OF TABLES 3 AND 4.**

Owner's Surplus: See Appendix 1.

**Index of Irrigation Level:**

Acre feet of water used per effective area of the farm; one acre foot per acre = 100.

**% Crop:**

Percentage of the effective area of the farm in cash crops and small seeds.

**Stock Units per available acre:** See Appendix 1.

**Lamb Meat per available acre:**

Only fat lambs were considered here. The total lamb meat produced (including an allowance for store lambs purchased for fattening) was divided by the area available for grazing.

**Wool per available acre:**

Total wool clipped including lambs' wool and crutching, but not slipe wool, expressed per acre available for grazing.

**APPENDIX 3. DETAILS OF TABLES 5 AND 6**

**Beef Cattle per 100 Breeding ewes:**

Includes breeding cows, and fat cattle.

**Dry Sheep per 100 Breeding ewes:**

Includes ewe and wether hoggets carried through to the two-
tooth stage, but does not include hoggets sold to the butchers' market in the winter and spring.

**Bought in lambs per 100 lambs sold:**
Includes all lambs purchased for fattening as lambs or hoggets.

**APPENDIX 4. DETAILS OF TABLE 7.**

**A. Land Utilization and Estimated Carrying Capacities: Grassland System.**

<table>
<thead>
<tr>
<th>(1) Spring Summer</th>
<th>(2) Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>acres</td>
<td>S.U.</td>
</tr>
<tr>
<td>182 irrigated grass @ 5</td>
<td>910</td>
</tr>
<tr>
<td>72 dry land @ 3</td>
<td>216</td>
</tr>
<tr>
<td>21 lucerne—for hay</td>
<td>—</td>
</tr>
<tr>
<td>22 fallow</td>
<td>—</td>
</tr>
<tr>
<td>3 new lucerne</td>
<td>—</td>
</tr>
<tr>
<td>10 waste</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>310</td>
</tr>
<tr>
<td>Plus 1260 bales lucerne hay @ 3/S.U.</td>
<td>420</td>
</tr>
<tr>
<td></td>
<td>1,141</td>
</tr>
</tbody>
</table>

**B. Land Utilization and Estimated Carrying Capacities: Mixed Arable System.**

<table>
<thead>
<tr>
<th>(1) Spring Summer</th>
<th>(2) Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>acres</td>
<td>S.U.</td>
</tr>
<tr>
<td>15 linseed</td>
<td>—</td>
</tr>
<tr>
<td>15 wheat</td>
<td>—</td>
</tr>
<tr>
<td>30 → turnips @ 5</td>
<td>150</td>
</tr>
<tr>
<td>15 ryegrass</td>
<td>—</td>
</tr>
<tr>
<td>30 Second year white clover @ 3</td>
<td>90</td>
</tr>
<tr>
<td>30 first year white clover @ 3</td>
<td>90</td>
</tr>
<tr>
<td>10 irrigated grass @ 5</td>
<td>50</td>
</tr>
<tr>
<td>15 turnips and Italian</td>
<td>—</td>
</tr>
<tr>
<td>12 barley and new grass</td>
<td>—</td>
</tr>
<tr>
<td>3 rape</td>
<td>—</td>
</tr>
<tr>
<td>3 new lucerne</td>
<td>—</td>
</tr>
<tr>
<td>36 dry land grass @ 3</td>
<td>108</td>
</tr>
<tr>
<td>12 lucerne grazing @ 4</td>
<td>48</td>
</tr>
<tr>
<td>12 lucerne hay</td>
<td>—</td>
</tr>
<tr>
<td>12 new grass @ 7</td>
<td>—</td>
</tr>
<tr>
<td>50 autumn saved pasture @ 7</td>
<td>350</td>
</tr>
<tr>
<td>10 waste</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>310</td>
</tr>
<tr>
<td>Plus 720 bales lucerne @ 3/S.U.</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>994</td>
</tr>
</tbody>
</table>
## C. Capital Details

<table>
<thead>
<tr>
<th>Land and buildings</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>310 acres @ £54 per acre</td>
<td>£16,740</td>
<td>£16,740</td>
</tr>
<tr>
<td>(Buildings £4,500)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(2) Plant</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding ewes @ 55/-</td>
<td>£3,629</td>
<td>£2,619</td>
</tr>
<tr>
<td>Ewe hoggets @ 55/-</td>
<td>820</td>
<td>900</td>
</tr>
<tr>
<td>Rams @ £8</td>
<td>17</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(3) Plant</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorized</td>
<td>£800</td>
<td>£3,600</td>
</tr>
<tr>
<td>Non-motorized</td>
<td>£500</td>
<td>£1,165</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(4) Working capital</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% of fixed capital</td>
<td>£1,083</td>
<td>£1,206</td>
</tr>
</tbody>
</table>

## D. Income

<table>
<thead>
<tr>
<th>Lamb Sales</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>110% survival-to-sale</td>
<td>£934</td>
<td>£2,228</td>
</tr>
<tr>
<td>45/- F.O.M.</td>
<td>135</td>
<td>990</td>
</tr>
<tr>
<td>40/- F.O.F. shorn</td>
<td>315</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ewes</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3% deaths + 5 lambs per ewe</td>
<td>£1,193</td>
<td>£225</td>
</tr>
<tr>
<td>C.P.A. ewes @ 25/-</td>
<td>164</td>
<td>180</td>
</tr>
<tr>
<td>2-tooth ewes @ 80/-</td>
<td>247</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(3) Wool</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambs 3lb</td>
<td>£3,600</td>
<td>£1,165</td>
</tr>
<tr>
<td>Hoggets 7lb</td>
<td>9,006 lb</td>
<td></td>
</tr>
<tr>
<td>Sheep 10lb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rams—S.D. 8.5lb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rom. 12lb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average price 50d net</td>
<td>£2,851</td>
<td>£1,876</td>
</tr>
<tr>
<td></td>
<td>13,683 lb</td>
<td>9,006 lb</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(4) Crops</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>White clover 90lb per acre @ 3/- lb</td>
<td>3,600 lb</td>
<td></td>
</tr>
<tr>
<td>White clover 120lb per acre @ 3/- lb</td>
<td>2,700 lb</td>
<td></td>
</tr>
<tr>
<td>Ryegrass 20 bu per acre @ 19/- bu</td>
<td>300 bu</td>
<td></td>
</tr>
<tr>
<td>Wheat 40 bu per acre @ 13/6 bu</td>
<td>600 bu</td>
<td></td>
</tr>
<tr>
<td>Barley 50 bu per acre @ 8/10½ bu</td>
<td>600 bu</td>
<td></td>
</tr>
<tr>
<td>Linseed 12cwt per acre @ £37/10/- per ton</td>
<td>9 ton</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Farm Income</th>
<th>Grassland Farm</th>
<th>Mixed Arable Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£4,978</td>
<td>£6,568</td>
</tr>
</tbody>
</table>
### E. Expenditure

#### (1) Stock Purchases

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-tooths @ £4 per head</td>
<td>207 head</td>
<td></td>
<td>£891</td>
</tr>
<tr>
<td>Rams @ £15/15/- per head</td>
<td>3 head</td>
<td></td>
<td>£47</td>
</tr>
<tr>
<td></td>
<td>4 head</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### (2) Standing charges

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insurances</td>
<td>£26</td>
</tr>
<tr>
<td>Rates and Land Tax</td>
<td>£175</td>
</tr>
<tr>
<td>Water charges</td>
<td>£40</td>
</tr>
<tr>
<td></td>
<td>£241</td>
</tr>
</tbody>
</table>

#### (3) Administration

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£60</td>
</tr>
</tbody>
</table>

#### (4) Working expenses

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£60</td>
</tr>
</tbody>
</table>

##### (a) Wages

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent @ £14 per wk</td>
<td>£60</td>
</tr>
<tr>
<td>Casual @ £3 per day</td>
<td></td>
</tr>
<tr>
<td>Shearing @ £7 per 100</td>
<td>£285</td>
</tr>
<tr>
<td>Crutching @ £2/10/- and</td>
<td>£235</td>
</tr>
<tr>
<td>£1/10/-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>£464</td>
</tr>
</tbody>
</table>

##### (b) Animal Health

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipping @ 6d per head</td>
<td>£1270</td>
</tr>
<tr>
<td>Drenching @ 7d per head</td>
<td>£1585</td>
</tr>
<tr>
<td>Vaccination @ 7½d per head</td>
<td>£820</td>
</tr>
<tr>
<td>Docking rings @ 1d each</td>
<td>£900</td>
</tr>
<tr>
<td>Vet fee @ £5</td>
<td></td>
</tr>
<tr>
<td>Foot rot @ £1 per 100</td>
<td>£121</td>
</tr>
<tr>
<td></td>
<td>£93</td>
</tr>
</tbody>
</table>

##### (c) Crop Harvesting

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>23in sacks @ 1/-</td>
<td>584</td>
</tr>
<tr>
<td>48in sacks @ 1/3</td>
<td>80</td>
</tr>
<tr>
<td>Twine</td>
<td></td>
</tr>
<tr>
<td>Dressing—</td>
<td></td>
</tr>
<tr>
<td>Ryegrass @ 4/- bu</td>
<td>300 bu</td>
</tr>
<tr>
<td>W. clover @ 6d per lb</td>
<td>6,300 lb</td>
</tr>
<tr>
<td>Wheat Board levy @ 4/9</td>
<td></td>
</tr>
<tr>
<td>per 50 bu</td>
<td>200 bu</td>
</tr>
<tr>
<td>Cartage @ 1/2 F.O.R.</td>
<td>665</td>
</tr>
<tr>
<td></td>
<td>£238</td>
</tr>
</tbody>
</table>

##### (d) Cultivation Contracts

<table>
<thead>
<tr>
<th>Item</th>
<th>Acres</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>@ £6 per acre</td>
<td>25</td>
<td>£150</td>
</tr>
</tbody>
</table>

##### (e) Freight

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£25</td>
</tr>
</tbody>
</table>

##### (f) Feed

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baling @ 1/- per bale</td>
<td>£108</td>
</tr>
<tr>
<td>Cartage @ 8d per bale</td>
<td>£60</td>
</tr>
</tbody>
</table>
(g) Fertilizers and Lime

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>44/46 bagged @ £9/7/- ex</td>
<td>2.5</td>
<td>Tons</td>
</tr>
<tr>
<td>44/46 bulk @ £8/13/- ex</td>
<td>13.5</td>
<td>Tons</td>
</tr>
<tr>
<td>D.D.T. @ £15 ex</td>
<td>7.5</td>
<td>Tons</td>
</tr>
<tr>
<td>S/Ammonia @ £30 ex</td>
<td>1½</td>
<td>Tons</td>
</tr>
<tr>
<td>Freight @ 38/- per ton</td>
<td>24</td>
<td>Acres</td>
</tr>
<tr>
<td>Spreading @ 4/6 per ac.</td>
<td>280</td>
<td>Acres</td>
</tr>
<tr>
<td>Lime @ 50/- sown</td>
<td>28</td>
<td>Tons</td>
</tr>
</tbody>
</table>

£425

(h) Crop seeds

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnips @ 4/6 lb</td>
<td>34 lb</td>
<td></td>
</tr>
<tr>
<td>Italian ryegrass @ 15/- per bu</td>
<td>4 bu</td>
<td></td>
</tr>
<tr>
<td>Rape @ 2/6 lb</td>
<td>9 lb</td>
<td></td>
</tr>
<tr>
<td>Linseed @ 7½d lb</td>
<td>225 lb</td>
<td></td>
</tr>
<tr>
<td>Wheat @ 24/- per bu</td>
<td>23 bu</td>
<td></td>
</tr>
<tr>
<td>Barley @ 15/- per bu</td>
<td>24 bu</td>
<td></td>
</tr>
</tbody>
</table>

£88

(i) Grass Seeds

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial ryegrass @ 20/- per bu</td>
<td>27 bu</td>
<td>46 bu</td>
</tr>
<tr>
<td>W. clover @ 5/- per lb</td>
<td>57 lb</td>
<td>159 lb</td>
</tr>
<tr>
<td>R.C. @ 4/- per lb</td>
<td>27 lb</td>
<td>36 lb</td>
</tr>
<tr>
<td>Cocksfoot @ 4/- per lb</td>
<td>40 lb</td>
<td>66 lb</td>
</tr>
<tr>
<td>Timothy @ 2/6 lb</td>
<td>13 lb</td>
<td>30 lb</td>
</tr>
<tr>
<td>Lucerne @ 5/- lb</td>
<td>36 lb</td>
<td>36 lb</td>
</tr>
</tbody>
</table>

£63

£117

(j) Weed and Pest control

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucerne @ £2/10/- per acre</td>
<td>21</td>
<td>Acres</td>
</tr>
<tr>
<td>Barley grass @ £3/15/- per acre</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>White clover @ 15/- per acre</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Linseed and wheat @ 8/6 per acre</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Barley @ 34/- per acre</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

£90

£174

(k) General Expenses

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% of Cash Income</td>
<td>£50</td>
<td>£1,267</td>
</tr>
</tbody>
</table>

£66

£1,801

(5) Vehicle expenses

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel tractor @ 3/- per hour</td>
<td></td>
<td>£111</td>
</tr>
<tr>
<td>Petrol @ 4/- per hour</td>
<td></td>
<td>£219</td>
</tr>
<tr>
<td>Header @ 4/- per hour</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

945 hours

200 hours

2,000 miles

2,000 miles
(6) Repairs and maintenance

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings @ 2½%</td>
<td>£4,500</td>
<td>£4,500</td>
</tr>
<tr>
<td>Motorized plant @ 2/6 per hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant @ 10%</td>
<td>£500</td>
<td>£1,165</td>
</tr>
<tr>
<td>Fences @ 2/6 chain</td>
<td>300 chains</td>
<td>300 chains</td>
</tr>
<tr>
<td></td>
<td>£219</td>
<td>£361</td>
</tr>
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</table>

(7) Rebordering

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>@ £2/10/- per acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 acres</td>
<td>£25</td>
<td>£55</td>
</tr>
<tr>
<td>22 acres</td>
<td></td>
<td></td>
</tr>
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</table>

(8) Depreciation

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings @ 2½%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car @ ¼ of 20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motorized plant at 20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-motorized plant @ 10%</td>
<td>£373</td>
<td>£999</td>
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</table>

(9) Total Expenditure

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£2,343</td>
<td>£4,649</td>
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</tbody>
</table>

(10) Estimated Net Farm Profit

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£2,635</td>
<td>£1,919</td>
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</tbody>
</table>

(11) Interest @ 6% on total farm capital

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£1,365</td>
<td>£1,520</td>
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</table>

(12) Owner’s Surplus

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£1,270</td>
<td>£399</td>
</tr>
</tbody>
</table>
NEW DEVELOPMENTS IN IRRIGATION TECHNIQUES

W. R. Lobb, Superintendent, Winchmore Irrigation Station, Ashburton.

Irrigation in Canterbury is a subject about which a great deal has been said, it has been discussed by many people almost since the settlement of Canterbury. Informed statements however, have been few. This is understandable because there are few people informed on the science of water use. Most people however, see in Canterbury's climate one great limitation to full exploitation of its real potential, that is a deficit of soil moisture for adequate plant growth at some stage in every year. They also see large volumes of water flowing to the seas in a number of snow-fed rivers which have their high flows during the summer. They may know also that water can be taken by gravity over most of the vast plains area and that there need be no storage of this water to have adequate supplies available throughout the summer. They may know there are no significant drainage problems. What then could be more appropriate than to advocate this moisture deficit be removed by flooding the plains with this available supply of readily obtainable water. This I think is about the stage our knowledge had reached when the irrigation schemes in Canterbury really got under way some twenty years ago. (Actually irrigation started with the Redcliffs scheme for which water was available in 1936-37).

However, there is much more to irrigation than this. Nevertheless I must join with those early advocates for irrigation in Canterbury and endorse the fact that despite anti-irrigationists and economists and because of man's ingenuity and the pressure of economic necessity irrigation is a logical progressive and necessary development for the future advancement of Canterbury. A province which has available some 750,000 acres of land which can be commanded by cheap available water supplies and which can be irrigated by cheap flood methods of water distribution, which bring no drainage or salting problems and which every year has a need for that water, would be remiss indeed if it were not at some stage to exploit this asset. Throughout this paper I hope to present some logical arguments to endorse this thesis.

Firstly, let's deal with Canterbury's climate to see if there is a need for irrigation. The loss of water from a free water surface is recorded by meteorological stations. This loss is related to wind, temperature, humidity and hours of sunshine. Water lost in this way is returned in rain. In this way a simple deficit between water loss and water gain can be calculated. However, it would be necessary to show what relationship existed between the loss of water from the soil by evapotranspiration by plants and meteorological data before a soil moisture deficit could be calculated in this way. A study of this information has been made by Mr Rickard at Winchmore using daily measured soil moistures as a guide. The correlation is good. We thus have a measured soil moisture record on a daily basis for 12 years and can have a calculated one for 50 years, using Ashburton records for the latter.
In simplifying this information to relate it to climate it is neces­sary to give you two important points in a soil's physical properties. These are “field capacity” and “wilting point.” At field capacity a soil is holding all the water it can against free drainage, any more water simply drains away through the subsoil. At wilting point mois­ture is still held but this cannot be removed by plants. For the average light Canterbury soil such as at Winchmore these percentages are, thirty for field capacity and ten for wilting point. The available soil moisture range is therefore twenty per cent. For practical purposes we consider the top soil as the depth to which pasture roots pentetrate and this is about 8 to 15 inches for most of these soils. Twelve inches is taken as a good working average in making our calculated soil moisture determinations. At field capacity the top foot of soil holds about two and a half inches of available soil mois­ture. From this information any measured (or calculated) soil moisture percentage can be converted to a soil moisture deficit. We can thus speak of a deficit of 50 points, 100 points or 200 points when the soil would need these amounts of rain or irrigation to restore to field capacity.

Monthly evapotranspiration losses for Winchmore, on average, per day are:

<table>
<thead>
<tr>
<th>Month</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>5</td>
</tr>
<tr>
<td>October</td>
<td>8</td>
</tr>
<tr>
<td>November</td>
<td>9</td>
</tr>
<tr>
<td>December</td>
<td>11</td>
</tr>
<tr>
<td>January</td>
<td>12</td>
</tr>
<tr>
<td>February</td>
<td>11</td>
</tr>
<tr>
<td>March</td>
<td>9</td>
</tr>
<tr>
<td>April</td>
<td>6</td>
</tr>
</tbody>
</table>

If a daily record of rainfall is kept it is a simple matter to calculate the moisture status of a soil on a day to day basis. For pasture a general recommendation as to when to irrigate can be given from such a balance sheet. (For irrigation schemes of the type reticulating Canterbury the position must be complicated by a roster.)

In calculating a balance for an irrigation year some assumptions are made: that the soil is at field capacity on the 1st of September—that the position is not complicated by a water table—that by flood irrigation the soils are returned to field capacity at each irrigation and that the top foot of soil is the effective depth for pasture roots. For practical purposes these can be accepted as correct.

Despite its rain Canterbury is a dry area. Based on a study of 44 seasons (1912-56) the following is the drought situation. If we consider a day when soil moisture has fallen to 10 per cent (wilting point) as a drought day then the number of drought days per season varies from 107 to 6 with a mean of 59. Drought conditions never occur in September and only occasionally in October. Eighty per cent of the drought days occur between December and March. There are more dry seasons than wet; in 75 per cent of all seasons there were more than forty drought days, in 52 per cent more than sixty and in 25 per cent more than eighty (getting near three months of the growing season).

The length of the dry spell is important and the study shows that in the forty-four seasons there were ninety periods when the drought was greater than ten days, as many as five in one season, and there was one period of forty-two consecutive drought days. (This season—1964—set a new record of fifty-five consecutive drought days from January 16 to March 10th). This information simply shows
that Canterbury's climate is a dry one and that every year there is insufficient effective rainfall for plant growth. (Irrigation reduces the amount of effective rainfall but corrects the effect of a lack of it).

However, one of the major difficulties of planning an irrigation system is due to the variable rainfall which can fluctuate by as much as from 12 inches to 36 inches from one irrigation season to another.

The influence of the season, of the soil moisture deficit and of the roster system will be mentioned again later.

In the schemes administered by the Ministry of Works the usual practice is to deliver eight cusecs of water. There is a somewhat variable duty of water operating throughout the various schemes. There are several important features with regard to the efficiency of the use of this water which requires emphasis.

It is obvious from the figures of water used on the various schemes that a number of factors operate to restrict the effectiveness of irrigation. The figures shown in Dr Stewart's survey of the Ashburton-Lyndhurst scheme show this.

Outstanding among these factors would be:

(1) The labour necessary to apply the water using it for the full periods available. This assumes day and night continuous watering.

(2) The difficulty of making a decision to water in face of the labour problem.

(3) The inefficient irrigation rates which seldom reach two acres per hour and often are about one acre or even less per hour.

(4) The fact that few farms are dependent solely on grass and animal products for their income.

(5) That most farms are large enough to embark on an insurance type of irrigation which enables them to afford the luxury of irrigating only to produce feed when a dry year restricts their normal supply.

With these points in view Winchmore set high priority to investigating ways and means of reducing the most obvious of these problems, that was the problem of labour. The main search in this field was to develop a pre-set or semi-automatic system of irrigation which would compress to a small period of time the labour necessary to attend to water distribution. It was said at the time, that time in irrigating could not be saved. This pre-supposed that a given quantity of water would irrigate a given area of land depending on slope and infiltration rate, factors which cannot be substantially altered, assuming of course, that full advantage is taken of the relatively steep slope and high infiltration of the average area.

The initial investigations were applied to the existing layouts by a number of workers. In general these commenced with the downstream control of water in the headrace and the names of Falconer and Hall come to mind as pioneers in this field. Hall and others proceeded to reduce the number of control units required by grouping the sills to discharge and split flow down several borders. This had been shown at Winchmore to increase the efficiency of irrigation to a small but significant degree. Later Pollard operating the Hall system of automatic water distribution reversed the process to upstream watering and later to regularised upstream grouped headraces which to be properly effective should be specially prepared.
At the same time farmers were installing grouped headraces to give them longer periods of unattended irrigation. Incidentally they are also indulging in the luxury of wild flooding which allows water to flow ineffectively for long periods unattended. The basic idea through all this is to get rid of the labour of attending to water distribution.

It must be remembered in any flood scheme of this sort there has to be a duty of water for the area. If water is wasted the area watered is reduced. It is obvious from the average irrigation rates that a great deal of water is being wasted in order to reduce the labour of distribution. To those who know the position this cannot be allowed to continue too far or water supplies will not meet the increasing demands.

Basically it is wrong therefore to reduce the labour content of irrigation by decreasing the efficiency of the water used. While this might satisfy the requirement of the individual it cannot hasten the day when a truly efficient system of irrigation farming will arise.

It is our belief now that some improvement in watering rate will arise as a result of mechanical methods of water distribution and also that the rate might substantially increase due to improved race design.

The figures obtained on our automatic farm indicate this. When this 160-acre unit was converted to downstream automatic irrigation in 1958-59 using alarm clocks and an aeroplane bomb release the irrigation rate achieved was 1.47 acre/hour. The next year 1959-60 with experience in using the equipment the rate rose to 1.74 acre/hour. For the following two years the rates were 1.86 and 1.81 acre/hour. In 1962-63 the rate again rose to 2.02 acre/hour as a consequence of converting the unit to upstream watering. The next step was taken in 1963-64 when 40 acres of the area were prepared with new races specially designed for automatic use. The length of the border was increased, the down slope preparation was improved, the race was raised to give all sills a true weir discharge and sills were in regular groups of four with an odd one of five and three. Each border had the same area and levees were down the greatest fall, in this case about four and a half inches to the chain, which would probably be about average for the district. This area is now irrigating 3.5 acre/hour which is a significant gain as a consequence of automatic irrigation.

In seeking explanations for this increase in the irrigation rate several factors come to mind, all of which contribute to the total gain.

1. The decision to shift the water is no longer made by man; it is planned by man but made by the clock. Once planned the shift is made with an error of plus or minus half a minute, the clock sees to this. If man had to judge the shift the time would never be as accurate as this and in many cases the delay could be as great as thirty minutes, or if it was the case of a night shift could be even more. A great deal of irrigation water is lost in this way.

2. Because the race has been properly constructed there is no leakage from sills. The only sills below water level are those irrigating at the time, the down stream sills have no water and the upstream ones are above water level. The banks are constructed so
there is no loss over banks. Thus all the water available in the race is actually used where and when it is wanted. In conventional layouts leakage can account for a substantial loss of water.

3. No ponding of the water down the borders. A little extra care is needed to remove low and high spots for the distribution of the split head of water both for down slopes and cross slopes. This prevents excess infiltration.

4. No drowned weirs. Because the race is built up water can be discharged with a minimum fall of six inches and a desired fall of nine inches from the sill lip to ground level on the border side. In the conventional layout how often does one see the sills at or lower than border level? If water won't come out of the race the tendency is to dig a hole and get it out. The initial slow-up of water movement in this way can be very great. With two cusecs of water over a six-foot weir, when this is drowned (i.e. at ground level) the initial forward advance is one foot per second. With a true weir discharge this becomes eight feet per second.

The effect of ponding down the border is the same as occurs with the drowned weir, a marked slow-up of the water advance. Once the water is slowed infiltration increases and water is lost.

5. Correct length of border. When developing mechanical control of water it is obvious that the greater area commanded by each unit the less will be the cost. Two factors operate to give this area, length and width. Attempts have been made to use excessive lengths as a means of unattended irrigation. This can be done, but over a certain length water will be lost by excess infiltration into the first part of the border. The loss increases as the length increases the time the water flows in the border. The greater the infiltration rate of the soil the greater the loss of water will be in borders of excessive length. For the average soils in the area lengths between 8 to 20 chains can be used satisfactorily for split flows. As eight chains increases the number of shifts necessary this tends to be too short. At 20 chains irrigation rate has slowed as a consequence of drainage losses and this tends to be too long although it will decrease the number of shifts necessary. A good working length would be 11 or 12 chains for the better soils and perhaps shorter for the more open soils.

6. The correct number of sills in each group. Again attempts have been made to reduce the amount of attention to water by increasing the number of borders irrigated at one time. As stated earlier work at Winchmore has shown that this can be done. However, this point cannot be stretched indefinitely or infiltration rate will exceed the advance rate and water will be lost. In general farmers find this a most convenient way to save attention of water and many consider no form of automatic control is necessary if their groups are large enough to make shifting necessary only two or three times a day. However, in achieving this reduction in shifting, water is being lost and irrigation rate slowed down which again reduces the need to shift and as a consequence about one acre per hour may be being done. While this may save labour it is so wasteful of water and irrigation time that it cannot be accepted as good irrigation practice.

In considering the number of borders in a group a good average figure would appear to be to divide the eight cusecs into four flows of two, although this can be as high as eight flows of one. In the
latter case slope and cross levelling would need to be good and short borders should be used and infiltration rates would need to be low. On average considerable water would be lost in reducing the flows to this degree. The headrace fall has a marked bearing on regular grouping of the race. At one inch fall per chain it is convenient to group four sills of six feet length, giving 24 feet of sill over the 160 feet length of race. This gives a drop of about two and a half inches between groups. If the race fall were two inches per chain it might be convenient to group only two borders and to keep bank height down. Two sills of 8 feet should be used. With the greater flow of water used, four usescs, the borders could be longer and the cross levelling need not be as good. This amounts to the fact that the headrace should be planned to give suitable falls, groups and banks so that each group irrigates independently of the other. On no account should groups be used where headgate boards are needed to control the flow of water. These give water loss and make automatic control almost impossible.

Another factor often considered a disadvantage by farmers to using a divided flow is long pasture. The influence of long pasture is to destroy the weir formula operating at the sill. This is true, and is one reason for having a sharp drop from a concrete sill in a race raised about ground level. Long pasture however, will irrigate better with a small flow than with a flow which just about submerges the pasture. If a large flow is to be used the pasture should be completely submerged. You can take it then, that long pasture is no disadvantage to using grouped sills.

The above factors then are all taken account of in an automatic layout for flood irrigation and because of this irrigation time may indeed improve.

Something about the time involved in handling automatic equipment. It must be admitted that this equipment is in its developmental phase. When our full equipment of 24 sheets and bomb releases were used down stream labour amounted to about two and a half hours for 12 hours' irrigation, or five hours to achieve day and night watering. From this we should advance to the special 48-acre block with its two races, and to the up-stream sheets, and concrete blocks and metal gates, now in use. On this unit one race is operated by sheets and the other by blocks and metal gates. There are eight sheets and eight metal gates and one race change to set for this 48-acre block.

The total set-up time for this is 40 minutes. It was anticipated, at the rate of about two acres per hour, this would give 24 hours' irrigation for 40 minutes setting time. Allowing for the fact that this required two settings because of the 12-hour alarm clocks used one might allow an extra 20 minutes for the double journey; a total of one hour for 24 hours' watering. This area however, irrigated in 13½ hours because of the factors previously mentioned. The labour time is therefore between 40 and 60 minutes for 13½ hours and 48 acres of irrigation. Operating at this rate the whole area of 160 acres could be irrigated in about 48 hours, and if it were all set up in the same way, this would require four 12-hour shifts, each requiring about 40 to 60 minutes; between two and a half and four hours labour time for 160 acres irrigated.

Not all areas will irrigate as well as this. Where infiltration is too fast it would be necessary to take great care in designing a lay-
out such as this but the factors taken into account here should all be considered.

Something about the equipment. This is being improved gradually. The sheet, the release mechanism, and the sheet release have all been improved by local firms and this augurs well for future development. Concrete race blocks are being developed and the metal gate and release improved.

It is still necessary to have sills. Concrete and timber are being looked at. A prefabricated concrete sill 6 foot x 12 inches x 1½ inches may cost about 10/- which compares favourably with the two head-gate blocks which were normally used at about 5/- each and a concrete sill to be added above that. No boards are used.

The main task ahead is to established on farms sufficient equipment on properly prepared races to evaluate the system described. If it operates satisfactorily its cost seems reasonable.

It is difficult to estimate the additional cost of land preparation which might be debited to automatic layouts but this should be within the range of 15/- to £2 per acre with a further cost of 10/- for the transportable sheet method or £2 for permanent concrete work. The former would not be more than the cost of a bog-sower for the header and the total land preparation cost for a 300-acre irrigation farm not as much as the header operated on many farms.

The duty of water should be provided at one cusec per 100 acre on average, with an allowance of one to 80 for the more difficult and stoney areas and one to 160 acres for the best. Areas poorer than one to 80 should be excluded from flood schemes.

There is one more important point which must not be overlooked. At present the irrigation farmer has great difficulty in deciding when to irrigate. Most of this indecision is because of the labour involved. Little is due to the problem of deciding if his pasture would respond to water. There are many ways of avoiding irrigation and chief of which is to stock below the potential of irrigation and this is consistently done. If the labour problem is solved then the problem of when to irrigate will be simplified but will be complicated by the roster, and the frequency with which the farmer can irrigate will depend on how efficient his irrigation is in relation to the duty of water available.

For our automatic unit we have operated at one cusec per 100 acre. At two acres per hour the duty would need to be one cusec to 95 acres to complete the total area at each roster date. At 3.5 acre/hours (which would require 46 hours) this could be one cusec to 167 acres.

When this position is attained the farmer can make a choice to irrigated by time, or by a combination of a calculated soil moisture deficit and his roster.

On the automatic unit we have examined several situations. Irrigating at roster date when the deficit is 0.5 inch or greater, irrigating at roster date when the deficit is 1.0 inch or greater and irrigating on a weekly or fortnightly roster.

With a deficit of 0.5 inch irrigation falls at most roster dates. This would mean 10-13 irrigations per season. Irrigating at 1.0 inch would probably average six per year. (This season nine because of
the record long dry spell.) There appears to be little advantage in a weekly over two-weekly roster.

At present we are making a detailed study of what will be involved for various deficit levels on a calculated basis taking the past 50 years of Ashburton's meteorological data as a basis. This should give us a reasonable guide to the frequency of irrigations and how these combine with a roster system. It may thus be possible to irrigate on a soil moisture basis and to take the decision of when to irrigate away from speculation and considerations other than soil moisture.

There are some pointers for the future arising from this work. One is that for future schemes it would be desirable to deliver to farms larger flows, of the order of 10-12 cusecs, for shorter periods. This would allow the planner to divide the head and have larger groups and less equipment.

It was not the purpose of this paper to discuss potential production or the economics of irrigation farming. There is no doubt in my mind that both of these require consideration, but a workable system of irrigation is a pre-requisite. I have indicated some necessary steps towards this goal.

A low cost system of all grass and legume farming can be developed as the next step. Potential production has already been demonstrated. It remains now for Canterbury farming to develop this opportunity. This province could become one of, if not the richest livestock producing area in New Zealand if full use is ultimately made of irrigation.

The Agricultural Targets Committee has indicated the problem of increased production. High on the list of priorities to obtain these necessary increases Canterbury citizens should advocate irrigation development. It means more opportunities for more people, more farmers' sons can benefit and as indicated in the Stewart report the whole volume of business within the area is increased.

I would remind you that the science of water application is only beginning; there has not yet been one generation of irrigation farmers in Canterbury. Three or four generations of farmers have developed the science and practice of the normal farming pattern. They have grown up with their farms, they have developed and advanced with new techniques and in some measure they have developed a science of agriculture. Under the circumstances the first generation of farmers in the first decades of irrigation have achieved a lot. I am not pessimistic about the future. The next generation will achieve more.
GORSE ERADICATION ON HILL COUNTRY

T. D. J. Holderness, Gebbie's Valley.

To many of you fortunate enough not to be troubled by gorse this paper will be of little interest but I trust it will be of some interest to those who do have a gorse problem. You at least will appreciate, as I do, that gorse, like the poor, is always with us on unploughable country. Perhaps that is overstating the case somewhat but I can't emphasise too strongly that there is no quick or easy cure to the gorse problem and any early success must be regarded as purely temporary unless followed up by determined efforts towards eradication in succeeding years.

I would not presume to tell you how you should go about eradicating gorse—I can only quote my own experience for what it is worth. I started to use 245T in the first year of its release and there were then no experts or anyone with any great technical knowledge. In an experimental way I tried spraying at different concentrations and at different times of the year and formed opinions in the process that differed from official recommendations, to some degree. So all I propose to do is to tell you how I have gone about my own job and describe my results.

My earliest conviction was that saturation was the all-important factor—much more important than the concentration of the mixture and in three or four years I had so reduced the time spent annually on grubbing (hitherto the only method) that I gave thought to tackling a ten-acre patch of 10-15 foot tall old man gorse, that I had merely confined previously. The progress made on the scattered and isolated bushes up till now can be indicated by telling you that, whereas for years it had taken two of us about two months each year grubbing my 200-acre block, I now found we could do it in about two weeks. Today it is only a matter of days, most of the time being spent in walking about looking for plants.

At the time I contemplated tackling the 10-acre patch there was a lot of aerial gorse spraying being done by fixed-wing aircraft. As I said before, experience had convinced me of the necessity to saturate the plant so I disregarded the fixed-wing aircraft. In a year or two the helicopter was adapted for spraying and in spite of reservations as to the likelihood of success I had seven of the ten acres sprayed in October, 1959. Contrary to advice I sprayed the growing gorse rather than burning first. I did this because of a belief that the hardest knock you can give a gorse bush is by spraying it when it is carrying the maximum amount of spine. Whether this is correct or not I'm not prepared to say, but the result, and subsequent treatment in reverse—i.e. burn first and spray after—of the remaining three acres, brings me down heavily in favour of spray first, burn after. In July, 1960, I fired the seven acres which had died off in a spectacular fashion although of course there was evidence of quite a bit of regrowth. The hot burn on a groggy plant gave it a second, and very heavy knock. Of course the remaining three acres that had not been sprayed went with the rest in the fire and burnt well. In August I topdressed on the ashes with two hundredweight super plus clover and cocksfoot. During 1961 the hill block was grazed hard and very little seedling gorse appeared that the sheep did not cope with. There
was a bit of regrowth on the old stumps but not too bad on the seven acres which had been sprayed and burnt. On the three acres which had by then only been burnt there was heavy regrowth, so in October 1961, I used the helicopter on this area while I spot sprayed with knapsack on the seven-acre area. Again two hundredweight super per acre was applied by air to the whole area. In 1962 I couldn't get a good fire through the three acres due to lack of dead trash and the kill from the spraying could only be described as mediocre. This year was a favourable one for growth and the ewes with free range of the whole 200 acre block, did not keep on top of the seedlings so that year we slipped backwards and I could see the desirability of fencing off the area so that it could be really controlled and punished when necessary. It took two of us (and at times three) a fortnight's solid work to cover the area with knapsacks. Very arduous work, too, I can assure you. Again two hundredweight super went on and a good sole of grass and clover was by now well established. At no stage did the three-acre area compare in any way favourably with the seven acres.

In February, 1963, we again attacked it with knapsacks but it was a losing battle as due to another growthy year for grass and seedlings the ewes had failed to control it and we had slipped a bit further back. Knapsacks were inadequate for the job, my heart quailed, and I very reluctantly tossed it in through physical inability to keep up with it, as I had by this time a further twenty acres on my plate—this fresh area is almost at my front gate. I have kept this new area separate from the other so as to avoid confusing you. Before leaving the original ten acres I should say that I am reluctant to see so much effort and money spent to no permanent avail, so I have recently spent a further £100 on a contractor who has covered the area with hoses and a Fontan motorised knapsack.

Well, now to show another side of the picture which has emerged on a twenty-acre block with precisely the same treatment but aided by the essential feature to successful eradication—fences. In 1959 I purchased 80 acres opposite my homestead and 20 acres of this was a solid block of old man gorse in full view of my front verandah. For twenty years I had been able to disclaim responsibility for this and now suddenly when visitors asked, "Is that yours?" I had to admit it was. At this stage I was greatly encouraged by the early success of the other ten acres so in October, 1960, I sprayed it with the helicopter on unburnt gorse. Again I got a pretty fair kill and a good burn. Seed and super followed the burn in August, 1961, and the area was grazed heavily with on-off grazing aimed at pasture establishment in the first instance. During the winter of 1962 it was stocked heavily with ewes at times and hay was fed out on it. In the spring it was set stocked with ewes and lambs and received a further two hundredweight super. Regrowth and a fair amount of seedling gorse was sprayed with knapsacks in November. This took two of us the best part of three weeks and ten gallons of 245T was used. In spite of heavy mob stocking at times in 1963 there was a fairly heavy germination of seedlings which took two of us again almost three weeks and about six gallons of 245T to cover. The kill was a good one and today driving past this area which bounds the road you would say it was gorse-free. However I am under no illusions and know that spraying of seedlings will be an annual job for many years to
come though I have the comforting feeling that on this job I am definitely on top of it. One lesson I have learn is that it does not pay to be too ambitious in this eradication business. Deal only with an area that your physical as well as your financial resources, not to mention the rest of your farming programme, will allow you to cope with.

Having started on a particular area be very sure you are in complete control of it before you take on another. This will take several years. I am told that some administrators of the Noxious Weeds Act require a certain portion (10 per cent I believe) to be done each year. If this means a fresh bit being started each year it could be quite impossible and financially wasteful. A farmer on some of the Peninsula hills for instance could have forty or fifty acres on his plate in the matter of a few years with no hope of following up adequately. 245T is a good weapon in our hands for the control of gorse, but make no mistake about it the job involves a lot of hard, tedious work and the really vital necessity to a successful programme is a genuine desire on the part of the farmer to see his land free of this menace and a determination to bring this about.

The new motorised units are a hopeful development and will do much to ease the pain of the old type of knapsack.

No doubt you will be interested in the costs involved. In order not to confuse you with areas and figures I will give you the costs of the twenty acres of which I also have some slides which might interest you and give you a visual comparison of “before and after.”

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original helicopter spraying</td>
<td>£200</td>
</tr>
<tr>
<td>Super and seed 1961</td>
<td>£45</td>
</tr>
<tr>
<td>Super 1962</td>
<td>£30</td>
</tr>
<tr>
<td>Super 1963</td>
<td>£30</td>
</tr>
<tr>
<td>10 gallons 245T November 1962</td>
<td>£45</td>
</tr>
<tr>
<td>6 gallons 245T November 1963</td>
<td>£27</td>
</tr>
<tr>
<td>Labour 2 men 6 weeks @ £15 per week</td>
<td>£180</td>
</tr>
</tbody>
</table>

£557

This is near enough to £28 per acre so you can see that eradication of gorse on hill country is a costly business in terms of cash and physical effort. On the other hand if the job were not tackled production from this area would be practically nil.
NEW WEEDKILLERS FOR ARABLE FARMS

W. F. Leonard, Senior Scientific Officer, Department of Agriculture, Christchurch.

Introduction

Since the discovery of the first selective weedkillers more than 20 years ago, profound changes have taken place in arable farming. Instead of the crop rotation being dictated by the nature of the weed problem, the cropping programme can now be planned to take full advantage of soil type, climate and market. In the meantime, many chemicals have been tested and a few have been chosen, either to replace a less-efficient material or to plug one of the holes remaining in the armour of the weed-killing farmer.

But, progress, even in the chemical field, is not won easily, and a great deal of work precedes the release of a new weedkiller. Chemicals must first be synthesised and manufactured. Preliminary screening tests have to follow before field tests under New Zealand conditions allow us to make a final assessment of a new material. The number that find their way on to the merchant's shelves is only a small fraction of those initially tested.

To see new chemicals in their true perspective, we should consider them in relation to the weedkilling requirements of arable farms. Some of these are met by new weedkillers and some by relatively old ones. In either case, they can be conveniently discussed in connection with pasture for grazing or seed production, cash crops, forage and hay crops and finally drains.

PASTURES

New Pastures. Only since the development of MCPB and 2,4-DB has selective weed control in young pastures been possible. Not only are they virtually harmless to clovers—the keystone of New Zealand farming—but can be used at a very early stage of growth. Seedling weeds are more easily killed than mature ones and in docks we have a weed that can be controlled as a seedling but is impossible to kill selectively when mature. Many broad-leaved weeds are controlled by MCPB and 2,4-DB but notable resistant ones are spurrey (Yarr) and the chickweeds.

These materials are not very new, but I do feel there is scope for their use on a wider scale than at present.

Established Pasture. MCPA remains the most widely-used chemical for control of broad-leaved weeds in mature pasture. Some 2,4-D sodium salt is applied in "hormonised" superphosphate and where there is a particular reason for avoiding clover suppression MCPB is sometimes chosen.

Seed prevention is the key to barley grass control. 2,2-DPA (dalapon) at 2 or 2½lb commercial formulation per acre is still the best we can offer for selective control in pasture. The barley grass must be at the seedling stage and even then, the margin of safety to the pasture is not wide. Paraquat is useful for preventing seeding in waste places if applied at or before the flowering stage.

Clover Seed Crops. Defoliation of red and white clover seed crops—and occasionally lucerne—prior to harvest is a growing prac-
tice. A wide variety of chemicals have been tried in the past but all have now been superseded for this purpose by diquat.

One of the most interesting recent developments in white clover seed production is the use of a chemical to suppress competition from grasses. 2,2-DPA (dalapon) has been used on a limited scale by farmers in the Southbridge district but not without some degree of risk. Though the amount applied was only 2lb commercial formulation per acre, a dry spell after spraying can bring about serious clover damage.

Paraquat, with its selectivity towards white clover, appeals much more as a material for this work and trials are being conducted to determine how to get the best result for the lowest cost. Results so far indicate that a rate of about one pine (4oz active ingredient) per acre applied about two weeks before normal closing time will give a marked increase in seed yield. Stock should be removed early enough to allow about two inches of new growth before spraying.

Before clover-growers become too excited though, a word of warning. The action of paraquat is governed by many factors. Among these are efficiency of spray coverage, stage of growth, soil moisture, intensity of light, humidity and so on. In short, paraquat is more sensitive to environmental conditions than most agricultural chemicals. This means that information must be accumulated over several seasons and for various soil types; but meanwhile many farmers, with a good deal to gain and little to lose, are trying the technique for themselves.

Flat-weeds and volunteer grasses in white clover stands following undersowing with wheat, can also be controlled by spring applications of paraquat.

On heavier soils grass suppression offers increased seed yields, but on drier soils the increased density of seed heads could be offset by difficulty in harvesting the shorter-stemmed crop. However, paraquat could find its place on the medium and drier soils as an aid to pasture renovation.

Pasture Renovation. In the absence of a reliable technique for employing chemical ploughing in dry climates renovation of run-out pastures could well be achieved. On many farms pasture vigour falls off after two or three years, with an increase in hairgrass, sweet vernal and browntop, and a decrease in clover content. The crop rotation imposed by soil type often prevents more frequent pasture renewal.

Paraquat is remarkably selective towards white clover; as long as some white clover is present this is the material to use. An autumn application of something between half and one and a half pints (two and six ounces) per acre will kill seedling hairgrass and at least check sweet vernal and browntop, allowing clovers to increase and restore pasture vigour. Pasture seed could be oversown or drilled in, but even if it failed to establish because of unfavourable season, pasture vigour and composition would certainly be improved.

CASH CROPS

Cereals. For about twenty years MCPA has been the standard treatment for broad-leaved weeds in cereals. In recent years the expected increase in resistant weeds has stimulated a search for alter-
native materials. Meanwhile, as an interim measure, the use of 2,4-D amine has increased and MCPP has enjoyed some success. Field trials indicate that weeds such as cornbind and redshank can be better controlled by certain new preparations.

Where a single chemical is unable to do the job, mixtures are sometimes used. For instance, a mixture of MCPA and 2, 3, 6-TBA has been used in England—and to some extent in New Zealand—on difficult weeds of cereals. Here we are also testing several new materials individually or as mixtures with standard hormone weed-killers. Among these are 2, 3, 6-TBA, a closely-related chemical dicamba, a new and highly versatile material named "tordon" and a compound chemically related to paraquat.

A high standard of weed control has been achieved but crop tolerances for some are still being investigated. Results so far indicate that when a substitute for MCPA is needed to control resistant broad-leaved weeds, suitable formulations will be available. However, care will be needed in selection of materials for undersown crops as some red compounds cause severe clover damage.

Grasses have not yet become serious weeds of South Island cereals, unless of course we regard wild oats as a grass. Certainly in some districts wild oats are a major weed of cereals and considerable interest has been shown in efforts towards chemical control. The material barban is being used successfully in Canterbury to protect crops against competition from wild oats. However, the present per acre cost (£3) and the inability of the treatment to eliminate seeding completely, have limited its use to moderately and heavily-infested farms. On such properties, nevertheless, the control of wild oats can be the deciding factor between success and failure of a crop.

Peas. Prior to the introduction of MCPB, weeds in pea crops were treated with the phenol preparation dinoseb (DNBP). This controlled a wide range of annual weeds but had to be used at the very early stage of growth. The use of MCPB allows more latitude concerning the time of spraying and controls the perennial Californian thistle. MCPB, however, does not control all weeds encountered in pea crops and one device used in Canterbury to broaden the spectrum of species controlled, is the addition of a small amount of MCPA. Mixtures of MCPB and dinoseb have been used quite extensively in Hawke's Bay for the same reason.

Barban, already mentioned for control of wild oat in cereals, is used for the same purpose in peas.

New materials under field trial in pea crops are linuron and prometryne, both of which seem to control quite a wide range of weeds.

Linseed and Linen Flax. Linseed resembles cereal crops in that MCPA was for many years the standard treatment but is no longer satisfactory in certain soils. Weeds resistant to MCPA are becoming more prominent in many places, and in districts heavily infested with spurrey, of course, we’ve never had effective weed control.

An extensive series of field trials has been conducted over the past two seasons and will be continued next year. Interim results suggest 24DB as an alternative material to MCPA on soils where weeds such as cornbind and redshank are involved. This treatment is, in fact, being used by farmers on a limited scale.
Prometryne and linuron look very promising for control of spurrey and seem capable of controlling a wide range of other weeds too. Tolerance of the linseed crop will need further checking but at present appears to be satisfactory.

Linuron is available commercially and prometryne will possibly be marketed during the coming season. Until the price of prometryne is known and definite rates of application decided, the cost per acre can’t be determined. It’s certain, however, to be higher than the 12/- to 15/- per acre for MCPA.

The stem distortion that follows the use of hormone type weedkillers is a disadvantage in linen flax fibre crops. So far this distortion has not been observed where linuron and prometryne were used.

Potatoes. Practically the only demand for weedkillers in potato crops is for haulm destruction in seed crops or destruction of weeds prior to harvest. A compound of arsenic was traditionally used, but in diquat we now have a less-toxic and highly effective defoliant. By efficient application the amount of chemical needed can be reduced to the point where the cost is not greatly higher than for arsenic. At the present retail price, one and a half pints of diquat costs 34/-.

Varieties with strong-growing haulms such as Rua and Tahi are more difficult to treat successfully, but this is a problem common to both arsenic and diquat.

FORAGE AND HAY CROPS

Brassicas. The absence of a selective weed control treatment for brassica crops has been a constant embarrassment. MCA was introduced several years ago but its failure to control fathen ruled it out in many districts. The first real hope for Canterbury farmers came with the introduction of nitrofen. This material was marketed on a limited scale during the past season and, although at present high in per acre cost (up to £4) it could eventually find a place on brassica-growing farms.

The new chemical “tordon,” already mentioned in connection with cereals, shows an unexpected selectivity toward brassica crops. To find that a material which will kill sweet briar can be used on brassica crops is surprising indeed, but “tordon” at low rates of application appears to be remarkably selective towards certain crops.

At this stage, chou moellier and kale seem able to tolerate the rates of “tordon” (one to two ounces active ingredient per acre) necessary to control weeds such as fathen and Californian thistle. Bulb crops though are less tolerant. Mixtures of “tordon” and nitrofen are also being included in brassica trials.

A good deal of field and laboratory research remains to be done before “tordon” is used extensively on crops but its unusual potential justifies inclusion in this essentially practical paper.

Lucerne. The discovery of 2,4-DB was a boon to lucerne-growers. Many new stands battling against annual weeds or infested by seedling perennials such as docks, would benefit from the use of this chemical. However, two important weeds of young lucerne, storks-bill and the common chickweed (Stellaria media), are resistant to 2,4-DB. Both of these weeds are controlled by the new weedkiller paraquat but further research is needed into the tolerance of young lucerne to it.
Common weed problems of mature lucerne are the grasses brown­
top and *Poa annua*, and the flatweeds storksbill, thistles, dandelion and plantain. The grass-killing chemical 2,2-DPA (dalapon) has been used successfully for several years, but outside the Ashburton county little has been done about chemical control of flat weeds in lucerne. The problem of storksbill in lucerne hay was tolerated but complaints of pelt damage in lambs has caused us to take a more serious view of this weed despite its value as a winter feed.

Fortunately, storksbill is susceptible to paraquat which can be applied to mature lucerne without causing damage of any conse­quence. Paraquat at one and a half pints (six ounces active ingredi­ent) per acre just before the onset of spring growth will kill storks­bill and *Poa annua* and check browntop. The tolerance of annual and biennial thistles to paraquat has not yet been clearly determined.

At 30/- per pint for paraquat this would cost £2/5/- per acre. There is, however, some prospect of a price reduction as paraquat becomes more widely used.

**DRAINS:**

Chemical control of drain weeds is a fairly recent development. Local bodies such as drainage boards and catchment boards—and to some extent farmers—are treating an ever-increasing mileage of drains for both emergent and submerged weeds.

For some years control of emergent weeds—there was not suit­able control for submerged ones—was confined almost entirely to the use of various mixtures of 2,2-DPA (dalapon), amitrole and 2,4-D. The choice of chemicals has since been supplemented by paraquat and the safety of diquat and paraquat for use in fish-bearing streams has stimulated research into control of submerged weeds. Already, in fact, the North Canterbury Catchment Board is treating many miles of waterways for control of submerged aquatic weeds.

On a cost efficiency basis chemical control compares more than favourably with mechanical and hand clearing.

**TOXICITY AND SOIL RESIDUES**

Unlike many modern insecticides most new weedkilling chemi­cals are relatively non-poisonous. Toxicology studies are begun early in the development of new materials and many potential weedkillers are discarded because of their toxicity. One chemical under field trial at present is about as toxic as common salt.

However, some newer weedkillers resist breakdown in the soil much longer than conventional materials such as MCPA and 2,4-D. When considering the use of 2,3,6-TBA, dicamba or tordon on crops we shall need to keep soil residues in mind if damage to succeeding crops is to be avoided.

**MANAGEMENT AND CULTURAL PRACTICES**

Modern weedkillers are not substitutes for good farming. This has been said before but I repeat it here particularly with soil fertility in mind. I’ve seen money spent on spraying browntop in a lucerne paddock that was crying out for sulphur. Similarly, if pasture reno­vation is contemplated care must be taken to see that the soil fertility is adequate to sustain the level of production hoped for. Crop rota-
tion, sound cultivation and maintenance of maximum crop and pasture vigour are, after all, the most rewarding means of weed control.

From the host of new chemicals that are produced by overseas organisations a few emerge as worthy of a place in New Zealand agriculture.

Certainly, there is no shortage of materials to be tested by our field research workers who have already demonstrated their ingenuity by developing for chemicals uses unforeseen by their discoverers themselves.
I want to thank the organisers of this Conference for inviting me to Lincoln today. It has given me an opportunity to see this beautiful and famous college. It has also enabled me to meet a large number of people concerned with farming so soon after my arrival in New Zealand. These same organisers have risked their reputations in inviting such an unknown quantity to occupy this platform as I know only too well that the standard of performance at this Conference is very high indeed. But I gather that my risk may be even greater, as my own neck may be at stake. However, the subject of my talk is harmless enough and should not disturb anyone unduly.

Some of you will have heard that I may be looking at your own Advisory Division while I am here, and I want to stress that, whatever I may say today does not imply that I think some of the ideas which we have are appropriate to your own organisation. I have only been here a few days, and I know very little about your climatic conditions, your systems of farming, or the people who serve the industry. I sincerely hope that my mission will be one of give and take. I have a great deal to learn from you, and I may in return have something to offer in exchange. Our goals are certainly identical. It is to improve the standard of living for farmers on both sides.

Establishment of the National Agricultural Advisory Service

The British farmer has enjoyed free advice since the early part of this century and up to the beginning of the last war this was provided by the agricultural departments of universities and the county councils. This had three major disadvantages—

(a) Advice took second place to teaching.
(b) The teams at the universities and the county councils were small, consequently very few farmers had contact with them.
(c) The wealthier counties were able to pay more, and consequently recruited the better men.

When the war ended in 1945 the urgency to produce on our farms remained. Food was still rationed, and a serious balance of payments was with us. This was the climate into which the N.A.A.S. was launched in October 1946. The structure of the Service was based on the findings of an exhaustive survey of advisory systems in other countries, including Europe, the United States, and New Zealand, and you will no doubt recognise some of the ideas which we borrowed from you. This new Service was to be a National one, divorced from the county councils and the universities, and every county, large and small, was to enjoy the same quality of advice. There was, at the
time, strong criticism of the decision to break from the universities, but provision was made for close working arrangement between the two institutions, and the N.A.A.S. Regional centres, wherever possible, were located near the agricultural departments of the university.

The organisation of the Service has several facets which are similar to the Advisory Division in New Zealand. It is based on a comprehensive structure, the focal point of which is the District Advisory Officer. This person is the main, and in many cases, the only channel through which advice will reach the farmers. He has under his charge some 500-700 farms, depending on their size and agricultural importance. The District Officer is responsible to a County Officer, who is the senior N.A.A.S. Officer in the county, who in turn reports to the Regional Director, of whom there are eight covering England and Wales. There are also at county level Specialist Officers in Livestock, Poultry, and Horticulture, and, at the regional level, there are specialists in the science subjects of Animal Nutrition, Bacteriology, Entomology, Plant Pathology, and Soil Chemistry. There are also at regional level Husbandry Specialists in Crops, Farm Mechanisations, Grass, Horticulture, Livestock, Milk and Poultry. Recently, a Regional Farm Management Adviser has been added to the regional team, and I shall be referring to him in greater detail later in my talk.

The Regional Director is responsible to a small group at the Ministry's headquarters in London. This small group is in close liaison with other divisions of the Ministry and are available to advise the Minister himself on agricultural matters.

The Husbandry Farm

Much stress was laid in the original recommendations on the need to bridge the gap between the research worker and the farmer, and, although it was accepted that the specialists and the general practitioners could do this to a large extent, there would still exist a vacuum between new findings and practical application, and in order to close this gap it was decided to purchase a number of farms for the purpose of testing under practical and local conditions the findings of the fundamental worker. These farms would also carry out experimental work not normally done at the Research Institutes and, in addition, the economic appraisal of new developments could be undertaken as we believe that any new findings should undergo an economic appraisal before it is offered to the farmer.

There are now twelve of these farms, ranging in size from 200 to 2,000 acres, catering for the agricultural needs; and a further nine dealing with horticultural matters. The directors of the farms and the scientific staff are N.A.A.S. officers, and there is an opportunity to interchange from one wing of the Service to the other.

The Farm Director is assisted in the formation of policy for his farm by two committees. One is composed entirely of N.A.A.S. personnel from a wide range of interests. This group will decide the broad national policy for all the farms, and the other is a local committee made up of farmers, university staff, the Regional Director, and one or two of his colleagues, who will advise on local problems.

The location of these farms is determined by the system of farming which they will represent, and not by geographical boundaries. They cover arable crops, mixed farming, dairy farming, beef, lowland sheep, upland sheep, etc. They will pick up a local problem and carry
out an investigation into it. All the farms publish an annual report of their activities and this is distributed free to farmers who ask for it.

Another important function of these farms is to serve as a meeting place where farmers gather together once or twice a year to see what is new, meet the N.A.A.S. personnel, and discuss their farming problems.

County Committees

I could not leave the organisation of the Service without some reference to the contribution that the farmer himself has made to the successful dissemination of information to his fellow farmers. There exists in each county a committee, composed of representatives from the farmers, landowners, farm workers, the local council, and the Minister's own nominees. Although these bodies are an inheritance from the wartime arrangement, their duties have been substantially changed. They now concern themselves with the technical and economic development within their area, and assist the county staff in transmitting knowledge to other farmers. These committees also act in a consultative capacity to the Minister, and their views are sought before any new or major change in agricultural policy is proposed. There are also committees at district levels who assist the district officer. The effectiveness of a committee depends very largely on the amount of thought and effort that the county N.A.A.S. staff will devote to stimulating the thought and interest of committee members. Some committees are now re-forming themselves into small groups, and making a detailed study of a local problem, and publishing recommended solutions.

The Work of the N.A.A.S.

Having described very briefly the organisation of the Service, I must now say something about its work.

Specialist Officers

The role of the Regional Specialist is quite clearly defined, and has not changed materially since 1946. It is to keep himself fully informed on new developments in his particular field and in turn keep the D.A.O. in the forefront of knowledge. He will be called upon to deal with any special problem that may arise within his region and, in order to keep himself informed, he conducts a number of trials concerned with local and national problems. He pays regular visits to research establishments and university departments. He meets his colleagues from other regions three or four times a year, and is allowed to attend meetings of learned societies which may be appropriate to his subject.

The County Specialist, on the other hand, is more concerned with the day to day specialised advisory problems, but he is nevertheless very much part of the county advisory team and his advice is, in the main, channelled through the District Officer. Exceptions to this are the Horticultural and Poultry Officers who are dealing with special problems in independent enterprises, and they generally have their own clients.

General Practitioners

I want to dwell for some time on the work of the county officer and his team of general practitioners whom I described earlier as being the king-pins of the Service.
Since 1946, when the N.A.A.S. was established, it has undergone three quite distinct and important changes and I propose to say something about each of these three phases.

Phase I. Immediate Post-War Period. This was the period immediately after the war during which the County Officer and his staff were responsible for the administration of the 1947 Agricultural Act, an Act with far-reaching powers of control. Various grants and subsidies had to be administered, and certain commodities, notably feeding stuff and fuel, were still rationed. Although the C.A.O. was provided with a team of experienced administrative staff to do much of this work, he was still the arbitrator in disputes. During this same period he was also engaged in building up a new Service which was designed to help the farmer with his technical and economic farming problems. Consequently, the N.A.A.S. officer found himself in the dual role of parson and policeman. But perhaps more important was the fact that these men and women had elected to become advisers rather than executors of Government agricultural policy, and they were understandably anxious to develop the advisory side of their work.

In December, 1954, the Minister appointed a committee to enquire into the regional organisation of the "department's" services, and when this group reported in 1956 one of its main and important recommendations (and which was adopted) was that the N.A.A.S. should shed as much as possible of non-advisory work. This recommendation was quickly implemented and the Service became a purely advisory body unhampered by two-edged responsibilities. This was an important milestone in the life of the Service. Officers were able for the first time since 1939 to devote all their energies to advisory work, and farmers were quick to appreciate the unbiased nature of their duties.

Phase II. The late 'forties and the early 'fifties was a period of high prosperity. The balance of payments crisis which had overcome the U.K. emphasised the need to grow food at home in order to save money on imports. The outlet for farm produce was unlimited, and the rewards were high.

It was during this period that great strides were made in the adoption of better husbandry techniques, fertiliser consumption increased, yields of milk from our herds continued to improve, new crop varieties were quickly adopted, meetings and demonstrations were well attended. Farmers were receptive to new ideas and the N.A.A.S. took this golden opportunity to make itself known to the farming community.

During the early part of this happy spree the concept of production at any price still remained, and only few of the N.A.A.S. officers were paying any real attention to the economic implication of this technical revolution. It was a philosophy of "grow more and you make more," which was largely true in an unsatisfied market.

Such a Utopia could not last and, almost overnight, the great shortage which had been predicted to last for many years began to disappear and a period of abundance was with us. This quite remarkable advance in farming technology had caught up with us and threatened to become an embarrassment to its creators. It is at this stage that we entered into the third and I believe the most important phase in our short history.
Phase III. Mr Clay Gibson of Manitoba has expounded a theory concerning evolutionary trends in an extension service operating in a rapidly developing agricultural economy and his theories are particularly appropriate to our own evolution. He refers to this concept as the "Extension Continuum," and he divides this into five stages:

(a) Technical Orientation:
This is the period when great stress is laid on the application of physical and biological knowledge towards increasing production of agricultural commodities, each discipline working in isolation from the other.

(b) Adjustment Orientation:
This is the stage where the adviser begins to look at the farm as a whole, and measures the impact of separate items of advice as it may affect the profitability of the entire unit, and when farm management techniques are employed to determine this end. The N.A.A.S. would fit into this stage at present and is beginning to overflow into the next stage.

(c) Farm Business Orientation:
In this stage the principles of pure economics are applied to groups of farms and large production units. The economics of finance, credit, and marketing would assume special importance at this stage.

(d) Family Orientation:
The emphasis is now moving from scientific facts to group and community development; and the adviser becomes somewhat of a missionary and social worker within the farm community.

(e) Individual Orientation:
Having covered the field of technological, economic and social requirements, the behavioural science of psychology would then be employed to ascertain the needs and aspirations of the individual.

Gibson suggests that the orientation is cumulative, and although the importance of one phase is not lost as the other emerges, he does suggest (and I think it is important as far as the N.A.A.S. is concerned) that agencies other than government advisory services will take over the responsibility for some of the duties associated with the earlier phases. This is indeed happening in England and Wales. Fertilizer and feeding firms are doing a considerable amount of sound advisory work. Chemical sprays are almost entirely the responsibility of those who supply them. The Marketing Boards are now providing technical management service to their members.

As I mentioned earlier the N.A.A.S. has arrived at Stage II in Gibson's continuum with some overflow into Stage III. Straight technical advice in isolation is giving way to a comprehensive economic approach, but embracing into any plan the most up-to-date technical know-how. Every District Officer is now aware that this is the only method of advice that is acceptable to his own superiors and to many of the farmers whom he serves. The struggle to persuade many of the Advisory Officers to adopt this approach was long and difficult. Many believed that farm management could only be done by the economist. Indeed, there was some grounds for this belief because such work had in the past been done by the agricultural
economics departments of the universities, and a few of the N.A.A.S. staff who had a flair for this type of work and had been trained for it.

During the last 10 years, however, every N.A.A.S. officer has attended one or more intensive courses in Farm Management, and the District Officers have attended several. These officers have also been supplied with a comprehensive instruction book known as "The Farm as a Business," and this provides a very full account of the basic principles of farm management. It contains chapters on Farm Accounts, Budgeting, and Planning; it also mentions the different techniques that are available to do management work. It includes standard input/output figures against which performance can be measured. In addition to this book, several leaflets and bulletins have been published on the different items. I must not, however, mislead you by implying that every District Officer is a competent management adviser, but I would be perfectly safe in saying that 80 per cent of them now approach their work with the economic impact uppermost in their minds, and interest is still growing, particularly among the younger men. The effect of this whole farm economic approach is evident throughout the country. Traditional patterns are being abandoned, and new revolutionary methods are taking their place. To mention but a few: Barley beef is replacing grassland fattening on many farms, and is showing better profit margins; self-feeding of silage with cattle on slats or in cubicles is a means of lowering bedding and labour costs; in-wintering of ewe lambs in hill areas in order to overcome the high cost of away-wintering. These changes are the direct result of the application of new findings into carefully considered budgets and re-planning. I should, however, emphasize that any decision to adopt a new plan or amend the old rests with the farmer himself. The Advisory Officer will lay before him the alternatives and what reward they will offer.

The importance of Farm Management has been deliberately emphasized in recruitment into the Service and promotion within it, but I hasten to add that first and foremost the officer must have a sound technical background. Unless he has this he cannot fit new findings into his plan and advise the farmer on their operation.

Management Aids and Techniques

During the early stages of management advisory work there was not, quite rightly, dictation from above regarding the techniques to be adopted. Consequently almost every county devised its own method and prepared drill sheets to go with it. Some were simple input/output exercises, whereas others were more comprehensive containing all the physical and financial data of the holding which was analysed and translated into a useful planning tool. The less experienced officers were encouraged to develop simple feed recording sheets, particularly for dairy farms as in the U.K. feed represents a very high proportion of the cost of producing milk, and it was not difficult to show a substantial financial gain where this commodity was misused. This stimulated the officers' interest, and made the farmer record-conscious, and often these simple cases lead to full management cases.

It was out of the multiplicity of these drill sheets that the present standard form, known as M.A.1, was produced. This is a sheet which contains all the physical and financial data on the holding, and is completed by the farmers, generally with the help of his Dis-
District Officer. The data on this sheet is then analysed and transferred to M.A.2, and this gives both D.A.O. and farmer a clear picture of what has taken place on the farm. His production is compared with that of similar farms, and the strengths and weaknesses are quickly revealed and remedial measures taken. These forms are now widely used, and it is hoped that all counties will adopt them in the fairly near future.

However, some counties, notably in the arable areas, have preferred the gross margin system to the account analysis. They claim that it is simple to use, farmers understand it better, a weakness can be spotted quickly, and the economic efficiency of each crop and livestock enterprise can be treated separately. These counties are now taking the technique a step further and are using more sophisticated methods, such as linear programming, in order to obtain the maximum benefit from the production resources. I do not want to discuss the merits or otherwise, even if I was competent to do so, of the different systems. Suffice it to say that each system, when properly used, has given satisfactory results and as the work develops we may eventually agree on a standard technique.

Data Processing Units

As already mentioned, the District Officer may have under his charge up to 700 farms, and clearly he cannot hope to call on even half of those in any one year, particularly now that he is spending more time on management work. As he became loaded with more figures (one M.A.1 form can take up to three or four hours to complete and analyse) it became clear that something ought to be done to relieve him of this clerical chore, and it was decided some six years ago to establish a unit composed of experienced clerks equipped with electric calculators (but still under the supervision of a fairly senior N.A.A.S. officer). The work of these clerks is to extract the data as supplied by the farmer on M.A.1 and do the necessary calculations which would provide the farmer and his local officer with an analysed account of the physical and the financial state of the farm. This unit, which is in the South-East Region, has now processed more than 3,000 complete farm cases, and last year it was decided that to extend the service to each of the eight regions. The Service is now being relieved of a time-consuming clerical chore so that more time can be spent on farms, dealing with new cases. These units, in addition to processing the full farm management cases, will also be doing the single enterprise costings, such as dairy and poultry monthly feed checks. It is our aim to make it possible for the farmer to have his returns back within a week of completing the original sheet.

In addition to the local processing unit, there is a move afoot to provide a more sophisticated type of analysis, using the electronic computer. This is still in an experimental stage, but its development is being carefully watched, particularly by the exponents of the linear programming method who see this as the only means of providing a fully comprehensive farm plan.

Farm Management Advisers

Up to quite recently we had no Farm Management Specialists within the N.A.A.S., but relied on the agricultural economics departments at universities to provide us with this service. This was done by Farm Management Liaison Officers who were appointed some 10
or 12 years ago to each region. These men have played a leading part in stimulating interest in management work, and training our men for the job; but as demand for economic advice increased it became obvious that the N.A.A.S. would need Management Specialists of its own and, early this year, one officer for each region was appointed. I believe it is significant that six of the eight were recruited from within the Service, the majority with an agricultural degree, with agricultural economics as the second string.

The work of the Regional Farm Management Adviser will be:
(a) To promote management work in his region by holding courses, addressing meetings, etc.
(b) To maintain contact with economics departments at universities, and particularly the liaison officers.
(c) Instigate and carry out economic investigations in his area.
(d) Supervise the data processing unit that will be part of his department.
(e) To be available to assist with difficult or complicated management cases.

It is important to note that these men will not be doing day to day advisory work. This, we feel, is the responsibility of the District Adviser who should be trained for this work. It is too early to talk about the effect of this new wing of our Service, but already it is making a strong impact, and there is talk that the numbers will be increased.

Farm Records and Accounts:

The basis of any management advice is adequate records, but I cannot say that the U.K. farmer is very good at keeping accounts. In fact, it is rather the reverse, and often the records that are available are kept for the purpose of making a return to the Inland Revenue. These sometimes are not a complete or accurate picture of the transactions that have taken place. To add to the problem, there are so many different ways of preparing accounts, some elaborate, some simple, and in recent years it has been customary for the feed, fertilizer, machinery, and other merchants to give the farmer a record book as a Christmas present. The Marketing Boards have also prepared some very useful books for their members.

About 18 months ago the N.A.A.S. invited the N.F.U. to discuss with it the possibility of preparing a standard Farm Accounts Book that could be universally used. The Union accepted the suggestion and the N.A.A.S. with the help of university economists undertook to prepare the book, and the N.F.U. accepted the responsibility of printing and distributing it to farmers. During the course of preparing this book interested parties, including the N.F.U. and the Institute of Chartered Accountants, were consulted and we believe that we now have a Farm Account Book that will suit all purposes. It is already on the market and is available to farmers through their Union at £1/1/- . We sincerely hope that 80,000 to 100,000 of these books will be in the farmers' hands in the fairly near future.

Farm Secretaries:

Another interesting development in farm records and accounts is the mobile Farm Secretary. An organisation, usually a farmers' co-operative, will engage a number of qualified persons who are able to deal with the complete range of secretarial needs of a farmer's busi-
ness. A farmer will pay a sum of money, usually about £8 a month, and in exchange for this a mobile secretary will come to the farm for about half a day per week and take complete charge of the records and correspondence, fill in the subsidy forms, do the P.A.Y.E. slips where labour is employed, prepare the material for the accountant and the advisory officer, and do a host of other office duties which the farmer dislikes doing himself. This idea is comparatively new, but it is spreading rapidly and farmers consider this good value particularly as they are able to charge this expense for taxation purposes. The Advisory Officer naturally welcomes this development. The data is already assembled when he visits the farm, thus saving much precious time.

**Farm Management Groups:**

As demand for advice increases a time comes when an officer is unable to cope with the demand, and as there is no provision for extra recruits a collective method of giving advice has had to be developed. Every District Officer is expected to have under his charge up to seven or eight Farm Management Groups. These consist of about fifteen farmers with strictly common interests, such as size of farm, system of farming, and, if possible, similar personalities, but above all a keen desire to meet and discuss technical and economic problems concerning their farms. These groups will meet weekly or fortnightly, and a popular form of conduct of this meeting is for one of the members to offer his farm as a guinea-pig. He will disclose his accounts and the group will discuss his techniques and financial achievements and, if these are not up to standard, suggestions for improvements will be made. If there are no volunteers with their holdings, a hypothetical farm will be devised and a planning exercise will be carried out.

Another form of group advice is to hold courses for farmers; some will be for four or five days, a day commencing after morning milking, and finishing in time for the afternoon milking. At these courses a study will be made of farm accounting, budgeting, planning, use of capital and sources of credit, plus discussions on husbandry practices. A less elaborate course will be the one-day academy where only one enterprise will be discussed, but still delving pretty deeply into the techniques and the financial implications. These courses are popular and always well attended. In fact they are often over-subscribed.

Before I leave the management side of our work there are two important points I must mention to you. They concern the confidential nature of this work. Some farmers have been reluctant to accept financial advice because they are afraid that the data disclosed would be used to determine Government agricultural price policies. I am happy to say that—

(a) The N.A.A.S. officer does not collect any economic data for this purpose. This work is done entirely by the agricultural economics departments of the universities.

(b) The financial data that the farmer will disclose is strictly confidential between him and his local officer. The farmers' name does not at any stage appear on any sheet that goes to the processing unit. It carries a number which is only known by the local officer. It is only by adopting this practice that we can expect to gain the complete confidence of the farmer.
Advice in Marketing

The N.A.A.S. is not responsible for giving advice on marketing of farm produce, but there is a strong feeling within the Service that it should be more closely associated with the marketing of the produce which it helps to grow. Recently a Chair of Marketing was established at Newcastle University, and others may be established in other colleges. It will be the responsibility of the N.A.A.S. to provide a bridge between this new department and the farmer.

Many officers do, however, assist in the formation and the running of marketing groups. Members of the group will agree to produce a commodity of a uniform quality and of the type the customer is willing to buy. These groups have been highly successful, with suckled calves, pig weaners, egg groups, fat and store lambs, etc., and they are increasing in number.

The N.A.A.S. in the main is composed of well-qualified and highly trained men. An applicant without an Honours degree may find it difficult to come in. Ten years ago we were begging for recruits but today we can afford to skim the top and leave a very deep layer of skim to find jobs elsewhere.

The officers are well paid, with good conditions of employment, and it is generally recognised that the morale of the Service has never been higher than it is today. This is because its task has never been so rewarding.

I would have liked to tell you something about the initial training which we provide for the new recruit, and how we try and keep the established members continually on their toes, but time does not allow a detailed discussion on these points. I have said enough to indicate to you how we are organised and the sort of work we do—so to sum up:

1. The N.A.A.S. is a comprehensive service with experts to cover most of the problems that arise. It is supported by a chain of farms to demonstrate known techniques and to test out new ones.
2. The channel of advice is through the District Officer. We believe it is wrong to have a number of advisers working on the same farmer.
3. Whole farm advice is replacing the old-fashioned piecemeal approach.
4. Technical advice is still important, but it is now dovetailed into the comprehensive plan.
5. Agencies other than N.A.A.S. are undertaking some of the advice concerned with feeds, fertilizers, sprays, etc., thus releasing the Service to do more rewarding work.
6. The N.A.A.S. consider that marketing is an integral part of a modern advisory service, and it may soon be more closely associated with this work.
DEVELOPMENTS IN BRITISH FARMING

J. W. Calder, Sometime Assistant Director and Professor of Plant Husbandry, Lincoln College.

To a visitor from New Zealand, England is a green land with extensive areas of fertile farmed lowlands. In Scotland and Wales the proportion of fertile lowland is less—these two countries being much more like New Zealand in the proportion of hill country. Lowland Britain has a forest climate and a variety of deciduous trees grow as spaced specimens in live hedgerows in many parts of the country. They also abound in spinneys, copses and parkland and together with the live hedgerows provide shelter for livestock and food and shelter for a wide range of bird life and for several kinds of small wild animals.

The growing season in the lowland area extends for about six months—from mid April to mid October—a month or so shorter in the north and a month or so longer in the south. In this period the climate is mild and humid and very favourable for the continuous growth of pastures and crops. The land is often wet and on heavy clays. This causes problems of grazing management of cattle as well as problems for the cultivator. Conditions for harvesting grain and small seed crops are far from favourable; but these difficulties have been met by the almost universal use of powerful harvesters and of farmer or group-owned grain driers and storage bins.

Sunshine hours and sunshine intensity are rarely more than 60 per cent of those of the sunnier parts of New Zealand. In the eastern regions rainfall varies from 18 to 25 inches and on the west from 35 to 45 inches. Although mild droughts occur in spring, summer or autumn there is no prolonged arid period to interrupt, seriously, the growth of pastures and crops by two or more months as we frequently experience in several parts of New Zealand. The winters can be long and cold. The record winter of 1962-63 was responsible for increased feeding costs for livestock, and caused considerable inconvenience and added cost for transport of feed and livestock in many areas which were cut off by deep snow for a month or more. Over the centuries the British farmers have developed their systems of livestock husbandry and have provided the facilities for housing and feeding under these winter conditions. More than 100 years ago when farming was prosperous after the Napoleonic wars, large barns, yards and court shelters were built for livestock and for winter feed storage. Many of these are still in full use and farm workers can tend their animals in fair comfort while severe winter conditions exist outside. Today with the assistance of grants of up to 30 per cent for approved schemes new large concrete or steel-girded structures of umbrella or individual design are being erected on many farms where the older buildings are inadequate for modern needs.

Outwintering of milking cows is controversial. It is more common in the south where the winters are shorter; but it is not increasing significantly in spite of the masterly achievement of Mr Rex Paterson of Hatch Warren who operates about 20 one-man bail units of 60 cows each on his Hampshire farms. The main winter feed for his herds is clamp silage—self fed on an excavated chalk platform.
During the coldest part of the winter concentrates are fed according to the level of milk production.

One of the objectives of agriculture in the U.K. is to provide as high a proportion of the food supply for a population of over fifty-two million people as the government considers desirable. The government policy for agriculture is contained in the 1947 Agricultural Act which states that the main objective continues to be “a stable and efficient agricultural industry, capable of producing such part of the nation’s food and other agricultural produce as in the national interest it is desirable to produce in the United Kingdom, and of producing it at minimum prices consistently with proper remuneration and living conditions for farmers and workers in agriculture and with an adequate return on capital invested in the industry.” Lord Walston at a recent farmers’ conference is reported as saying that about two-thirds self sufficiency was desirable on strategic, economic and social grounds. Pre-war Britain produced about 30 per cent of its food requirements; in recent years agriculture, in response to government support, is producing over 60 per cent on average though as little as 11 per cent of butter, 26 per cent of wheat for human consumption, 46 per cent of cheese and 76 per cent of carcass meat. Self sufficiency is more or less complete for milk, eggs, potatoes and most vegetables. Some authorities claim that full utilisation of all land could result in self sufficiency for the present population. But Britain is a trading nation and the adjustment of home production and imports to national needs and to international trade remain a Government responsibility. I don’t intend to discuss here the standard practices and techniques of husbandry and the establishment of farming in Britain which produce a gross output of 1700 million sterling, but they well repay study. There are about 300,000 farms and about one half are small farms—50 acres or less. In the past these have been a source of worry to the Government and to the industry but in recent years the Government has introduced the Small Farm Aid scheme in which additional grants and particularly advice based on budgeting and management have improved the lot of many of the small farmers. At the other extreme there are men who farm four or five thousand acres of arable land. This may be freehold or leasehold from some of the big landlords such as the Coal Board, the Church Commissioners and educational institutions who often encourage efficient men to take additional land as it becomes available.

You can imagine how interesting it is for a New Zealander to visit a 4,000-acre farm growing 1200 to 1500 hundred acres of wheat; 1200 to 1500 acres of barley, 300 to 400 acres of potatoes; 300 to 400 acres of cocksfoot for seed and 300 to 400 acres of rape seed for oil. No stock at all and therefore no stockproof fences to maintain, no gates, no water; but all the buildings and machinery for drying and storing grain, seeds, potatoes and fertilizer. Fertilizer applications are heavy by our standards and yields and run up to 40 to 50cwt per acre of grain; 10 to 15 tons of potatoes per acre, 10 to 20cwt of rape seed and 5 to 10cwt of cocksfoot seed.

The British farmer has a market of over 50 million people on his doorstep and these require fresh milk every day, fresh eggs, potatoes and vegetables, and as much fresh meat—pork, poultry, beef and
as they can afford. As a result the farmer has a wide choice of enterprise he can undertake and he often has several. Mixed farming in which animals and cropping are integrated into a balanced system is characteristic of British farming and the level of arable farming and livestock husbandry is high. It is unnecessary for me to emphasise the fact that systems and techniques change. Most of us have experienced revolutionary changes in New Zealand in our own time. I propose in the remainder of this paper to give an account of some of the changes that are occurring in British farming. In other words to have a look at what the farmers are doing to adjust themselves and their practices to the challenge of this scientific and business age. Some are short term, some long term, some economic, some technical. Whatever they are and whether they are successful or not they do show that the spirit of enterprise which has characterised British agriculture since Jethro Tull invented the grain drill and Robert Bakewell bred his Leicester sheep is much alive today.

Of considerable significance is “The Marketing Group” movement. This started in a small way three or four years ago and is now snowballing. It is difficult to find out the actual number of groups already operating but it runs into several hundreds. A group consists of a number of local farmers producing a similar product—be it grain, potatoes, vegetables, eggs, pigs, fat lambs or beef and marketing their joint production of a particular commodity to best advantage. The wholesale merchants give a better price because of organised regular deliveries of increased quantities, reduced buying expenses, and sometimes better grading. The group may consist of as few as four or five local farmers or it may grow to county or regional size. One farmer running several enterprises may be a member of several different groups such as a pig marketing group, a barley marketing group and a fat lamb marketing group. The scheme is a form of producer cooperative with a high degree of specialisation. The N.F.U. give guidance on group formation which are free to trade when they will and a proportion of them work closely with the N.F.U. sponsored Agricultural Central Trading Organisation (A.C.T.). Some of the early formed groups have grown big enough to employ business managers, market research and technical advisory staff. The Government established two years ago the Agricultural Market Development Executive Committee (A.M.D.E.C.) with a fund of £3,000,000 spread over three years. This committee may support groups by paying half salary for management or secretarial staff for the first two years, by help in market research and in other ways. By taking part in group marketing the individual farmer has given up his independence of selling in favour of more efficient selling. This is causing concern to established trading firms who have been growing fewer and larger. Producers have been forced to act in this way in their own interests and have started something which will be interesting to follow during the next few years. The situation is ripe for association, federation, amalgamation or takeovers.

When I arrived in England in 1958 several new techniques were causing considerable discussion amongst farmers and sometimes heated argument. Zero grazing was one. It is in effect the old system of cutting herbage or forage and carting the cut stuff to cattle; but now the gang mower and forage harvester replaces the
sythe or horse-drawn grass-mower and the trailer with mechanical unloader replaces the horse-drawn wagon. Cut herbage surplus to immediate stock needs is made into silage. The system has some merit but it has not taken hold except where or when the land is too wet for grazing cattle or when the layout of the farm requires too much time for stock travelling to and from the grazing land. It boils down to the fact that under present conditions the animal with its four legs is a cheaper form of transport than a tractor and trailer and a cheaper collector of herbage than a forage harvester; but this may not always be so.

Another practice which is likely to be more lasting in Britain has developed as a result of a combination of three things: high producing strains of Italian ryegrass (Aberystwyth S22; New Zealand Certified, and several European varieties) relatively low cost supplies of nitrogen and the introduction of economic irrigation systems—yes, irrigation in humid England. In the Midlands and eastern parts of England milk production is often associated with grain production and enterprising farmers who plan to grow as much grain as possible are using Italian ryegrass for the grazing crop. The Italian is undersown in a cereal or sown alone on stubble cultivation with 3 to 4cwt of a high nitrogen compound fertilizer. In late winter or early spring 2 to 3cwt of nitrogenous fertilizer are applied and the field strip grazed throughout the season. After each grazing more nitrogen is applied and the strips are irrigated when required. As much as 20 or more hundredweight of nitrogen may be applied in some seasons and yields of milk per acre range up to 1,500 gallons or more, i.e. from grazing during the growing season.

The use of nitrogen for intensive forage cropping without irrigation is also popular on arable farms. For cows or sheep a mixture of rye corn, Italian ryegrass and rape is sown in autumn on stubble ground with 3 to 4cwt of a high nitrogen compound fertilizer. A grazing may be taken in late autumn. Nitrogen is applied in late winter for early bite for dairy cows or for lambing feed for ewes. Throughout the spring three or four grazings are taken and nitrogen applied according to growth requirements. A silage cut may be taken in early summer and the field then ploughed for sowing kale in June (December). This kind of intensive forage cropping is more reliable in Britain than it would be in New Zealand for two reasons—a low cost supply of nitrogen fertilizer—it costs the farm around 12/- per hundredweight—and more favourable growing conditions in summer. Nitrogen fertilizers are produced from atmospheric nitrogen in England by I.C.I. and Fisons at around £20 a ton. In New Zealand we certainly are unable to use imported nitrogen in any quantity at around £30 per ton except for high value crops. We have learned to use clover nitrogen and as long as we can maintain yields of pasture and crops at reasonable levels in this way we can manage without large quantities of fertilizer nitrogen; but we should be aware that nitrogen is of major importance in securing good crops and nitrogenous fertilizers can be manufactured from atmospheric nitrogen using electricity as a source of power. In time, which may not be too far distant, more intensive cropping will be necessary in some parts of the country and then we may be forced to use nitrogenous fertilizer on lines similar to those of Britain and Europe.
Creep grazing of lambs is worth some discussion. Creep feeding of calves and pigs is an old custom. An extension of the principle to grazing lambs on pasture was developed at the Grassland Research Institute at Hurley and at Cockle Park in Northumberland. A number of farmers who have been trying a more intensive system of grazing management for fat lamb production have designed successful systems while others are satisfied with the more familiar rotational or set stocking systems. One important result of creep grazing as practised in the United Kingdom is the widespread publicity given to the system which has demonstrated more effectively than any other form of publicity the high level of production that can be obtained from good pastures where they are heavily stocked with ewes and lambs. Many carefully conducted experiments at research institutes, universities and husbandry farms have shown that from 6 to 10 ewes with twin lambs can be carried per acre during the growing season. Most of the experimental work has shown that as the stocking rate rises above a certain level on a particular grazing area a smaller proportion of the lambs will be graded fat. In examining United Kingdom results several factors must be considered—lambs are carried to heavier weights because there is no marked reduction in price per pound as the weight increases; worm infestation begins to show its effect as the lambs get bigger and eat increasing quantities of herbage contaminated by the ewes. Creep grazing can then benefit lamb production by providing a continuous supply of fresh, clean, high quality herbage. Whether the system fattens lambs or not is influenced by the amount of clean high quality feed the lambs eat. The system has much merit under United Kingdom conditions, especially with the small flocks of from 100 to 500 ewes which are common. I expect the system to expand as the new generation of shepherds become experienced with intensive fat lamb production but as the size of the flocks increase to a one-man economic unit they will then swing back more to some form of set stocking or rotational grazing, associated with judicious use of drenches.

The main breeds for fat lamb production are Scotch halfbreds, Welsh halfbreds, Greyface, Masham as well as the pure breeds such as Kerry Hill, Clun Forest, and to a less degree the Kent or Romney. These ewes are crossed by one or other of the down breeds—Suffolk, Dorset Horn and Dorset Down, Hampshire and Oxford perhaps being the most popular. There are well over thirty breeds in the United Kingdom and yet we find Mr Oscar Colburn and his father before him setting out to produce a new breed—the Colbred—by intercrossing several local breeds and a prolific European breed. The objective is a ewe producing a flock average of 200 per cent of lambs, long life and a good wool clip and lambs with rapid growth, and meaty carcass. Recently he has joined forces with the Thornbury organisation which is a successful commercial poultry breeding company employing geneticists and statisticians to aid their breeding programmes. The aim is to apply the methods which have been so successful with poultry breeding in an attempt to speed up the achievement of the objectives set by Mr Colburn. He is a very enterprising young man in the tradition of former breeders of British livestock We can only wish him the best of luck with his interesting project.

Another animal breeding project based on the fullest use of scientific principles is that supervised by Dr H. P. Donald of the
Animal Breeding Research Organisation. The scheme involves three way crosses between the Fresian, Ayrshire and Jersey breeds and has been in operation for more than ten years. Data on the inheritance of conformation and production during several thousand lactations are being analysed by the staff and while the project is not completed it is giving valuable information and guidance to those commercial breeders and milk producers who are using similar crossings.

Returning to sheep. You all know that most lowland fat lamb ewes are wintered on hay and silage with or without roots as the basic ration and supplemented with concentrates. Concentrate or trough feeding of ewes with grain, cake, sheep nuts or pellets is almost universally practised and towards lambing up to one and a half pounds per day are fed. It is usual to budget for about half a hundredweight per ewe which at around £30 per ton is equivalent to 15/- per ewe for concentrates alone. You also know that the United Kingdom farmer expects to sell about 130 per cent of lambs and many well shepherded flocks sell 170 per cent or more. Good quality grazing in autumn and trough feeding in the long cold winter play a major part in getting these high percentages, associated with close shepherding day and night in shelter sheds or in pens made of straw bales. A lamb grows to be worth around £7 at selling time and so justifies the cost and effort put into the feeding and shepherding. For the same reason there is some increase over the past few years in wintering ewes on slatted floors or on straw. It is claimed to be more economical in the use of feed, that the shepherd can follow the thrift and health of the ewes, that less time in shepherding is involved and that lambing is more easily supervised. It is certainly more comfortable and convenient for the shepherd.

Intensive beef production has followed the discovery that Fresian or Fresian cross calves can be grown to beef at 11 to 12 months by adopting the broiler or feed lot techniques to beef production. There is a large reservoir of calves in the dairy industry which in the United Kingdom is mainly based on the Fresian and Ayrshire breeds. Calves are purchased from dairy farms by rearers who feed them on milk substitute and grain to weaning age. They are then taken over by the feeders who feed under intensive conditions in yards on concentrates and limited roughage. With mechanised handling of the feed one man can attend several hundred animals in large barns. Some of the enterprises run by a group of farmers have slaughtering facilities, butcher shops and pie-making factories to complete a vertical integration of their enterprise. The intensive beef enterprise has recently been stimulated by the introduction of "barley beef." Calves are fed on a mixture of rolled barley with a protein and mineral substitute developed by Dr Preston of the Rowatt Research Institute. These developments are far removed from traditional British beef producing systems and show how versatile the British farmer can be when he is challenged to compete for his market against other forms of production and against imports.

The official importation of the Charollais to cross with the Fresian and other breeds under supervision of the livestock authority is an example of the encouragement which the Government are giving the farmers in their efforts to improve the economy of beef production.
And now I will finish on a pasture note. The British and European plant breeders are making some progress with two or three new approaches to pasture plant improvement. The Grassland Research Station at Hurley, the Welsh Plant Breeding Station at Aberystwyth and the Plant Breeding Institute at Cambridge have recently joined forces for plant exploration to Portugal and Northern Africa. The objective was to search for pasture plants which have the natural ability to grow in the cooler months and in the shortening day-length and declining light intensity of autumn. Most British pasture plants have the contrasting habit of increasing growth in spring and summer. Some promising material for direct use or for crossing with the valuable British leafy strains can be seen at the research stations and it is expected that these new forms will help with autumn and early winter feed problems of British agriculture.

The European plant breeders have been successful in producing leafy and productive strains of most pasture grasses which for European conditions are comparable with the best of the Aberystwyth and New Zealand pedigree strains. They have not been so successful with white clover. New Zealand certified white clover is the only reliable strain that is available to British farming in sufficient quantity for widespread commercial use. In the Netherlands the plant breeders have also been successful in producing polyploid forms of perennial and Italian ryegrass by doubling the chromosomes in these forms. Several commercial varieties are coming on to the market and while they have not yet received official recognition they are creating considerable interest. The characteristics are high palatability (15 per cent to 20 per cent more sugar), winter hardiness, good persistency and productiveness. The plants themselves are darker in colour and have thicker stems, broader leaves and fewer tillers than the normal variety and the seed is up to twice as large. Further breeding and selection will no doubt result in improvement on the present types which are the first result of this new approach.

The examples I have given cover some of the activities which are evident in British farming and show something of the enterprise of the British farmer when the industry is in a prosperous state. Government support for agriculture has given confidence for the future and farmers have justified the support by greatly increased production. But we must remember that they have the great advantage of a market of over fifty million people to supply with a considerable variety of foodstuffs. They are thus traditionally mixed farmers and can produce grain, potatoes, milk, beef, mutton and lamb, eggs, poultry, pig meat and vegetables in various combinations and swing the emphasis to one or other of these enterprises in response to Government policy. By comparison New Zealand farmers are specialists. New Zealand takes just pride in the achievement of her farmers and in the efficiency of production in those enterprises they are in a position to operate—namely fat lambs and dairy produce for export. There is no country which can produce these basic world foods of such standardised quality at such low cost as the New Zealand farming industry. In Britain there are few, very few farmers who farm grass, run an intensive fat lamb enterprise or an intensive butterfat enterprise on pastures to our standards. This is probably because they don’t need to. These low cost systems have not become necessary while feeding concentrates to supplement extensive grazing.
and hay and silage feeding are profitable. The criticisms of such an experienced and astute observer as John Cherrington are not to be dismissed lightly; but he and we should remember he is comparing the recent and almost revolutionary developments of the mixed farming system of Britain which, with considerable Government support, has occurred since the war, with the longer established, efficient but specialist enterprises of the New Zealand farmer. These need no apology by any standard.
STREAMLINING DAIRY FARMING
G. Aldridge, Farmer, Martinborough.

The centrepiece of the whole system which enables a person to milk and manage a large herd of cows without strain, is of course the cowshed. Most of what I have to say to you this morning will be concerned with the design and operation of the so-called Production Line cowshed. However, as most of you know only too well, dairy-farming can be a very full life, and there is more to it than merely milking. Obviously, a man who has convinced himself that he can actually milk 100 or more cows comfortably, is also going to have to face up to special problems at calving time, special problems of pasture management and feed conservation, problems which were of an entirely different order when he was milking, say, 60 cows.

So before we get on with the cowshed, I would like to put before you a few of the ideas, the attitudes and approaches to dairying which an increasing number of farmers are trying out, and in many cases to their surprise, finding eminently successful.

To begin in the logical place, calving time, how does a man cope with 100 cows and their multitudinous offspring? The bellowings and bleatings that in the past have at times almost put him into orbit, are now multiplied, say, by two. Forty calves to rear instead of 20. Sixty or 80 bobby-calves instead of 30 or 40. Twice as many heifers to break in each year, twice as much sickness and so on and so on. It sounds quite disheartening when you put it that way, until you realise there must be an answer. People are managing, and in my experience they are managing more easily, and with less tears and frustration, than they were a few years ago with smaller herds.

Take this little matter of feeding the calves once a day instead of twice. The natural reaction on first hearing this suggestion is to throw up the hands in horror. But what happens in practice? The calves are quite happy with once a day feeding, starting from the day they are removed from the cow. What effect does it have on them? They grow just as fast, just as healthily. Moreover, their tendency to eat grass, and their ability to handle increasing quantities of grass, are a natural outcome in favour of once a day milk, as well as being a factor in minimising the check they receive at weaning. Weaning at eight weeks has of course been fairly standard practice for some years now.

How about the problem of feeding large numbers of calves? What a timely invention was the calfeteria system. Twelve or fifteen calves feeding around a 20 gallon can. Forty odd calves feeding around three cans. You drive into the paddock, dump the load and drive out. Home to breakfast. The only hard part is keeping your mind off the amount of milk they are getting away with. We'll have a demonstration model of one of those cans at the Field Day tomorrow.

As for bobby-calves, here again it is a matter of adjusting our methods to deal with large numbers. In brief, a method on these lines works very well. Bring in the freshly-calved cows, say twice a week, collecting the calves straight into a calf-pen on wheels. Providing they can see their calves in the trailer, the cows will usually
follow to the shed. In any case, they should be in a small handy paddock at this stage. Drive off with the calves, unload the ones to be reared into the small yard or pen which is their transit camp for a few days while they learn to drink, then off down to the gate to unhook the calf-pen-trailer with its consignment of bobbies. Then back to the shed to milk the new cows, give them a thorough inspection and whatever special attention they need to start off the season on the right foot, e.g., rim the tail and shave the brand number.

Naturally I'm skipping details and exceptions galore, but that is the bones of one system that can be made to move fairly sweetly through the whole of the calving season with the minimum of fuss. If we hand-feed bobby calves at all (perhaps the lorry comes only once a week), again it is on the calfeteria system, not out in the paddock, but in the transit yard with the learners, and using the special training setup, i.e. a smaller can incorporating three-eighth-inch plastic tube instead of the usual half-inch, the idea being that with the narrower tube the milk arrives at the calf's mouth with the first suck.

Now a word on how to go about providing the vast area of crop needed to keep the herd happy at all seasons. The solution to this one is both cheap and simple. Forget it. Don't crop. Brave words? I haven't met anyone yet among the type of farmer I am referring to who has regretted giving up cropping. Remember we are dealing with people who have stepped up their herds, but not necessarily their acreage, consequently they have to use their acres more efficiently than they did in the past. They can't afford the luxury of a crop. They aim at having sufficient cows to keep the grass well under control in the spring. In other words there is ample feed at a time when the cows need plenty, but not so much that they can afford to put a paddock or two under the plough.

What about hay and silage? I can almost hear you thinking it. The same principle applies. The aim is to have so many cows on that in an average spring there is no real surplus. Why turn good grass into hay and straightway and inevitably lose about half its feed value? Or turn it into silage and be sure that you will irrevocably lose at least a third of its feed value. Have enough cows to turn that precious grass straight into milk. More cows means higher fertility, means a longer growing season, means less supplementary feed required. If you can buy cheap hay, pea straw, rye straw, barley straw, it is often better economics than making hay yourself when you take everything into account.

I realise that these recommendations are shot full of exceptions, dictated by circumstances of climate, soil type, availability of outside grazing, availability of cheap fodder and a host of other things. Perhaps the biggest consideration is whether you are supplying a factory or trying to maintain a year-round town-milk quota. Neverthe­less there may be something in these ideas on the approach to dairy-farming that you can use. It may well be even more applicable than you think, e.g., my own farm is so similar in climate and soil type to your light shingle loams in Canterbury, that virtually the only difference is that we might be a bit drier in Martinborough. Not good dairying land at all, which is all the more reason why we are obliged to use these streamlined techniques to keep afloat.
Fencing, draining, top-dressing; where possible we use contractors for all these things. They are the specialists. They have the experience, the equipment, the skill and the labour. We are specialists, too. Specialists in the art and science of milking and managing herds of cows, the mere suggestion of which would have made our grandfathers tap the forehead.

Enough of the incidentals. Let’s have a look at the Production Line shed, and this new bird in the aviary, the Production Line milker. The past few years have seen quite a surge of ideas for milking shed design. It was inevitable that once the first radical departure from the orthodox walk-through bail was made, and people began thinking along the lines of greater economy of time and labour in the milking shed, the door was wide open for a host of innovations, new approaches, gadgets, gimmicks, some useful, some hopeless, some fitting in well with the dairy cow, others invented without any real understanding of either efficiency or dairy cow psychology. We can’t deal with all of them today, so if we confine this discussion to one fundamental, proven type of shed, the reason is to avoid confusion, and not to condemn or exclude some of the many minor variations of the same theme, whose merit or otherwise varies with the particular circumstances of climate, topography, herd size and other factors.
Now let's have a look at this diagram depicting the bare outlines, so that we can define our terms and get the picture straight. Three things stand out immediately: the circular yard, the backing gate and the omission of the end wall. The backing gate is designed to move round the yard at the press of a switch and its object of course is to keep the cows up to the milker. Inside the shed we have the pit, dug out to a depth of 30 inches and inhabited by one or more milkers. Surrounding the pit are the two exit gates and the various pipe rails which hold the cows in position and prevent them from falling on top of the milker. This one in front, at a height of 30 inches is the head rail, and behind the cows at three feet above floor level is the breach rail. Along each side of the pit is a four inch high nib, which these days is usually made of angle-iron. Its function is twofold. First of all it takes a lot of the splash out of droppings, and secondly it prevents the odd cow from being squeezed through like an orange pip under the breach rail into the pit. I am told it is no joke trying to break a herd into a new shed before the nib is in position. Just alongside the exit race are two drafting gates, one opening into the small area behind the backing gate, and the other into a handy yard or small paddock, so that selected cows may be held back during the breeding season or for special treatment. Both gates are operated from the pit and as a batch of cows is departing (in single file at this stage) it is a simple matter for the milker to pick out the one he wants and send her in the appropriate direction.

Now we will fill the yard with cows, shut the entrance gate and watch what happens. The machines are switched on, the cooler is running, the milker is in his pit, and already the first batches of cows have lined up, just like so many angle-parked cars, with udders within easy reach and sight of the milker. The time is seven o'clock in the morning and the tanker is due to pick up the milk at 8.30. However this particular farmer has just the bare 100 to milk so he won't need to rush. In fact he is so completely in command of himself and his job, that the casual observer could be excused for thinking that he is exercising some hypnotic or magical influence over his cows, so smoothly do they proceed through the shed, and so effortlessly does he saunter up and down the pit. The truth is that this farmer that we are going to watch now (and there are dozens just like him), is blessed with a well-designed and equipped shed, a well-trained herd, and for his own part obeys a few simple rules based on common sense and his understanding of the mental and physical processes of the dairy cow.

First of all a brief run through the milking sequence, and then a quick look at some of the underlying reasons. In one hand he has a cake of dairy soap, in the other a small hose supplying clean warm water, running at the touch of a finger and automatically shutting off when released. He wets and soaps the first three cows, places the soap by the nib, and proceeds with soapy hands to stimulate and massage the three cows. He rinses off excess soap with a squirt of the teat-washer and then slips on the cups. He repeats this performance with three more cows. Let's suppose he is operating eight sets of cups. (Some chaps are doing more.) That leaves two cows at the end of the row, so he washes them and puts the cups on. Returning to the exit end of the pit, he now begins washing and stimulating the first three cows in the other row, switching the cups.
across as soon as they are available. Four, five and six the same. Now watch him closely. He prepares cows seven and eight, but before putting the cups on them, he takes a second or two off to pull gently on a cable which operates the exit gate, opening it in front of the batch just milked so that they can be on their way while he is changing over the last two sets of cups. He not only has time to do this, but normally also has time to put the weights on before shutting the gate behind the departing batch and in front of the next row of cows, who are already moving quietly into position. Sooner or later, of course, as the ranks of the unmilked begin to thin, the milker will find that perhaps three cows have moved in but no more. What does he do? He carries on unperturbed, washing the available cows, then while one hand is stimulating an udder, the other reaches for the overhead cable which operates the backing gate switch. The gate moves forward, perhaps to the musical accompaniment of a bell, so that the cows can hear it coming as well as see it. Thus gently reminded of their purpose in life, the cows take up the slack, move into position, and milking proceeds without missing a beat. Have I made that sound simple? I hope so. It is simple. And that is the way it should be and can be right through milking, with slight modifications of procedure to accommodate the slow cow, the shy cow and the kicker.

A legitimate question at this stage is how does this design and system square up with recommended milking technique? The open end of the shed makes for easy access to either milking alley. No narrow doorway to pass through from light to dark, no difficult corner to negotiate and balk at. A row of cows departing after milking, in full sight of the waiting herd, stimulates the follow-the-leader instinct so that they tend to walk into position without any persuasion from the milker. Once in position, each cow is comforted by the nearness of her mates, so that she stands quietly and contentedly. This leaves the milker free to concentrate all his efforts on those operations which the cow cannot perform for herself. Namely, washing, stimulating, changing the cups, opening and shutting gates, etc. Everything he needs is right at his fingertips. Soap, water, udder, weights, cables for operating gates. No stooping, no straining, no bustling. All the time he needs to keep six or seven or eight or more sets of cups continually in operation.

That is the theory. If you want the proof in practice, I would refer you to two surveys which the Dairy Board conducted during the 1962-63 season, the results of which are contained in the Farm Production section of the Board’s Annual Report for that year. The first survey, covering 395 sheds, involved a comparison between various types of walk-through sheds on the one hand, and herringbone type sheds on the other. The second survey covered 133 herringbone type sheds of various sizes and with varying numbers of milkers, and of course the Board was able to produce from these surveys several pages of most fascinating and enlightening conclusions.

Let me pick out just one or two for you.

1. In the one-man sheds, production was higher by 4,927 lb of butterfat in the herringbone type.

2. When comparing various herringbone sheds, it was found that there was no difference in production per cow between sheds
turning out 20-29 cows per man per hour, and sheds turning out 60 or more cows per man per hour.

3. A general conclusion. Quote: “Less time and less effort are required to milk a given number of cows in a herringbone shed than in a walk-through. The saving in time is achieved not through cutting down on the time spent on each individual cow, but by cutting down on the time spent on unnecessary activity. It is made without the milker having to move faster or work harder. The saving in time should not reduce the efficiency of milking; in fact as less time and effort are required, and the cows udders are much easier to see, efficiency is more likely to be increased.” Unquote.

The reason I have placed these findings of the Board before you, is partly for their own interest and persuasion, and partly to help remove from your minds any suspicions you may harbour that perhaps this bloke has allowed himself to get a bit carried away in his enthusiasm for streamlined milking. Furthermore let me point this out. In the Dairy Board’s surveys there were all sorts of herringbone sheds, but not all of them were Production Line sheds, and even those that were right up to the minute in design were not necessarily operated in every case by Production Line mentality milkers. I can assure you the differences would have been even more glaring if they had been.

What does all this amount to, this streamlining of our dairy-farming? It amount to this: Not only a happier, more satisfying, more rewarding and less frustrating life for those engaged in it, but also it is an opportunity for the present generation of dairyfarmers to keep ahead of costs, by increasing production, with less effort than many are now expending in the achievement of a lower level of production. If we don’t take this opportunity to keep in front, it is inevitable that we will ultimately lose our chief advantage on the world markets, low cost dairy production.

Mr Chairman, I am conscious of the many and important gaps in my story. It would be impossible to cover them all. It would also be undesirable, because that would leave no room for questions. I’m sure I have left plenty of scope.
RECENT DEVELOPMENTS IN MILKING MACHINE CLEANING

W. G. Whittlestone, Principal Scientific Officer, Ruakura Research Centre, Hamilton.

One of the main problems confronting the dairy industry in New Zealand at this time is the need to improve the quality of the product which we export overseas. With increasing competition on the international market quality as well as price plays a very big role. New Zealand has long held a reputation for quality in her dairy products; however, we cannot stand still. One of the main aims of the industry at this time must be to make a good product even better.

It is the object of this paper to examine some ways in which we can improve the cleaning of the milking machine. A point which is often overlooked by the dairy farmer is the fact that the quality of the milk as it leaves the farm determines the ultimate quality of the product as it leaves the factory. The farm is the first step and the most important step between the cow and the final product. While much can be done in the factory to offset the bad effects of poor hygiene on the farm, nevertheless, to make the finest quality product it is essential for the factory to have the finest quality milk.

Generally speaking one can classify contamination of the milk into two categories. Chemical contamination and bacterial contamination. It is also convenient to sub-divide the sources of contamination under three headings. First, internal contamination within the udder of the cow herself. The disease mastitis is responsible not only for an increase in the bacterial and cell contamination of the milk but also it has the effect of reducing quality, from the chemical point of view. Mastitic milk tends to be low in total solids. A second origin of contamination is the external surface of the udder which is a source of bacteria and also of sediment. Milk contaminated from this source reflects poor cowshed hygiene. The third source of contamination which will be the subject of this paper is the contamination within the milking machine itself. Badly designed and constructed milking machinery can give rise to chemical contamination in the form of copper and an effect known as lipolysis. Both of these chemical defects give rise to a reduction in the palatability of the final milk product be it butter or whole-milk. Bacterial contamination in the milking machine arises of course from poor cleaning. But it also reflects in many cases the poor design of the milking machine from the cleaning point of view.

A visible sign of the inadequacy of a cleaning process in the milking machine is the presence of so-called milkstone and it is the object of this paper to discuss the nature of milkstone, its formation and ways in which we can go about reducing or eliminating it. Table 1 sets out the composition of a typical milkstone deposit, alongside the figures for milkstone are given figures for milk. As can be seen most of the constituents of milkstone also appear in milk but the ratio of the various constituents is quite different. In the third column of the table is set out the type of cleaner which is required to remove the particular constituent. Fat and protein for example require an alkaline cleaner while the ash constituent of the
stone requires an acid for most of its components. The second part of the table shows ash constituents again with the cleaner required set against them. These constituents are rarely in the forms set out but consist of complex salts which are usually more insoluble than the oxides shown in the table. It is customary, however, with a mixture of this kind to present its constituents as oxides.

The presence of milkstone in a milking machine is seriously detrimental to milk quality. Milkstone itself forms an excellent medium for the growth of bacteria. Particularly when the final sanitizing of the milking machine is dependent on so-called boiling water and the water temperature is inadequate, there is a very severe tendency for milkstone deposits to become heavily infected by thermoduric or heat resisting organisms. Such organisms are dangerous to the quality of whole milk and to the production of high quality milk powder. In some countries the “laboratory pasteurized count” or L.P.C. is used as a criterion of milk quality. Where this is done it is found that there is a high correlation between the L.P. count and the presence of milkstone in a machine. Such stone deposits tend to protect the organisms against the hot water rinse particularly if the temperature is not high enough. Thus the milking machine in effect becomes an incubator for thermoduric organisms, the worst kind of contamination from the point of view of the factory manager.

The prevention of milkstone involves an understanding of how its precipitation is brought about. The first important factor in this precipitation process is the presence in the rinsing water of impurities known as hardness which can react with the constituents of the milk. Salts of calcium and magnesium which make up most of the so-called hardness in the water react particularly with milk protein to form an insoluble complex. This will stick to the surface of metal tubing and form stone. A second factor well known to encourage the formation of milkstone deposit is the application of hot water to a machine which has not been adequately rinsed. The rinsing water used immediately after milking should be cold or slightly warm. Hot water will definitely cause a precipitation of milk protein. Similarly if the machine is not rinsed properly and a hot detergent solution is put through it, the heat will bring about a precipitation of milk protein. The addition of a small amount of non-ionic wetting agent to the cold rinsing water will help in many cases to reduce the build-up of milkstone. This wetting agent prevents the sticking of the insoluble protein-hardness complex to the internal surfaces of the machine. It also helps to improve the efficiency of the rinsing process.

The composition of the detergent solution itself is another big factor in controlling milkstone build-up. For the efficient cleaning of a milking machine or any other milk handling equipment it is essential to have in the detergent a substance which is capable of softening or sequestering the water hardness. As can be seen from Table 1 a high proportion of a typical milkstone deposit is so-called ash. If a sequestering or water softening agent is added to the detergent it will tend to dissolve this ash constituent thus making the stone deposit friable and readily removed. In the original Ruakura detergent formula the sequestering agent is sodium hexa-
metaphosphate or calgon which is a true milkstone remover. However, even with such a sequestering agent added to an alkaline detergent there is a frequent need for an acid detergent to deal with those components of the milkstone residue which are not dissolved by an alkali. Thus arose the original Ruakura cleaning system involving an alkaline detergent on six days of the week and an acid detergent on the seventh.

Some years ago the writer noticed in some types of milking plants that there was a tendency for milkstone to build up in certain areas despite the fact that an adequate cleaning system was in use. This raised the question of whether there may not be yet another mechanism for causing the build up of milkstone. The parts of the machine where the deposits were observed were parts where two different metals happened to be exposed to contact with the milk. This raised the question of whether or not some kind of electrical action might have been taking place due to the fact that two different metals were coupled together in solution and so could act somewhat like an electric cell in bringing about a chemical reaction. To test this idea sets of slides were sent out into the field in the course of a detergent test. The slides were paired, one member of the pair being made of pure copper coated with pure tin over the entire surface. The other member of the pair consisted of pure copper covered over half of the area with pure tin. After a period of four weeks, exposed to the action of the milk and detergent, the slides were brought back to the laboratory. The amount of milkstone deposited on them was measured and the degree of corrosion was also determined. Table 2 sets out a summary of the results for two different cleaning systems and for the two kinds of slides. As can be seen milkstone deposits were always greater for the half-tinned slides. In the case of cleaning system 1 the deposit was just under twice as much for the half-tinned slides, while under the cleaning system number 2 the deposit was nearly three times as much when the slide was only half covered with pure tin. Similarly the rate at which tin corroded was greatly influenced by the presence of bare copper nearby. The corrosion figures in both cleaning systems were enormously higher with half tinned slides than they were for the whole tinned ones. These results have been confirmed in many other experiments and it is now quite clear that a very important factor in the formation of milkstone is the existence of an electrolytic system within the milking machine. The commonest type of electrolytic system to be seen on a typical New Zealand milking machine is one in which part of the tinning has worn away exposing some bare copper underneath.

It has been shown in the laboratory that this electrolytic process is accelerated by turbulence and the presence of air-bubbles in the milk. This is not the place to discuss the mechanism of the action but there is no doubt that when copper and tin are exposed side by side an electric current flows which is kept going by the agitation of the milk flowing over the copper surface and its contact with the oxygen of the entrained air. The tin going into solution discharges the negative casein molecules thus making them unstable so that they readily become attached to the tin surface. This then causes a
secondary type of corrosion because, under the milkstone deposit, chemical action can take place due to the release of lactic acid by bacteria. Also local cells of corrosion build up caused by differences in oxygen concentration. It would therefore appear that a major factor in the causation of milkstone in the typical milking machine is exposure of a small area of copper on a tinned surface. Once a small area has become exposed the system starts a rot as it were and the tin corrodes away quickly while at the same time building up stone deposits. In a badly cleaned system this process is to some extent self-limiting in that heavy stone deposits help to prevent further electrolytic corrosion. But this occurs at the expense of the hygienic condition of the machine. Thus a first and a most important step in the elimination of milkstone from a milking plant is to ensure that all copper and brass surfaces are completely tinned and that dissimilar metals do not come into contact at any stage in the presence of milk. Not only copper and tin can cause this trouble but the exposure of dairy metal in the presence of stainless steel presents a similar type of problem. Such a couple can give rise to the formation of milkstone or slime. In practice the combination of dairy metal and stainless steel appears to cause a rather gelatinous kind of precipitate whereas in the case of tin and copper the precipitate is a hard and tough one. To eliminate the formation of these untoward deposits in the milking machine, dairy metal should not be used in direct contact with stainless steel components.

Table 2 makes it quite clear that by eliminating electrolytic effects the rate of milkstone build-up can be substantially reduced. However, there still is a build-up which can only be tackled by either taking steps to soften the water which is used for rinsing and cleaning the machine or by using a better detergent. As indicated above the original Ruakura detergent system involved the use of an acid detergent once a week. This was found at the time to be better than any other system in use. However, there have been substantial advances in the fields of detergency and hygiene since the original Ruakura formula was developed. In particular a new type of detergent sanitizer has been discovered. The "iodophor" is a complex of elementary iodine and a non-ionic wetting agent. The iodine retains its chemical and bactericidal activity while remaining adsorbed to a wetting agent molecule; thus it functions both as a detergent and as a bactericide. The iodophors are normally prepared as acid-solutions and in the formulation preferred for use in the dairy industry the acid is phosphoric. The combination of a wetting agent with phosphoric acid is well known as a milkstone remover. This therefore raises the question, is it possible to eliminate the use of acid detergent once a week by sanitizing the machine before milking each day with a dilute solution of an iodophor? An experiment was therefore planned in which the original Ruakura system of cleaning was compared with one in which the machine was pre-rinsed with an iodophor containing 25 parts per million of iodine and 230 per million of phosphoric acid in the working solution. Half a gallon of this solution was rinsed through the machine for each set of cups. While the machine was draining the cows were brought in so that the detergent sanitizer had a brief time in which to work. It was not rinsed from the machine before milking commenced. After every milking the clean-
The cleaning procedure was a standard one using Ruakura alkali. The same method was applied every day of the week after every milking. In the case of the original Ruakura system the machine was sanitized before milking with a rinse of sodium-hypochlorite solution. Table 3 sets out the results of this experiment (incidentally Table 2 comes from the same trial, system 1 being the Ruakura system, system 2 the iodophor-alkali system). With completely tinned slides there was a very substantial reduction in the build-up of milkstone. Similarly when the slides were half tinned, which corresponds to the actual condition of many machines in practice, the rate of milkstone build-up was reduced. The table makes it clear that the half-tinned slide system tends to build up much more stone than when the slides were wholly tinned. The corrosion figures for the iodophor-alkali system were somewhat higher than for the original Ruakura system. This difference did not reach statistical significance. However, the results do suggest that the iodophor-alkali system is a little more corrosive than the original Ruakura method. The stock iodophor solution used in this trial contained 16 per cent of phosphoric acid. In a later trial the iodophor contained 9 per cent of phosphoric acid. This showed less corrosion than the original Ruakura system while its effect on milkstone build-up was only slightly lower than that of system 2 shown in Table 3. It would therefore appear that the ideal phosphoric acid concentration for the iodophor concentrate should be about 10 per cent.

A criticism of the above system of cleaning is that it still retains the need for two different detergents. In the original Ruakura system there was a substantial basis for the criticism in that if one wished to use a sanitizing pre-rinse, such as hypochlorite one had to use three different solutions in order to keep the machine clean. The iodophor-alkali system at least reduced the number of solutions to two but this is thought by some to be too many. An attempt was therefore made to reduce the number of solutions to one by using a detergent sanitizer based on the new chlorine releasing substances which are derivatives of isocyanuric acid. These substances contain a large percentage of chlorine which is freely available as soon as the material goes into solution. Furthermore these chlorine derivatives in a dry alkaline power are quite stable. A series of three detergent sanitizers based on the new chlorine releasing substances was made up and subjected to a widespread test in the field in comparison with the iodophor-alkali system. The results of this trial are summarized in Table 4. System 2 is the iodophor-alkali system while system 3 involved the use of a chlorine releasing detergent sanitizer. Before milking the machine was rinsed with one quarter of an ounce of chlorine releasing detergent to each gallon of water and half a gallon per set of cups. After milking half an ounce of detergent sanitizer was added to one gallon of the hot water used for the final cleaning operation. In this test three types of slides were used, namely tinned copper slides, slides entirely plated with tin-nickel alloy and slides made of polished stainless steel. The table makes it clear that for all three types of slide the chlorine releasing detergent system left a heavier deposit of milkstone than did the iodophor-alkali system. In the case of stainless steel the chlorine releaser left more than 10 times as much milkstone on the surface. The most easily cleaned surface
was that of the tin-nickel alloy plated slide while the pure tin surface cleaned very much better than stainless steel in the case of the chlorine releasing cleaner system. However, stainless steel was better than tin in the iodophor-alkali method. As would be expected the stainless steel showed virtually no corrosion. Tin nickel alloy showed remarkably little and the pure tin slide showed slightly more corrosion with the chlorine releaser than with the iodophor-alkali system. However, the corrosion even on pure tin may be regarded as satisfactory with both cleaning system.

This experiment brought out under practical conditions what has been known for some time from laboratory tests, namely the fact that in the presence of chlorine releasing solutions, polished stainless steel, the surface of which is covered with very fine scratches, tends to build up milkstone at a high rate. However, the important general conclusion from this experiment is that a chlorine releasing alkaline detergent sanitizer system is not nearly as efficient in the prevention of milkstone build-up as the iodophor-alkali system. This does not preclude the possibility that in the future a single solution system may be discovered. However, in the meantime it would appear that the most practical system for cleaning milking machines under New Zealand and Australian conditions is the system involving a pre-rinse with iodophor followed after milking with an alkali based on the original Ruakura specification.

In the light of the foregoing experiments the following is a recommendation for a cleaning technique which will do much to reduce the rate of milkstone build-up and at the same time improve the bacteriological quality of the milk.

The materials required are an alkaline detergent based on the Ruakura standard specification and an iodophor concentrate containing 1.75 per cent free iodine and 10 per cent of phosphoric acid. The alkali is used at a concentration of a quarter of an ounce to the gallon of hot water. The iodophor is used in cold or slightly warm water at a concentration of 25 parts per million of iodine.

The procedure for cleaning the machine is as follows (after milking do not let the vacuum drop until after the detergent has gone through). Before milking rinse with cold or slightly warm iodophor solution at the above concentration using half a gallon of solution for each set of cups. The solution as it runs from the releaser should be saved and used to rinse the vat, the cooler and the cans, taking care not to use it after the colour has faded.

After milking rinse the machine with cold or slightly warm water at the rate of one gallon for each set of cups adding to the water .05 per cent of non-ionic wetting agent (Lissapol N 450 or similar type). Pass one gallon of hot detergent solution containing Ruakura alkali through each set of cups. Finally rinse through each set of cups one gallon of really boiling water.

This system ensures good sanitizing of the machine with boiling water immediately after cleaning together with a pre-milking sanitizing and stone removing rinse which will help to eliminate contamination picked up between milkings and reduce the rate at which milkstone is built up.
### TABLE 1
Composition by Weight (%)

<table>
<thead>
<tr>
<th></th>
<th>Milkstone</th>
<th>Milk</th>
<th>Cleaner required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>5</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>10</td>
<td>4</td>
<td>Alkali</td>
</tr>
<tr>
<td>Protein</td>
<td>35</td>
<td>3</td>
<td>Alkali</td>
</tr>
<tr>
<td>Ash</td>
<td>50</td>
<td>1</td>
<td>Acid</td>
</tr>
<tr>
<td>Luctose</td>
<td>—</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Ash Constituents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium oxide</td>
<td>25</td>
<td>0.2</td>
<td>Acid</td>
</tr>
<tr>
<td>Phosphorus pentoxide</td>
<td>20</td>
<td>0.25</td>
<td>Alkali</td>
</tr>
<tr>
<td>Magnesium oxide</td>
<td>2.5</td>
<td>—</td>
<td>Acid</td>
</tr>
<tr>
<td>Iron oxide</td>
<td>0.1</td>
<td>—</td>
<td>Acid</td>
</tr>
<tr>
<td>Sodium oxide</td>
<td>2.4</td>
<td>0.05</td>
<td>Acid</td>
</tr>
</tbody>
</table>

### TABLE 2

<table>
<thead>
<tr>
<th></th>
<th>Ruakura Acid-Alkali</th>
<th>Iodophor-Alkali</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tin</td>
<td>Tin-copper</td>
</tr>
<tr>
<td>Milkstone Corrosion</td>
<td>0.114</td>
<td>0.207</td>
</tr>
<tr>
<td></td>
<td>0.086</td>
<td>0.667</td>
</tr>
</tbody>
</table>

Results in mgm/cm²

### TABLE 3

<table>
<thead>
<tr>
<th></th>
<th>Ruakura I/A</th>
<th>Tin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milkstone Corrosion</td>
<td>0.115</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>0.086</td>
<td>0.143</td>
</tr>
</tbody>
</table>

Results in mgm/cm²

### TABLE 4

<table>
<thead>
<tr>
<th></th>
<th>Tin</th>
<th>Tin-Nickel</th>
<th>Stainless Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I/A</td>
<td>Chlorine</td>
<td>I/A</td>
</tr>
<tr>
<td>Milkstone</td>
<td>0.038</td>
<td>0.104</td>
<td>0.017</td>
</tr>
<tr>
<td>Corrosion</td>
<td>0.046</td>
<td>0.063</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Results in mgm/cm²
OBSERVATIONS ON A MASTITIS SURVEY IN THE WAIKATO

E. O. Brookbanks, Veterinary Advisory Officer, Department of Agriculture, Hamilton.

In 1934 Dr Hopkirk showed that 35 per cent of all cows in New Zealand were suffering from sub-clinical mastitis as indicated by the leucocyte or white cell count of the milk.

Thirty years have passed since these figures were published; years of tremendous advance in scientific and medical knowledge, years which have given to us the antibiotics and other germ destroying substances. Yet, in spite of our increase in knowledge and the new drugs in our armoury, results in a survey I am at present conducting show that this figure has increased slightly and now 37½ per cent of cows examined so far are suffering from sub-clinical mastitis. This sub-clinical mastitis is detected only by special tests but it is responsible for a big drop in production and a reduction in milk quality.

The incidence of clinical mastitis closely parallels that of sub-clinical and the farmer is normally aware of the first type only, that is, visibly altered milk. It is very disappointing to find that the incidence of a disease has not dropped over such a long period. Veterinarians and farmers alike must bear the responsibility for this situation. The veterinarians have been too few in number and have concentrated on clinical, rather than preventative medicine. Farmers in general have been content to buy vast quantities of antibiotics for treatment of mastitis instead of concentrating their energies in pursuing a policy of prevention. One adverse result is the increase in detectable amounts of antibiotics found in milk and the introduction of severe penalties to prevent this occurring. In future, we must cooperate in attempts to control this economically crippling disease.

I would now like you to look at the figures in column 1 of Table 1.

This is an indication of the level of sub-clinical mastitis. The C.M.T. or California Mastitis Test is a field test which gives a rapid and accurate indication of the number of white cells present in milk. In normal, healthy udders the white blood cells or leucocytes are few in number and the milk gives a negative reaction to the C.M.T. When the udder is subjected to irritation by the presence of bacteria in the quarters or physical abuse, the number of leucocytes per millilitre rises very rapidly and this is reflected in the degree of reaction to the C.M.T. The milk may still appear normal but the inflammation has a marked effect on milk production and quality.

Table 2 shows the effect of sub-clinical mastitis on production. These figures were obtained by Schalm and Gray of California, who worked on large numbers of cows, mostly Fresians.

Look at the average loss shown in the last column. You will see that a cow with a C.M.T. score of 3 has a production loss of one gallon of milk per day compared with a negative cow. When this is related back to the herds surveyed in New Zealand, the herd with the highest percentage of C.M.T. positive cows would show a production

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TABLE 1
Distribution of Mastitis Infection

<table>
<thead>
<tr>
<th>18 herds with a total of 1816 cows</th>
<th>% Strong C.M.T.</th>
<th>% Total Infection</th>
<th>% Staph. Infection</th>
<th>% Strep. Agalactiae</th>
<th>% Miscellaneous Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>37.6</td>
<td>40.8</td>
<td>28.8</td>
<td>16.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Highest</td>
<td>63.0</td>
<td>75.2</td>
<td>50.4</td>
<td>43.6</td>
<td>6.0</td>
</tr>
<tr>
<td>Lowest</td>
<td>16.0</td>
<td>12.2</td>
<td>12.2</td>
<td>One only completely free</td>
<td>6 free</td>
</tr>
</tbody>
</table>

TABLE 2
Production Loss According to C.M.T. Score

<table>
<thead>
<tr>
<th>Month of Lactation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.M.T. -ve cows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pounds of milk 24 hours</td>
<td>53.0</td>
<td>52.0</td>
<td>47.5</td>
<td>43.9</td>
<td>41.0</td>
<td>38.0</td>
<td>35.4</td>
<td>32.7</td>
<td>29.5</td>
<td>26.5</td>
</tr>
<tr>
<td>Milk loss in pounds per 24 hour period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.M.T. Trace</td>
<td>3.0</td>
<td>3.5</td>
<td>1.4</td>
<td>2.3</td>
<td>2.5</td>
<td>3.7</td>
<td>3.9</td>
<td>3.3</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>C.M.T. 1</td>
<td>4.8</td>
<td>3.9</td>
<td>5.2</td>
<td>4.0</td>
<td>4.0</td>
<td>4.2</td>
<td>4.3</td>
<td>4.9</td>
<td>5.4</td>
<td>5.4</td>
</tr>
<tr>
<td>C.M.T. 2</td>
<td>8.4</td>
<td>6.8</td>
<td>7.8</td>
<td>9.6</td>
<td>10.1</td>
<td>7.9</td>
<td>10.7</td>
<td>10.5</td>
<td>9.1</td>
<td>12.8</td>
</tr>
<tr>
<td>C.M.T. 3</td>
<td>10.5</td>
<td>14.3</td>
<td>10.6</td>
<td>9.6</td>
<td>10.1</td>
<td>9.7</td>
<td>10.7</td>
<td>10.5</td>
<td>9.1</td>
<td>12.8</td>
</tr>
</tbody>
</table>

The average herd with a mastitis-free herd. The average loss of about 14 per cent compared with a mastitis-free herd. This is a hidden loss and doesn't include the loss due to clinical mastitis which involves the expense of treatment, loss of cows in some acute cases, and milk discarded. The...
C.M.T. may also be used on bulk milk to pinpoint herds with mastitis problems.

Table 3 shows the distribution of C.M.T. reactions on bulk milk samples in the survey herds:

<table>
<thead>
<tr>
<th>No. Herds</th>
<th>C.M.T. Reaction Bulk Tank Milk</th>
<th>Expected Production Loss Compared with Negative Herd</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Negative</td>
<td>5.4</td>
</tr>
<tr>
<td>6</td>
<td>Trace</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>One</td>
<td>5.9</td>
</tr>
<tr>
<td>5</td>
<td>Two</td>
<td>14.0</td>
</tr>
<tr>
<td>1</td>
<td>Three</td>
<td>20.4</td>
</tr>
</tbody>
</table>

The effect of sub-clinical mastitis on milk quality is a marked reduction in the percentage of solids not fat. The drop may be as high as 24 per cent and is mainly in the sugar content.

Getting down to your individual cows, the percentage of C.M.T. positives is much higher in older animals. This higher rate in older cows is due to the increased risk of infection with age. Figures from my survey show that about 60 per cent of all cows aged seven years or older have a high C.M.T. score and are infected.

Now let us look at some of the known causes of mastitis. As you will have already gathered, most cases of mastitis are associated with infection. If we go back to Table 1 you will see the percentage distribution of mastitis organisms in the survey herds. In column 2 you will see the total percentage of cows infected. This bears a close relationship to the figures in the first column. Any discrepancy is due to some infected cows showing only a suspicious reaction to the C.M.T. and this group hasn't been recorded on this table. The next three columns show the distribution of the various species of mastitis organisms.

Two groups of organisms are responsible for most of the mastitis seen in the Waikato: Staphylococcus pyogenes and Streptococcus agalactiae.

Most of those in the miscellaneous column are other groups of Streptococci. There are some who do not consider the presence of Staphylococci in milk of any significance, but almost without exception the presence of Staphylococci in the milk of survey cows was associated with a C.M.T. reaction. Not one herd was free from Staphylococci and in some, as many as 50 per cent of cows were infected. Overseas workers have stated that Staphylococcal mastitis is more common in machine milked than hand milked herds. This theory receives some support from statistics. In 1932, in New Zealand, only two-thirds of dairy farms had milking machines and about the same time Dr Hopkirk found that thirty per cent of all cases of mastitis were caused by Staphylococci. Now, every dairy farm
worthy of the name has a milking machine and Staphs. would now appear to be responsible for almost twice as much mastitis as any other organism. In the course of my work I am called in to investigate mastitis problem herds and in all cases Staphs. have been responsible. My opinion is that the rise in importance of Staphylococci is due not so much to the design of the milking machine but to the fact that so many of you farmers don’t handle it properly.

Column 4 gives the incidence of Steptococcus agalactiae. An average of 16% per cent of cows showed infection. In some herds as many as 43% per cent of cows were infected and only one herd was completely free.

This organism, which commonly caused a large percentage of infectious mastitis, is completely sensitive to penicillin and cannot live for very long away from the cow’s udder. In many herds overseas these facts have been made use of to eradicate this organism, by regular examination of milk samples to detect carriers and penicillin treatment for all infected quarters. In New Zealand, in spite of hundreds of thousands of pounds spent on penicillin for mastitis treatments since it came into general use in 1949, 16 per cent of cows are still infected with this susceptible organism. It’s obvious that the indiscriminate use of penicillin will not eliminate this organism.

I have discussed the incidence of mastitis and some of the organisms responsible. Let’s now take a look at some of the contributory factors. I am not going to attempt in the short space of this talk, to discuss the effect of the various components of the milking machine. There are many interesting theories, but at present a lack of facts to support them. However, even a perfect machine can cause a great deal of trouble if it is not properly managed, and it is this aspect I would like to talk about. As I said earlier, poor milking management is a major factor in many, if not all, outbreaks of Staphylococcal mastitis. In the course of my survey I have attempted to note milking faults. The one most often seen is over-milking. This is commonly due to one man attempting to handle too many units. Milking rates of only five or six cows per unit per hour are far too common. This gives an average bail time per cow of 10 or 12 minutes. Most cows will milk out in four or five minutes. If you allow about a minute for preparation and stimulation of the udder and half a minute for machine stripping, these cows are being over-milked by three to four minutes. Observation confirmed this as the cups were repeatedly seen hanging on cows long after milk had ceased. Over-milking pre-disposes to mastitis infection. Vacuum applied to the teat for a long period damages the streak canal and infection can more easily penetrate into the quarter. The effect of prolonged vacuum on the teat end is seen in Figures 1 and 2. Most farmers don’t realise that if they are handling too many units they can get through the milking just as quickly by cutting out one bail. The elimination of over-milking reduces the average length of time each cow is in the shed and the total output of cows per hour may even be increased. Another fault commonly seen was the lack of efficient pre-milking stimulation of the udder. Research work has shown that stimulation increases production and allows quicker and more complete milking.

Good stimulation consists of twenty to thirty seconds’ vigorous massage of the base of the udder and the teats, and the withdrawal
of a squirt or two of milk from each quarter, preferably into a strip cup.

Don’t overdo the stimulation. I have seen one farmer who made a beautiful job of it but it took a long time. As a result the cows completely milked out in about two minutes. However, the man was so busy stimulating the next cow that he couldn’t get back to remove the cups in time and the cows were over-milked. Perhaps the worst fault seen was the absence of the practice of good hygiene in order to prevent the spread of infection.

Hospital staff are well aware of the need to observe strict hygiene if Staphylococcal cross-infection is to be controlled. And farmers must realise the importance of good hygiene at milking time. This is the cornerstone of a good mastitis control programme and without it the whole edifice will crumble. There are four points to remember and if you go away with these firmly fixed in your minds, I’ll be happy:

1. The source of infection is in the udder and on the skin of the udder and teats of an infected cow.
2. The shed and surroundings must be kept as clean as possible to minimize residual infection.
3. Personal cleanliness.
4. Practically all mastitis infection is spread from infected to clean cows during the milking process.

Now, let’s take a closer look at these points:

1. **Source of Infection**
   
   Almost without exception the source of infection is the carrier cow. Streptococcus agalactiae can only exist for a long period and multiply within the udder or on the udder skin and teat surfaces. It may live for a short time in other places. The Staphylococci associated with mastitis are also, for all practical purposes, confined to the same areas. They may be introduced into a herd from outside sources, such as boils, or infected cracks on a milker’s hands, and this infection may then become established in the cows’ udders. My observations show that about 60 per cent of old cows carry mastitis organisms in their udders and this has also been shown by many other workers. It’s obvious that the old cow is the principal source of infection. In some cases these old cows should be culled, but where this is not practical then every effort should be made to establish a hygienic milking order: heifers first, cows which have never suffered from mastitis next, then recovered cases, and finally clinical mastitis cases. When I discussed sub-clinical mastitis earlier, you will remember I said that many cows carry infection without any obvious changes in the milk. The best advice I can give you is to have your herd C.M.T. tested regularly and use these results to establish your milking order: negative cows first, suspicious next, and positive last.

2. **Shed and Surroundings**

   While Strep. agalactiae cannot live away from the cow for more than a few weeks, its presence in such sites as dirty woodwork, leg ropes and door handles for even a short period can upset any attempts
at mastitis control. Staphs. can exist for a longer period in such sites. It's essential, therefore, to keep all parts of the shed as clean as possible, especially those places which a milker handles in the course of his work.

3. Personal Cleanliness

This is tied up with the previous statement. It's not much use having a clean shed if the milker wipes his hands on filthy clothes as he goes about his work. Too many farmers seem to keep their oldest and dirtiest clothes for milking and these must be loaded with infection. Milkers should wear clean overalls or a light plastic or rubber apron which protects the clothing and can be hosed clean.

4. The Spread of Infection from Cow to Cow

This takes place via the milker's hands, clothes (if used), and the inflations. Hands may be kept clean by the use of soap or a suitable disinfectant when stimulating the cows. Hexachlorophene soap is slightly more expensive but its continued use will reduce the bacterial population of the udder and teat skin and the milker's hands. A good disinfectant will serve the same purpose. It may be applied with a disposable paper towel.

Whatever method is used, the udder should be allowed to drip dry or preferably be wiped dry with a disposable towel before the cups are applied.

I do not favour common cloths even if they are kept in a bucket of disinfectant between uses. I think that in future, disposable paper towels will be an essential item in every dairy. I found them already in common use in Australia, Britain, and North America.

The inflations may be potent spreaders of infection. They are bathed in the milk of infected cows and immediately applied to the teats of clean cows. This method of spread of infection may be controlled by dipping the cups in an efficient disinfectant or flushing them through with clean water between each cow.

This latter method is under trial at the moment and it has several advantages, namely cheapness, ease of operation, and efficiency. Several semi-automatic methods for flushing teat cups are at present being developed and should further simplify this procedure.

In spite of the above preventative measures, some infection may still be transferred. This may be dealt with by dipping the cows' teats in a disinfectant before they leave the shed.

Finally, to summarize, I have shown you that mastitis is just as prevalent as it was thirty years ago and that the indiscriminate use of antibiotics will not control it. It will only be controlled by strict attention to milking management, a more scientific approach to treatment and the adoption of the hygienic measures I have outlined earlier, namely,

Segregation of infected cows
Clean premises
Personal hygiene
Prevention of spread from cow to cow.

Follow these recommendations and I promise you that the little extra work and expense involved will bring you a dividend in healthy cows, quality milk and increased production.
MARKETS FOR NEW ZEALAND DAIRY PRODUCE

S. J. Murphy, Chief Marketing Officer, New Zealand Dairy Production and Marketing Board, Wellington.

There are few now who question that New Zealand's ability to maintain living standards for an increasing population depends mainly upon a continued growth in farm exports. The Agricultural Development Conference has concluded that an annual increase of 3½ per cent in livestock numbers is necessary to support desirable rate of growth in the national economy. Cow numbers in New Zealand have been increasing at a rate considerably below this level. The annual rate of increase over the past five years has averaged not much more than one per cent, and in the five preceding years cow numbers actually declined. My purpose is to consider whether markets exist or can be found at sufficiently remunerative prices to enable the dairy industry to continue and perhaps to accelerate the rate of expansion of the past five years.

Recognising the possibility of Britain's ultimate entry into the Common Market, and the attendant danger for New Zealand, it is still reasonable to assume that the United Kingdom market will continue to be available for the quantities of goods we now sell, and that it will go on expanding at the average rate of recent years. Butter consumption in the United Kingdom has risen from 430,000 tons in 1960 to 461,000 tons in 1963. Given maintenance of reasonable price levels, the upward trend ought to be maintained, at least at the rate of increase of the United Kingdom population, or about 2 per cent per annum. New Zealand butter holds a dominant position in the United Kingdom market, where we now sell 168,000 tons per annum, and where our two main brands command trade totalling about 80,000 tons annually. There is no reason to doubt that we can at least maintain our share of an expanding British market.

The measures taken by the United Kingdom to control imports of butter have been and are of great benefit to New Zealand, and that benefit is enhanced by the agreement which gives New Zealand the right to supply 40 per cent of butter imports entering the United Kingdom. This year the United Kingdom has fixed the basic import quota for butter at 420,000 tons. New Zealand is entitled to 168,000 tons and to 40 per cent in total of any supplementary quantities that may be admitted.

There is no reason to believe that the British will object to a continuation of prices at the present levels, this year and in the future. The regulation of butter supplies by import quotas has resulted in a steady flow of goods to the British market and has largely removed the elements of speculation and risk which contributed to the violent price fluctuations of earlier years. Over the past four years the price of New Zealand butter in the United Kingdom has moved up from 250/- to 335/- ex store. Every movement in the price since October, 1961, has been upwards. For cheese, the ex store price of New Zealand crated cheddar stood unchanged at 231/- per cwt for four years before the recent 10/- advance. The reason for this stability is the predominance of
cheddar and cheddar type cheese on the British market and relative freedom from European competition, allied with the ability of the main suppliers in the United Kingdom, Australia and New Zealand to coordinate their cheese marketing policies.

The threat of surpluses from the countries of Western Europe may have influenced thinking in New Zealand more than it ought to have done. It is necessary to take account of trends of production and trade to see how these may affect long term prospects, but there is an important difference between projections and estimates, and there may have been some tendency in New Zealand to confuse the two.

F.A.O. studies over the past two years have suggested, partly on the basis of averages of earlier years, that there could be a widening gap between production and consumption of milk products, which could result in very large surpluses. The F.A.O. projections indicated for example that by 1970 the equivalent of about 525,000 tons of butterfat could be available as an exportable surplus from the major dairying countries—which would represent about a three-fold increase over present exportable supplies.

Even since the last F.A.O. Committee report was issued in February, 1963, however, there has been a radical change in the pattern of milk production in the United Kingdom and a number of European countries. In the United Kingdom, production of milk for manufacture in 1963 fell 10 per cent below 1962, and the decline has continued this year. Butter production in the United Kingdom declined from 59,600 tons in 1962 to 43,200 tons in 1963 and a further decline is expected this year. Milking cow numbers in the United Kingdom have been shrinking because the small farmer, who is the marginal producer, has been turning to other forms of farming.

Cow numbers declined also last year in a number of the major dairying countries of Europe, as they did in the United States. Indications are that this downward trend has continued in 1964; butter production in the first three months of this year in eleven of the main dairying countries of Europe (excluding France) was reported as 224,000 tons or 3 per cent below last year and 6 per cent below 1962.

The main causes of the declining cow numbers have been a switch from dairying to grains, beef and other products. In Denmark, where cow numbers fell by 4 per cent last year, butter production was down from 164,000 tons to 147,000 tons mainly because of a switch to grains.

Over 1964 as a whole, given normal weather, there is no reason to expect any significant increase above 1963 in Western Europe's total milk production, and there could be a further decline in view of the downward trend in cow numbers. All the indications are that export supplies of butter and cheese will be generally tight through the remainder of this year.

Corrective action will no doubt be taken to reverse the present short supply situation (and the tendency for a time may well be to over-correct), but I doubt whether surpluses of the kind projected by the F.A.O. Committee will occur. Producing countries have learned better how to avoid severe surpluses by adjusting support price levels,
and by consumer subsidies and other means of promoting consumption; and of course, the restrictions against entry of surplus butter into the United Kingdom, which takes two-thirds of butter entering international trade, have forced producing countries to give more though to surplus problems in relation to their own policies.

There are indications that dairying in some countries is becoming less attractive as a way of life and that labour problems are becoming a serious obstacle to the further development of dairying. For example recent studies in Belgium and Eire have shown that the lot of the family dairy farmer has deteriorated substantially in comparison with the industrial employee. In the United States, the family dairy farm is disappearing and the dairy industry generally is becoming geared to the requirements of the fluid milk market. Returns from manufacturing milk in the United States are in general not comparable with other forms of agriculture. The result is that in Minnesota, Iowa and other States of the Mid-West region where milk is produced chiefly for manufacture there is a gradual but steady move out of dairying.

At the beginning of this year, cow numbers in the United States were 3.2 per cent below a year earlier marking the tenth successive year of decline and, at just about 18 million head, the lowest level since 1905. Milk production in the United States declined last year by 1 per cent or 550,000 tons below 1962. The result is that American so-called “surplus” stocks have been greatly reduced, the figures at the end of March, compared with a year earlier, being as follows:

<table>
<thead>
<tr>
<th>Uncommitted Stocks Held by Commodity Credit Corporation</th>
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<tbody>
<tr>
<td><strong>March 1964</strong></td>
</tr>
<tr>
<td>(In long tons approx.)</td>
</tr>
<tr>
<td>Butter</td>
</tr>
<tr>
<td>Cheese</td>
</tr>
<tr>
<td>Skim-milk powder</td>
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</tbody>
</table>

If the trend of recent years should continue, the United States would become a large import market for dairy products within a few years. A similar situation exists in Canada where dairying in the Prairie region particularly is giving way to grain, and where good beef prices are providing incentives to kill off dairy cows. A continuation of demand from China and the Soviet Union for North American wheat at the level of recent years would bring about changes in production patterns that could profoundly affect North American farming and our own dairy produce trade with that Continent. Our dairy produce trade, excluding dairy meats, with the United States is running now at a value of about £3 million per annum, and it is entirely possible that North America will rank with Asian countries as a market of the future for our dairy produce.

So much has been said on the subject of Asian markets that it is scarcely necessary to repeat that the region generally, Japan in particular, holds promise as an important market for New Zealand dairy produce. Since the mid-1960’s, Japan’s national income in real terms has more than doubled. The explosive development of her industrial economy has been matched by equally dramatic changes in domestic.
living standards, which have significantly altered patterns of consumer demand.

The Japanese rice-based diet is changing towards protein foods of which milk is one of the most important. Japanese consumption of milk has increased by 25 per cent in the last two years, of butter by 70 per cent and of cheese by 76 per cent. In quantitative terms, butter consumption has risen since 1961 from 13,400 to 22,600 tons and cheese from 6,600 tons to 11,800 tons. Not large totals yet, but the significant factor is that per capita consumption is still only half a pound of butter and a quarter of a pound of cheese, and that the rate of increase in consumption is the fastest in the world.

It would be wrong to suppose, however, that the Japanese market is there for the taking. Japan is strongly inclined towards agricultural protectionism. Butter, like milk powder, is admitted only when high-priced domestic supplies are short, and both butter and cheese are subject to penal rates of tariff.

New Zealand’s trade policy will have to be shaped to secure better access for dairy produce to the Japanese market before we can hope to realise the potential that exists. We have succeeded in capturing a major share of the Japanese casein market, and in converting the Japanese cheese processing industry largely to cheddar instead of traditionally Dutch cheese. Opportunities are beginning to occur for closer collaboration at the technical level in Japanese dairy processing industries. But in the final analysis, the Board’s efforts can succeed only if the existing restrictions against entry of our produce into Japan are eased.

There is a growing body of opinion in Japan which holds that Japanese dairying is too costly and that more of Japan’s requirements should be imported. There are about 420,000 cow holding farmers in Japan milking 1,150,000 cows. Over half of them have either one or two cows. Prices paid for milk and manufactured dairy products are high, the producer’s price for milk averaging about 3/- a gallon. Butter in Japan retails at about 7/- a pound, which is too high for the average consumer. If lower priced imports could be admitted more freely, it should not be too difficult to devise a system of pooling the imports with the higher priced domestic products, so as to obtain lower average prices for the benefit of the consumer and the producer alike.

South East Asian and the Caribbean-South American markets are the other areas that hold promise for our future trade. In the Philippines and Malaysia we have very nearly doubled the volume and value of sales in the past two years, to a present rate of just over 18,000 tons of produce annually, worth just over £2 million. Similar, if less striking, increases have occurred in sales to other Pacific and Asian markets. The actions of the Board in establishing milk recombining plants in Singapore and Hong Kong, and the Board’s decision to enter into a recombined condensed milk project in Thailand afford us a more assured place in the future expansion of these markets.

In the Caribbean and South America, sales have been expanded at a rate of 5 per cent per annum and are now valued at about £5 million annually. The steps taken by the Board to establish trading and processing companies in Trinidad and Barbadoes will identify
New Zealand more closely with the commerce of these countries and consolidate our place in markets which are already predominantly New Zealand.

In total, the tonnage of New Zealand dairy produce sold in markets outside the United Kingdom has grown in the last two years from about 70,000 tons to over 100,000 tons. The greater part of this expansion has occurred in the non-fat solids, the growth in butter and cheese trade to markets other than the United Kingdom being relatively modest—in round figures, from 10,000 tons to 14,000 tons of butter over the last two years, and from 9,000 to 13,000 tons of cheese. There is scope, however, for continued expansion and diversification of the butterfat products, particularly for cheese, demand for which is growing in almost all major markets under the stimulus of an increasing variety of forms and types. Cheese has no direct substitute, and a continued expansion of consumption and trade is virtually certain.

It is likely, however, that trade in non-fat solids, which have freer access to markets, will continue to expand more rapidly than the butter and cheese trades, and that the values of skim-milk powder and casein will improve, relative to the values of the fat products. There is no doubt about our ability to share in this expansion. Our casein exports have grown in the past six years from 14,000 tons to 40,000 tons, and we are now easily the world's largest supplier, with a trade that is worth about £6 million annually. The uses of casein are becoming increasingly diversified, especially in the edible field, and the work being done by the New Zealand industry on these and other milk proteins holds much promise.

Our export sales of skim-milk powder in the season now ending will total about 60,000 tons, representing a value at current prices of about £4½ million. This trade is also expanding rapidly, and is widely diversified. The magnitude of the growth in these non-fat milk products is seen in the fact that the weight of the non-fat solids of milk exported in New Zealand milk powder and casein is now nearly four times the weight of milk solids not fat exported in New Zealand cheese. The export earnings of these relatively new industries, exceeding £10 million a year, are at least three times the total value of New Zealand's export of secondary manufactured goods.

The one factor which can never be ignored in considering the outlook for a food producing industry is the enormous increase that is occurring in world population. People talk of a population in Britain of between 70 and 80 million by the end of this century. The number of Americans is increasing by the number in New Zealand every year, and in the next twenty years, the United States' population is expected to grow by one-third to 250 million people. The population explosion in the Orient is exerting progressively heavier pressures on food supplies. The world population increased by 50 per cent in the last 20 years, and on the present trend would double by the end of the century.

Today our market prospects are sounder than at any time since the war. The problem is not where to find the markets for our dairy products, but rather where to find the goods.
“BOSSMANSHIP”

or

THE RETENTION AND MOTIVATION OF FARM LABOUR

A. T. G. McArthur, Senior Lecturer in Rural Education, Lincoln College.

One man dairy farming is a life sentence. There are ways of escaping. Dairy farmers can switch to sheep or cropping on large farms. Alternatively they can intensify production and use streamlining methods. Eventually the output of the farm reaches the level at which it can support another man and the farmer can enjoy a better way of life. However, some one-man farmers feel that to employ labour would be jumping from the fat into the fire. They claim that good men are hard to find and in any case they are likely to leave at a critical time. “The worry would not be worth it,” expresses this point of view. Consequently they become resigned to their life sentence.

At the moment, a Manpower Working Party of the Agricultural Development Conference is attempting to find out if there is a farm labour shortage. They will have before them suggestions for national policies such as a superannuation scheme for farm workers, a farm cadet training programme, improved rural education and medical services, village settlement schemes, and a forty-hour week with overtime along English lines. All these suggestions aim at helping farmers to attract their share of the national labour force. However, the purpose of this talk is to discuss labour problems from an individual rather than from a national point of view. The hope is that a better understanding of the principles of bossmanship will encourage dairy farmers to intensify production and make the step to the two-man farm.

To achieve a better way of life on a two-man farm, an employer needs to obtain the services of a man who will work at a satisfactory level and who has the skills of stockmanship that are vital for successful dairy production. The employee must be reliable and not leave the job at a critical moment. To achieve this desirable situation, it is helpful to understand the reason why farm workers leave their jobs and seek work elsewhere and to consider the individual factors causing both satisfaction and dissatisfaction with the job.

The Balance of Satisfaction

Let us first enquire why you as farmers stay on your farms and then look at the situation for farm workers. (Reference 1.) Now farmers put into their farms certain contributions—work, capital, and planning. They receive from their farms certain rewards—income to live on, capital gain, various job satisfactions, status in the community, security in old age and so on.

This situation is shown in diagram 1.
A farmer becomes dissatisfied when he finds that other farmers are getting better rewards for the work, capital, and planning they are putting into the farm. Consequently he searches for alternatives. There are two kinds of alternatives he may find. Either he can sell his farm and buy another or he can change the way he farms and try to get better results.

Next, let us examine the position of the farm worker. He also makes a contribution to the farm in the form of work. His reward is a wage though he may receive considerable job satisfaction as well. The situation for the farm worker is shown in diagram 2.

Now, if a farm worker becomes dissatisfied with his rewards from the farm in relation to his contributions, he too will search for alternatives. If he can find a better job on another farm, driving a tanker, working for the county, or shifting to town, he leaves.

Several observations can be made from this simple analysis.

Firstly, dissatisfaction with a job or with a farm is a matter of balance between contributions and rewards. It is not just a question of wages but how much work has to be done to get those wages.

Secondly, dissatisfaction is a relative matter. Just as a farmer may be quite happy with the rewards he receives from his farm if he knows very little of how other farmers are getting along, so a farm worker may be quite satisfied with his lot if he has few contacts with other farm workers or other workers in town.

This is well illustrated by agricultural students who work on farms during the summer. A student may be quite happy with £10 per week until he hears that another student in the district is getting £15.

Thirdly, a farmer can change his farm if he becomes dissatisfied, but only with difficulty. Leaving the farm and buying another job is the only response available to the worker if he becomes dissatisfied.
He is much more mobile than the farmer particularly a young unmarried man though today married men can easily buy a house in town by capitalizing on the family benefit. Of course if the worker cannot find a better job then he readjusts his ambitions and becomes satisfied with his job again.

Fourthly, rewards from the farm for both worker and boss amount to more than money. This is frequently overlooked. Workers forget that farmers have to contribute capital and planning as well as work. On the other hand farmers sometimes overlook that as well as income, they make capital gains, receive a sense of achievement and a status in the community at a higher level than the level usually enjoyed by the farm worker. No doubt, it is because of these non-financial rewards that few of those farmers whose profits are so low that they are making no interest on their capital, seldom sell up, invest money and look for a job in town.

The problem of maintaining good labour for the farming industry, either on the individual farm or for the industry as a whole, is a question of lifting the level of rewards in relation to other jobs.

The next section focuses on those factors which add to or subtract from the satisfactions of farm jobs.

Psychological and Economic Factors in Satisfaction

Industrial psychologists have added a great deal to our knowledge of job satisfaction since work in this field was started forty years ago. On the basis of this research, most large firms in America run special courses on industrial relations. In New Zealand, the Labour Department offers a course called “Training Within Industry” for factory and office supervisors. The basis for the suggestions made in the paper came from knowledge gleaned from these studies of industrial psychology together with the experience of farmers with whom the author has discussed labour questions. One group of psychologists (Reference 2) have identified two kinds of factors which affect the way a worker feels about his job. The first group they call satisfizers. There are the factors which make workers feel good about their job. These factors are satisfaction from the work itself, satisfaction from achievement on the job, satisfaction brought about by advancement, responsibility and increases in wages. The second group they call dissatisfizers. These are the factors which work in the opposite direction and make workers feel bad about their jobs. They are conflict between the demands of the job and the demands of family and social life, lack of status, bad interpersonal relations, lack of security and inadequate wages.

Satisfizing Factors

The effect of these satisfizing factors is to make a man work better and stick to his job.

Work itself gives people satisfaction. Good stockmen enjoy working with cows. Growing plants gives a great deal of pleasure and the high standard of gardens through town and country support this view.

An efficient, well-run farm is a way of increasing satisfaction from the work itself. Working for the worst farmer in the district can be most frustrating. One young man who was keen to save every pound to climb the farming ladder told me why he left a very well
paid job on a North Island dairy farm after a few months. "I got on with the boss very well but I could not stand throwing skim milk to his rangy pigs wallowing in that cesspool behind the shed. The only thing I learnt was how not to farm."

With good gear and good up-to-date facilities and where boss and worker keep on top of the work by planning and forward thinking, workers will get satisfaction from the job itself.

**Achievement gives pleasure.** I know of farmers who herd test because of the interest it gives the milkers rather than because of any genetic gain which might be made. Topping the group can give great satisfaction. A well ploughed paddock, a record hay crop, a new shed completed, are all incidents in farming life which give pleasure. Farm work may give greater satisfaction from achievement than the specialised job in town in which the worker fashions only one part of the completed article. A solo butcher hanging up a line of lambs gets more of a 'kick' from his job, than the man on the chain punching briskets. It is significant that farm jobs have become sports—shearing, ploughing, wood-chopping, sheep dog trials and sheaf tossing.

Here again the efficient farmer provides the environment in which a man can get a feeling of achievement.

**Advancement** is an important factor in job satisfaction such as advancement from worker to manager, from milker to share-milker, or from lecturer to professor. Unfortunately the opportunities for advancement up the farming ladder are limited if a keen young man stays on the same farm except in the occasional case. Usually he has to shift to the North Island to get a break as a share-milker.

Of course advancement for sons is easier. Rather than holding on to the reins until they have reached second childhood, fathers can advance their sons by forming partnerships or companies. This also reduces death duties.

However, keen young men can get a feeling of achievement by learning new skills, and good bosses do not let opportunities for teaching slip past. So often a boss who can do the job twice as well in half the time can not bear to watch the novice's clumsy efforts. He consequently does the skilled jobs himself and relegates the novice to hack jobs. Consequently he seldom has a chance to learn.

There is a simple drill for teaching a man how to do a job. (1) Tell him, (2) show him, (3) check his performance. When explaining how to do a job remember to arouse interest and keenness to learn. "This is a trick to save your back," or "I'll show you how to sew a bag without turning your hand into a pin-cushion," are examples of opening gambits. Most people do not change their habits unless they feel that there is some reward at the end for them. Equally as important is to explain "why" by giving him the reason for the method. "Keep the air inlet hole at the end of the claw clean. Air rushing in pushes the milk up the dropper." In step two you show him how to do the job. Remember that you have done the job hundreds of times yourself and have developed automatic habits. A new chum can not follow these swift movements, so you have to do them in slow motion so that he can follow. Complicated jobs need to be broken up into simple steps. When demonstrating how to kill a
sheep, train him to do each part of the job properly before giving him the task of doing the complete job. Step three, checking performance, is also vital. Let your trainee do the job under supervision and point out the mistakes that he makes in a pleasant way. Always remember a little encouragement speeds the learning process.

Finally, it is important to remember that there is a limit to the amount of fresh information a man can take in in one session. So often an employer swamps his new employee with information on the first day and from then on explains but little. He incorrectly assumes the man must be dumb because everything did not sink in. Teaching is a continuous business.

Training not only means that a man works more efficiently, but, because it leads to a feeling of achievement, it gives satisfaction.

Responsibility gives a feeling of satisfaction. As well as contributing work to the farm, a worker contributes his freedom. He cannot do as he likes. A man loses less freedom if he has partial control over his work and feels he is paddling his own canoe. The responsibility of rearing the calves or looking after the pigs can sometimes be delegated from boss to worker. A bonus system such as a percentage of the pig profits makes delegated responsibility a greater reward. However, it is no use delegating a job to a man unless you also give him the training, the tools and the resources to do the job. You must also be sure that he wants to accept the responsibility.

At another level the use of the participation method has much to recommend it. Instead of issuing instructions the boss and worker discuss the day to day plans for the farm before deciding on the best way of handling its problems.

However, the degree to which a farmer can use the participation method depends on several factors. Obviously an experienced man can help in making decisions which would be beyond the ability of an inexperienced youth. Further, some men object to taking responsibility and just like being told what to do.

Recognition is the next satisficer. Most of us like to be thought well of by others and therefore praise is a strong reward. Unfortunately its effect in terms of pleasure are rather short lived and there is a limit to the amount of praise one can heap on an employee without being thought insincere. Nevertheless opportunities for praise should never be missed.

Rises in wages also give satisfaction though again the length of time the feeling of satisfaction lasts is usually rather short. A practice used by one farmer is to pay award wages to young men to start with and then give frequent small rises in wages which coincide with periods of hard work. Thus a boss who wants to give an employee an extra £2 per week would probably create more satisfaction by giving an extra £1 per week immediately and postponing the second pound for another six months.

Dissatisfizing Factors

Dissatisfizing are those factors which if they are not at a relatively satisfactory level make workers search for another job.
Conflict of the role as a worker with other roles. A man plays many roles in his life. At one moment he is a worker on the farm. At another he is the head of a family. Then he is a member of a church, on the P.T.A. committee, in the race-listening school on Saturday afternoon in the local pub, with the local football club and so on. Conflicts between his role as a farm worker may often conflict with his role as a member of these other groups.

Without a forty-hour week, the farm worker is sometimes in a difficult spot due to role conflict. However much he may enjoy farm work, its demands can clash with the arrangements his wife has made to go to town or take the children for a picnic. A young man may find it hard to get to football practice or make his confession.

A good boss appreciates these other roles and adjusts the organization of the farm accordingly. He arranges for a set number of milkings off-arranged in a way that, as far as possible, his worker can play his many roles without undue conflict.

The condition of the house in which a worker lives may not come up to the level demanded by his wife and family. This is another cause of dissatisfaction. Sometimes the level of education for the worker's children at the local primary school or at the local district high school does not measure up to their needs. A responsible farmer can do his best to support the local school to make sure that it has the necessary facilities. In some isolated districts farm workers have to leave good jobs they like when their children reach secondary school age because there is no secondary schooling in the district and he can not afford to send them to boarding school.

Role conflict between the demands of the job and the demands of the home, and lack of advancement are probably the important factors contributing to the loss of men from the land in their middle years. Labour Department statistics show a normal proportion of farm workers in the 20-24 age group but an abnormally low proportion in older groups. (Reference 3.)

Status. New Zealand is not a classless society. Jobs rank in order of status. Congalton (Reference 4) in a survey of class consciousness found that a sample of 1,000 people ranked these jobs in this order.

<table>
<thead>
<tr>
<th>Job</th>
<th>Median Judgement</th>
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<tbody>
<tr>
<td>Doctor</td>
<td>1.4</td>
</tr>
<tr>
<td>Country solicitor</td>
<td>3.4</td>
</tr>
<tr>
<td>Company director</td>
<td>4.0</td>
</tr>
<tr>
<td>Business manager</td>
<td>5.4</td>
</tr>
<tr>
<td>Non-Conformist minister</td>
<td>5.4</td>
</tr>
<tr>
<td>Public Accountant</td>
<td>6.0</td>
</tr>
<tr>
<td>Civil servant (head of department)</td>
<td>7.1</td>
</tr>
<tr>
<td>Works manager</td>
<td>8.0</td>
</tr>
<tr>
<td>Farmer</td>
<td>8.2</td>
</tr>
<tr>
<td>Primary teacher</td>
<td>10.1</td>
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<tr>
<td>Jobbing master builder</td>
<td>11.0</td>
</tr>
<tr>
<td>News reporter</td>
<td>14.3</td>
</tr>
<tr>
<td>Policeman</td>
<td>14.7</td>
</tr>
<tr>
<td>Commercial traveller</td>
<td>15.2</td>
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</tbody>
</table>
In town, workers have a large number of people within their own social status group with whom they can mix. In the country this is not so and workers may feel the influence of class barriers more frequently. "You don't count in this district unless you own a farm," is a remark I have heard up and down New Zealand. The problem is often more acute amongst women folk.

Farmers I know make a special effort to organize activities in the district at which everyone will feel at home and enjoy themselves. This is one way of reducing the dissatisfaction for feelings of lack of status in a rural community. Other farmers refrain from using that feudal term "my man" when referring to their employee. The term "dairy technician" might be a better word to use.

Interpersonal Relations. Sometimes worker and boss fail to get on or, as more frequently happens, feuds break out between the boss's family and the worker's family. The problem is made more acute on farms compared with factory work because boss and worker have to live and work together. Causes and cures of friction are more the field of the clergyman than the agricultural scientist. However perpetual niggling and carping criticism make a boss hard to tolerate. Criticism behind a man's back is worse still. Promising future rewards, such as the possibility of shares, without any real intention of providing them is a dishonest trick. Good bosses work as a team taking their fair share of the rough and the smooth jobs. Leaving a man digging a drain while the boss fiddles in the workshop does not engender good relations. A farmer who spends his time on local affairs or enjoying his leisure must be a pastmaster in the art of human relations if he expects to hold the services of a good worker.

Security in old age. Workers in town often own a house of their own and they amortize it so that it is debt free by the time they retire. Because farms have "tied cottages" the worker may have nowhere to live when he is too old to work. Perhaps a National Farm Superannuation Scheme would help and I hope that the Manpower Working Party of the Agricultural Development Conference will come up with some useful suggestions for a such a scheme.

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<tr>
<th>Job</th>
<th>Median Judgement</th>
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<tbody>
<tr>
<td>Newsagent</td>
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<tr>
<td>Fitter</td>
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<td>Routine clerk</td>
<td>15.9</td>
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<td>Carpenter</td>
<td>16.6</td>
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<tr>
<td>Bricklayer</td>
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</tr>
<tr>
<td>Shop assistant</td>
<td>20.1</td>
</tr>
<tr>
<td>Carrier</td>
<td>20.7</td>
</tr>
<tr>
<td>Chef</td>
<td>22.4</td>
</tr>
<tr>
<td>Tractor driver</td>
<td>22.6</td>
</tr>
<tr>
<td>Agricultural labourer</td>
<td>23.7</td>
</tr>
<tr>
<td>Miner</td>
<td>25.0</td>
</tr>
<tr>
<td>Railway porter</td>
<td>25.1</td>
</tr>
<tr>
<td>Barman</td>
<td>27.7</td>
</tr>
<tr>
<td>Wharf labourer</td>
<td>28.1</td>
</tr>
<tr>
<td>Road sweeper</td>
<td>28.9</td>
</tr>
</tbody>
</table>
while I know of one farmer who has helped his employee buy a house in town which will be rented to a tenant in the meantime.

Wages and Perks are important variables in dissatisfaction with a job. Unless the farmer pays his employee at a level equivalent to the pay he can get elsewhere, other rewards being equal, then there may be dissatisfaction and the employee will look around for alternative jobs. A farmer was recently reported in the press as saying that if workers would put in fifty hours work for forty hours pay, then production could be doubled from New Zealand farms. This is an unrealistic attitude.

At present there is some discussion about raising the technical education of farm workers. Industrial psychologists have found that the higher the level of education the greater the likelihood of a worker leaving his job. Now farmers claim that they want well-trained men. If they are not prepared to pay for skill then well-educated employees will shift to other jobs. Also young men will not be prepared to join apprenticeship schemes unless there is an extra reward for this at the end. If farmers want better educated labour then, even if the education is provided by the state, they will have to pay them more.

Conclusion

This paper has covered a wide field. I have focused on factors which give rise to an increase in satisfaction—the work itself, achievement, advancement, responsibility, recognition and rises in wages. We have also discussed the factors which give rise to dissatisfaction—role conflict, lack of status, poor interpersonal relations, lack of security in old age, and low wages. When employing labour it is up to each individual farmer to diagnose his own situation to find which of these factors are involved, if any, in motivating farm employees to work and stay on his farm. While a boss must be able to get on with his employee, the predominant factor is farm efficiency. This provides a worker with an environment in which he can get satisfaction from the work he does, and supplies the revenue for the employer to give a good man sufficient rewards.

References: