

LINCOLN COLLEGE

(Canterbury Agricultural College)
UNIVERSITY OF NEW ZEALAND



The Proceedings of the 11th Lincoln College Farmers' Conference 1961

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14th Lincoln College
Farmers' Conference
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LINCOLN COLLEGE FARMERS' CONFERENCE

May 17, 18 and 19, 1961

Committee

- Mr C. Baird, Wendon, No. 3 R. D., Gore.
Mr C. S. Bowmar, Bowden Fields, No. 4 R. D., Gore.
Dr M. M. Burns, Director, Lincoln College.
Mr L. P. Chapman, Inverary, Mt. Somers (Chairman)
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Mr G. S. Slater, Hilton, South Canterbury.

Hon. Secretary,

A. T. G. McARTHUR,

Lincoln College.

PROGRAMME

1961

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CHAIRMAN'S OPENING REMARKS

As Chairman of the Conference Committee, I welcome you all here today. Before beginning the formal business of the Conference, I wish to make reference to the loss of a great friend of this College in the late Mr Gillespie. He served for many years on the Board, and for the past 10 years as Chairman.

But I would remind you particularly of his connection with this Conference. He never failed to attend and to welcome members with sound advice.

His genial and kindly nature made him popular with everyone who met him. The College and farmers generally have lost a worthy representative and a very good friend.

I would ask you to stand in silence as a tribute to his memory. There have been other changes in the personnel of the Conference. You will notice the absence of Professor McCaskill as Secretary. Over the years he has been such a familiar figure that he has seemed part and parcel of the Conference.

His efficiency, and his indefatigable energy have raised the organisation of this Conference to the high level it now holds. I feel that I can express the very best wishes of all of you to him in his new job in the Tussock Grasslands, and a warm welcome to his successor Mr McArthur and our interim Secretary, Mr McSweeney.

This year's programme reflects the rich variety of interest in the farming life of this country, and makes me realise again how fortunate is the farmer whose way of earning his living is also his absorbing interest. An interest shared equally by the genuine country worker who has resisted the temptations of town life with all its attractions of higher wages, shorter hours and greater leisure.

That this interest is often not found in town jobs, may explain some of the dissatisfaction and irresponsibility, so evident today in city youth.

However, farming is no longer a simple life, though we may often wish it was. The intelligent farmer today must take an interest in internal politics, in international developments and in world markets.

It is with these two aims, of increased efficiency and of informed opinion, that we are assembled here today for this Conference.

MEAT MARKETING

John Ormond, Chairman, New Zealand Meat Producers' Board.

I have been asked to speak about policy. I believe this is a very suitable moment to do so. There are some important policies which we should all be agreed upon—as far as that is possible.

The policy of the Meat Board is not something which nine men who sit around the board table determine among themselves and impose upon the industry. The policy of the Meat Board is the expression of the will of the meat producers through their elected representatives and it will be effective only so far as it is practical and in the interests of the producers and the country as a whole.

The better informed our producers are and the sounder their assessments and criticisms of policy, the stronger will our industry be. There is probably no need for me to tell you how important it is that we have such forums for sheep farmers as this one at which we are present today. There is always a danger—and it is particularly so today—that people may develop firm convictions about policy while they still have only a part of the information necessary to the making of sound judgement. It is no good formulating policies without having the broadest available view of all the problems involved.

It is necessary first to understand the system of trading in our industry. Whereas our wool is sold at auction and dairy produce is co-operatively owned right through to marketing, our meat is sold to private traders; it is they who determine the price they will pay to the producer and who market the meat and its by-products. It has been the traditional view of the sheep and beef cattle producers that private trading, as distinct from industry ownership, is the system they want. I am not going to argue that question here today, but I think those facts must be borne in mind as a background to discussion of policy in marketing.

I believe the health of the meat producing industry can be best maintained if we have—

Maintenance of consumer demand for its products.

Strong competition among those who trade in its products and among those who transport them and service the industry.

Reflection of market requirements back to the producer.

Favourable international trading arrangements.

The basis of the meat producing industry's thinking all through the years has been that there should be healthy competition for its products. In recent years this has been a very real necessity. To maintain the competitive element among those who process our products and transport them has been one of the greatest single problems in policy for the Meat Board.

There is a very strong will among New Zealand producers to protect the interests of their industry and their country wherever these are seen to be endangered. There has been ample evidence of this in the past. We can profitably look back to the years immediately after the First World War and observe what was done then. At that time, after years of bulk sale of our product to the United Kingdom, the meat trade fell into a chaotic condition and the foundations of the producing industry were being undermined. That great Prime Minister, the Right Hon. W. F. Massey (a Conservative) determined to take drastic action to establish order and fair trading. He put through Parliament the Meat Export Control Act, 1921-22, which established the New Zealand Meat Producers Board. It was

the intention of the Massey Government that the Board should be in a position to exercise full control over the meat export trade in the public interest.

In the words of the Act, "It has been resolved that the public economic welfare will be promoted by the establishment of a board of control with power to act as the agent of the producers in respect of the preparation, storage and transport of meat and in respect of the disposal of such meat beyond New Zealand."

The Board was given very wide powers indeed. I believe the existence of these powers has been a great factor for stability. The wisdom and restraint with which the early members of the Board administered the Board's powers under the Act have not perhaps been as widely appreciated as they might. Certainly they have been an example to those of us who have come later.

The scope of the Board's work today is greatly enlarged. That has been part of the growth of our industry. But the work of the Board rests still on the essential consideration which Mr Massey had in mind—namely, the promotion of the public economic welfare.

Most of you will know the principal responsibilities of the Board. We must ensure that the product is produced in quality and form acceptable to the consumer—hence maintenance of grading standards and supervision of these and the Board's promotion of a research institute. We are concerned to maintain order and fair play, hence the "open door" policy, the allocation of shipping space and the negotiation of freight rates. We must endeavour to maintain and increase the demand for our meat, hence our work in public relations and advertising, and we must see that market requirements are reflected back to the producer, hence our constant study and research into market trends and dissemination of news about them. We must maintain so far as possible favourable trading opportunities, hence our concern with negotiations and agreements between Governments.

With all these responsibilities undertaken, we must then return our minds to producers' immediate problems. We have to encourage production of types and quantities of meat which it is in our best interest to put on to the market, and we must create an environment of healthy competition for livestock.

This last point is a fundamental one. The Board has used its powers to enforce the "open door" policy under which we preserve the right of the owner of livestock to have his stock slaughtered and the products made available for sale as he wishes. I doubt if there is any other country in the world where producers of livestock have so many channels open for the disposal of their stock. They may use any one of these channels:

Sale in the paddock.

Sale at auction.

Sale on the hooks at the works, i.e., Schedule.

Sale on owner's account.

Sale through producer co-operatives.

The Board over the years has considered it a primary policy to maintain as many such channels as possible. There have been some very real difficulties and still are difficulties in maintaining this position. It is vital that we do so, because only in this way can we ensure that the producer will get the fullest possible value for his livestock. Here, incidentally, the farmer co-operatives play their part. Their trading not only gives their members full market realisation, but it is one more yardstick for measuring the fairness or otherwise of meat schedules. And it is a channel by which market requirements can be reflected back directly to the producer. Their operations and experience can also have a salutary effect upon those producers who might otherwise be disposed to take an unbalanced view of the trade as a whole.

Now let us look at developments in our markets and at policies which these developments compel us to consider. We all know that for the first three-quarters of a century in New Zealand's meat export trade it was sufficient to produce all that we could, to tailor it to the requirements of the United Kingdom market and to ship it there, supported by advertising programmes. After the Second World War it was not until 1954, after 16 years of bulk purchase and sale between Governments, that rationing ended in Britain and we returned to private trading in meat. The return to private trading after the First World War had brought chaos. The return to private trading after the Second World War found the sheep producers of New Zealand with a well-established and experienced organisation in the Meat Board, with power to act in the interests of stability and expansion.

One of the constant concerns of the Board has of course been to promote production in New Zealand. Notwithstanding the ebb and flow of supply and price in our markets, it has always been essential to maintain our output and to increase it. If we did not do this there would be no prospect of the economic growth which the whole community needs.

The Board, as you will remember, promoted the establishment of fertiliser works, lent finance to the aerial topdressing industry to enable it to put itself on a sound footing, and has in various other ways taken steps encouraging production. Producers have been quick to apply new techniques and new aids. These factors, coupled with years of good prices, have brought these results:

Killings of lambs for export have increased from 12.6 million in the 1953-54 season to 18.1 million in the 1959-60 season—an increase of approximately 44 per cent in six years.

Production of mutton in New Zealand freezing works for export rose from 52,616 tons in 1953-54 to 75,000 tons in 1959-60—an increase of 41 per cent.

Production of beef and veal for export rose from 45,737 tons in 1953-54 season to 84,052 tons in the 1959-60 season—an increase of 84 per cent.

In the years after the war, successive United Kingdom Governments committed themselves to a comprehensive policy of subsidy and support to domestic producers, for social and political reasons. This was to give stability to the Home industry, and promote production within the United Kingdom of a larger proportion of her requirements of meat. Thus both in New Zealand and in the United Kingdom output has been rising. At the same time, in other industrial countries in Europe rigorous policies of protection and price support for agriculture at the expense of the competitive overseas exporter, and often at the expense of the domestic consumer, are causing increases in livestock production.

There are some who would say that because of the increasing volume of meat being produced around the world, we should not develop our own capacity as fast as we have done. That idea is folly. Nonetheless, it became clear when rationing ended in Britain in July, 1954, and private trading resumed that the New Zealand meat industry must enlarge its horizons in marketing. It is a measure of the enterprise of the industry and the work of the Board that in the short period of six seasons since the end of bulk purchase we have reached the point at which more than 30 markets are regularly taking our meat and around 25 per cent of our total export volume has been sold outside the United Kingdom. I am sure that this is still not enough.

We do not want to desert our traditional market. In fact development of trade elsewhere must be tempered by the primary consideration—that we maintain adequate supply in the United Kingdom. It is possible to argue that because we have put in 18 million lambs at a total return not proportionately greater than we had

from 12½ million, we have been stupid. But I would ask you not to take that argument at its face value. We have demonstrated that we can produce three lambs where two grew before, and it followed that in developing and expanding consumer demand for this product, the unit price had to be lowered. Although we would like to maintain luxury prices for unlimited quantities, it is healthier that we can now produce a product undiminished in quality, recognised by the measure of pounds, shillings and pence as better than any of its competitors, and market it now at a more competitive figure, while retaining profitability, and extending our share of the market. Our increased production has in considerable measure driven our competitors in the imported meat trade out of the best market. It is most important that we maintain our volume of supply to the United Kingdom and retain the competitive position which the quality and promotion of our product have built up. Nor are the opportunities in the United Kingdom by any means exhausted.

As you will know, New Zealand's special role in the world meat trade is in the supply of sheep meats. New Zealand alone among the nations is a large marketer of lamb and mutton. Here are comparative annual figures of exports of lamb and mutton by the only large exporters:

New Zealand	322,600 tons
Australia	74,000 tons
Argentina	28,750 tons

At the other end of the world the United Kingdom alone among the nations is a substantial importer of these sheep meats. Hers is the only population outside the major producing countries that has a significant per capita consumption. Here are the figures of consumption of mutton and lamb per head of population in the principal markets:

United Kingdom	25 lb
France	6 lb (Almost entirely from European production)
United States	4.5 lb
Canada	2.7 lb

It can be seen from these tonnages that the world trade in lamb and mutton is primarily New Zealand's concern, and our business has lain almost exclusively with the United Kingdom. When one considers these facts and figures I have just given you it is easy to say, "Why produce this product; why not convert to beef, which every market may take? Why not cut back the sheep operation; make a drastic revision of policy, invest large capital (as it would need to be) in changing over to beef?" That thought has been very closely studied by the Board. We certainly believe that beef production should be increased, but in the main this will be beef production as part of the sheep operation.

Already, as the figures I have given you will show, our beef and veal output has risen substantially. Beef and veal in the 1959-60 season comprised approximately 23 per cent of our export meat, whereas not very long ago it was a negligible part. It is the Board's belief that wherever practicable sheep farmers can well increase their beef cattle numbers. The sheep operation, which provides income from both meat and wool, remains the cornerstone of the country's economy. Its two major products give greater balance to the producing industry than if it were substantially dependent on one. In the words of Mr Wright, the president of the North Canterbury meat and wool section of Federated Farmers, who discussed this point the other day, we would like to see more beef—not at the expense of lambs but supplementary to them.

The chief consideration I want to leave with you is that there is every reason for full confidence in our sheep industry, which as I have said, we must expand. We have this marketing of mutton and

lamb as our own particular responsibility. We can either fail to face up to it or we can accept it, as my Board has done, as a challenge to our initiative. We are taking the opportunity to establish New Zealand as a specialist, earning a special and continuing place in world markets. We have gone a long way on this road already and it would be unfortunate if in the middle of this operation people were to undermine the strength of the industry by refusing to see the opportunities before us.

When you consider the figures I gave you a moment ago on lamb and mutton consumption you will note that the United Kingdom consumes 25 lb per head of population, a figure a long way ahead of the next country. Why should this be so? It may well be the result of New Zealand's consistent supply and promotion over the years. The United Kingdom sheep industry could not have maintained sufficient volume to hold mutton and lamb before the housewife as a constantly available product.

It is not unreasonable to suppose that if New Zealand has been able to maintain sheep meats as a substantial item in the meat consumption of the United Kingdom it can do so elsewhere, too. We are already proving the truth of that. Undoubtedly there are some very real obstacles to be overcome, but I believe we shall overcome them.

The New Zealand Meat Producers Board has had extensive market research conducted, with this consideration in mind. For this purpose the nations of the world can be seen in three groups:

- (a) Countries with a high level of prosperity. These include the United Kingdom, the United States, Canada, Western Europe and Scandinavia. These are the only countries that could import the high-priced meats in quantity.
- (b) Countries of very low-level incomes, as in most of Asia, Africa and Arabia. These countries are not at present prospective markets for New Zealand meat in quantity.
- (c) Between these extremes is a group of nations including Japan, South American countries, the West Indies and certain countries of the Near and Middle East. In these countries standards of living have risen sufficiently to enable them to become importers mainly of the cheaper meats, notably mutton.

Future expansion for lamb can more reasonably be expected in the countries of group (a). At the same time in group (c) there are countries which can move into greater meat consumption by way of mutton. In this latter group already Japan, Greece and Jordan have become substantial purchasers of New Zealand mutton, and other countries in this group may be expected to join them.

Because of particular difficulties of supply, the Meat Board and the New Zealand-owned freezing companies established in 1960 the Meat Export Development Company (N.Z.) Limited, which is responsible for handling the market for lamb in Canada and in the United States, and arranging supply in accord with the requirements of those markets.

In Canada the Board began its promotion programme by instituting market research and procuring a market survey, which involved a study of meat supply and distribution and the preferences of housewives. Promotion work based on this survey began with the trade and has now developed to the point at which full-colour advertising in women's journals is supported by the point-of-sale material in the stores. The progress so far made on this long-term project has been most encouraging.

In the United States the sheep industry has been in difficulties since the war. Many causes have been cited. It would appear that high cost of production on United States farms and inability to maintain supply before the housewife have been two of the major reasons. The United States needs at least a quarter of a million

more lamb carcasses each year to maintain the present very low level of lamb consumption per capita, because the population there is rising at the rate of three million a year.

When it became apparent that New Zealand was going to have a big increase in her mutton supply for export, the Meat Board determined to investigate the possibility of interesting Japan in mutton, and did so in co-operation with traders.

Since the war Japan has been moving fast towards many Western habits, including the greater eating of meat. Japan has not the resources to produce readily livestock products in large enough quantity to meet expected future demand, although she will no doubt use her ingenuity to this end. Japanese traders in 1959 and 1960 accepted New Zealand mutton as a substantial ingredient for processed meats, which are making rapid progress with the consumer.

The expansion of New Zealand mutton sales to Japan is indicated in the following figures of New Zealand shipments.

Season	Tons
1957-58	4
1958-59	3,575
1959-60 (Provisional)	16,000

The 1959-60 figure represents 20 per cent of a heavy New Zealand kill. About 90 per cent of this mutton bought by Japan has been going into processing. There has been heavy capital expenditure on factories for this purpose and their requirements are now well established.

It is the view of the New Zealand Meat Producers Board that a still better future for mutton in Japan is dependent on its introduction to housewives and their acceptance of it as a meat in its own right. We have therefore decided to take steps to build a retail demand. For this purpose a programme of public relations and advertising has been instituted. This programme, based on market surveys, involves the introduction of mutton into Japanese and Western-style dishes. The advertising is based largely on cooking sessions on television (one out of two of the homes of Tokyo's nine million people has television) and cooking demonstrations.

This will be supported by advertising at the point-of-sale by way of posters and pamphlets and by display advertising throughout the Tokyo transport services. We now have mutton sold in most of the large department stores. In one alone, up to two tons of mutton cut into small pieces without bone is sold on a Sunday, the busiest trading day.

In 1960 New Zealand was the substantial exporter of mutton to Japan and was also the principal supplier of beef. By means of our promotion the name of New Zealand is being established as that of the predominant supplier of meat in a country whose future is surely one of expansion in consumer demand.

New Zealand exporters have been very active in Japan and the trade is now well ahead. There will always, of course, be the question of price. This year the demand from Japan has run up against competitive demand from other markets, notably the United Kingdom and Greece. This has had its effect on price and will have its effect on the relative proportions of New Zealand's mutton going to Japan, the United Kingdom and other markets. Japan's capacity to buy will naturally be dependent on her resources of foreign exchange. The immediate plans of the Japanese Government are based on an increasing export and import trade. These policies of promotion of mutton outside the United Kingdom market are clearly reflected in the trend of Smithfield prices. If you study the graphs which the Board's Market Information Service publishes each month in the "New Zealand Meat Producer" you will observe that during the last two seasons when demand outside Britain for ewe mutton has been grow-

ing the prices in the United Kingdom market have risen. Today we have prospect of still further widening our outlets for mutton.

I know you will be anxious to see the lamb operation developed in a similar way. It is not practicable for me to go into detail here of our activity in this field, but I have already indicated to you that the ground work has been done. It is only a few years since we were without regular shipping service to carry our product to areas in which we wished to place it. The shipping industry has had to adjust itself in these few years since the end of bulk purchase to the requirements of our trade. It was not easy for a start. There could be no trade without a shipping service, yet who was to start a shipping service when there was no trade? Yet today we have not only the traditional carriers of meat but also other lines we brought in, all taking their part.

Shipping services having been established, the next task was to ensure supply from New Zealand of the right types and at the right times. You may think that was an easy one, but for various reasons, particularly the nature of traders' business over the years, it was not easy. I have already told you of the foundation of the Meat Export Development Company to ensure supply in accord with market requirements. I have told you of the Board's market research and promotion work in Canada. I am confident that we shall establish ourselves soundly elsewhere as we have done in Canada.

At the same time the export trade is developing the smaller markets, too. Small lots build into a surprising volume. We are sending lamb in small quantities and large to about 20 countries at the moment, and I think over the years you will see expansion where the pessimists have not dreamed it could happen. Who among them, for instance, had the imagination enough to see the prospect for mutton in Japan?

While I speak about lamb I think it is important to note changes in the character of the trade. We all know that in North America the supermarket is dominant. The family butcher as we know him in New Zealand and the United Kingdom is practically non-existent in North America. And in the United Kingdom the self-service shop is becoming well established. The family butcher is still the discriminating housewife's counsellor, but there is no doubt that an increasing proportion of meat sales in the United Kingdom will be made through self-service stores. In these stores cuts are presented to the customer prepared and wrapped.

There is already increasing demand for cuts to be done in New Zealand. New Zealand processors adapted themselves efficiently to the requirements of the United States manufacturing beef trade. They are making changes also to meet the requirements of an expanding trade in pre-cut meat. This is giving new employment within New Zealand, and so far as it can be economically done here it will be. This I believe is the beginning of revolutionary changes in the meat trade, changes that are being reflected directly back to the works.

I would remind you that neither the industry nor the Board is blind to such questions as customer preference, market requirements, and standards. Attention to these factors has been the foundation of our trade. Our lamb trade is finely attuned to the United Kingdom market. That is a fact which our competitors greatly envy, and which the Home producer in Britain is being counselled by his own people to emulate. We are not going into new markets without paying attention to this same consideration. I have already indicated to you the work that is being done in market research, so that we may satisfy the trader and consumer. We are, of course, interested in research into such important matters as processing in the works, packaging, and the life of the product under various conditions of refrigeration

and transport. The industry and ourselves can now bring back technical problems in meat processing and transport to our Meat Research Institute, whose central function it is to study the capacity of our product to go through the channels of supply to the standards we require.

Constant striving towards quality standards has been the basis of our industry for many years. It is that work that has built for our product such a secure place in the United Kingdom market. Numerous comments we have had from North America and elsewhere make it clear that the conformation, quality and presentation of our lamb today is greatly superior to that of any other product of its kind offered for sale anywhere. In the greatly changed conditions of marketing the Board's first concern, and the industry's, too, is to preserve our reputation for quality and to carry it through into the new markets and new methods of presentation.

I have discussed with you some of our immediate policies. But the best of plans in trade expansion can come to nothing if we lack favourable international trading arrangements. We see on all sides today industrial nations raising barriers against the produce of the primary producing countries. They do this in order to protect their highly subsidised domestic producers. This leads to a forced growth, and, because it restricts opportunities for primary producing countries it must lead to contraction of world trade. It has already done that.

For political reasons which are very well known there is the desire in Europe to build the various Continental nations into one unit. It is calculated that by unifying the trade of those nations, promoting substantial economic growth and thus raising the level of prosperity, a strong bloc can be built. This would have a population of over 200 million people if Britain were included. It would be comparable with Soviet Russia and the United States of America. The Six nations of Europe—Western Germany, France, Italy, the Netherlands, Belgium and Luxembourg—signed the Rome Treaty in 1958 by which the European Economic Community is established. Trade and tariff barriers within the Community are being reduced and will be eliminated. Common external tariffs are to be applied to the import trade from countries outside the Six.

The United Kingdom has all along been anxious to participate in the integration of European trade, but because of her special position, in particular her privileges in Commonwealth trade, and the interests of her domestic agricultural industry, she has wanted a Free Trade Association, not a Customs Union. Furthermore, a decision by the United Kingdom to enter the European Economic Community would undoubtedly be the greatest political decision of a century. It would merge Britain, however gradually, nonetheless certainly, into a United States of Europe. She would become simply one department of the greater Europe.

The greatest difficulty that has arisen lies in the field of agriculture. As I have said, Britain's agriculture is supported in a manner very different from that of the European countries. The agricultural proposals of the European Economic Community embrace a system of rigid protection against imports of foodstuffs. There would not only be tariff, but for those countries who could produce efficiently like ourselves and surmount the tariff, there would be import levies and quotas. If Britain were to enter the European Economic Community on these terms she would be obliged to dismantle her existing subsidy and guarantee system for agriculture and embrace the Continental system. I do not need to explain to you just what drastic effect this could have on our export trade. The National Farmers Union in Britain has expressed its concern at the probable effect on the domestic producer.

You will know that we have strongly represented to both the present and the former Government in New Zealand the implications for New Zealand, should Britain propose going into the European Economic Community, particularly on the basis of the present agricultural proposals. We have been assured that New Zealand will be consulted before any action is taken. This is imperative, because such is the particular nature of New Zealand's trade in both meat and dairy produce that we are peculiarly vulnerable to the effect of changes of the type at present proposed.

There are some who argue that because of the long-term prospect we might have of building substantial markets for our lamb, mutton and beef in Europe there can be some adequate compensation arranged for us there, for any loss of opportunity we might suffer in the United Kingdom. This view appears to take no account of the E.E.C.'s declared intention to achieve self-sufficiency in meat—a position which she has almost attained at present.

There are those, too, who say that we should accept Britain's entry into the European Economic Community and take the loss as an investment for a stronger market in Britain in the future, but so drastic would the effect be of the present agricultural proposals that our industry would hardly be in a condition to enjoy the benefits theoretically to be received at some unspecified future date.

Meanwhile the nature of our trade has forced us to look to markets outside Britain. The beef shortage in the United States after the heavy kill there in 1955 and 1956 enabled us to build a beef trade there as a substantial alternative to the United Kingdom. I have already told you how we have taken a large portion of our mutton to other markets and now we are carrying out plans to ease the weight of lamb in the United Kingdom market. If we reduce our selling to Britain we must inevitably be obliged to reduce our buying. We do not want to see the Commonwealth trading links weakened. We would prefer to help build Commonwealth trade. That is the substance of Commonwealth. We hope that some alternative way can be found to associate Britain with Europe and to avoid further blows to the Commonwealth association.

The New Zealand Meat Producers Board attaches the utmost importance to the development of closer trading relationships with the United States, Canada, Japan, and all other countries where potential markets exist. I believe there is a great future for us in the Pacific Basin, both in large tonnages and in smaller quantities to meet the fast-growing Pacific tourist traffic. The Board believes that improved reciprocal trading arrangements are necessary with countries with whom we can trade. The Board will continue its exploration of potential markets in various parts of the world, but such exploration needs to be backed by assurances of all practicable Government action to facilitate access to markets.

If it has taken me some time to encompass the ground I have done, it will at least indicate to you the very considerable growth of the Board's responsibilities since Mr Massey had the foresight to establish an organisation to safeguard and promote the interests of our industry. I would repeat my view that the sheep industry can go forward with great confidence. I do not minimise the problems, but I want to assure you that I believe we shall have a sound future indeed. My belief is founded on my knowledge of the work that is being done at this moment, not only by the Board and its staff but by traders both in New Zealand and overseas. We could, of course, defeat ourselves if we were to fail to maintain the initiative we have taken—but that is unlikely indeed.

ECONOMIC RESEARCH ON FAT LAMB PRICES

Prof. B. P. Philpott, Lincoln College.

Introduction:

My purpose in this paper is to give you an idea of the sort of research we are conducting on the factors affecting fat lamb prices and to present some of the results achieved to date.

This work is part of a general programme of economic research into marketing problems in which we are initially trying to sort out the reasons for fluctuations in the prices of our farm products. Such investigations are necessary before it is possible to make any sound suggestions for the improvement of our marketing system.

I have divided up my discussion of the subject in to two sections. First the changes in the average price of lamb that occur year by year, making up, as it were, a general long term trend in prices; and second the price fluctuations that occur week by week or month by month within any one year. To some extent these two aspects are not separable, but for our purposes, as you will see, there is clear justification for such an approach.

Year by Year Changes in U.K. Prices of New Zealand Lamb:

In this section, we concentrate our interest on the general trend of prices over the years, and, disregarding the fluctuations which occur within the years, we attempt to show the nature and magnitude of the factors responsible for this trend. To do this we must go back to earlier years because, unlike the natural scientist, the economic scientist cannot conduct an experiment to provide the answers to his questions—he must use whatever uncontrolled experiments nature or history has already designed for him by taking the raw facts of history (in this case the history of lamb prices) and distilling from the statistical data available the pattern of cause and effect which appears to have been operative. In doing this heavy reliance is placed on mathematical and statistical methods which, today at any rate, will have to be taken for granted.

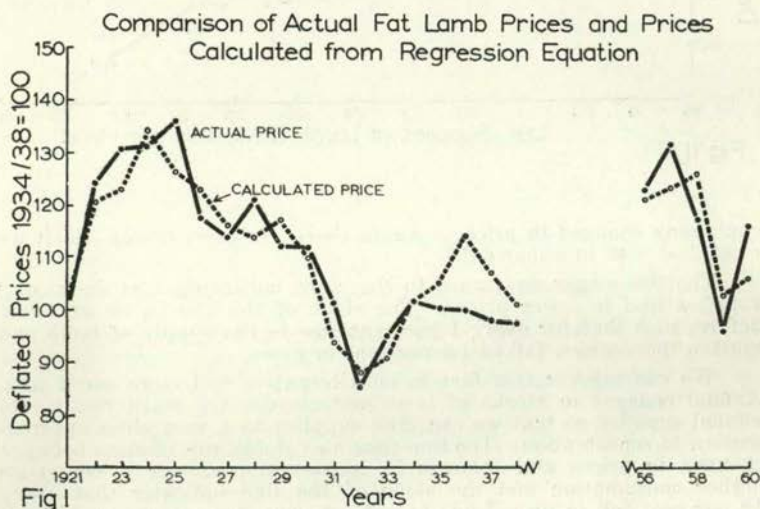
The history of the average prices we have received for lamb each year in Britain from 1921 to 1938 and 1956 to 1961 is shown in Table I. Because we are dealing with a long period of years over which the general price level has changed very considerably, the money price of lamb has been converted into an index number (with 1934-38 = 100) and then deflated or divided by the British cost of living index. In this table are also shown some of the variables we have used to try and explain these changes in prices. The best explanation which has emerged from our statistical investigations so far is that which uses as explanatory variables:—

1. The annual supply of lamb and mutton per head of British population.
2. The annual disposable real income per head of British population.

The relationship between lamb prices, lamb and mutton supplies and income is shown in the form of a statistical equation in the appendix to this paper. The indications are that over the whole period reviewed and at the present time, for every rise of 1 per cent in the supply of lamb and mutton there followed a fall of 1.5 per cent in

price and vice versa for falls in supply. (This relation is called by economists the "price flexibility.") The effect of income was very small indeed. Every 1 per cent rise in income was followed by a 0.1 per cent rise in prices.

The extent to which these two factors explain the lamb price changes is shown in Figure 1 where the actual price each year is plotted against the price derived by calculation using the equation referred to above. The degree of coincidence of these two lines is a measure of the success of the two factors, supply and income, in explaining these changes. You will notice that our explanation of price changes is by no means perfect—in fact we have explained about 75 per cent of the variation. There are probably therefore other factors operating but to this matter we'll return in a moment.



The Demand Curve

There is an alternative way of looking at this relationship between supplies and prices and this is shown in Figure 2.

Here I have plotted, with reference to the vertical scale, the deflated prices of lamb (after making an adjustment for the effect of changes in consumers' income discussed above); and with reference to the horizontal scale, the per head supply of lamb and mutton in the United Kingdom. A dot for each year represents the combination of price and quantity for that year.

To these dots I have fitted the heavy black straight line representing the statistical relation between changes in supply and changes in price which was derived before—in fact the line is derived from the equation mentioned. The closeness of the dots to the line is again an alternative indication of the extent to which we have succeeded in

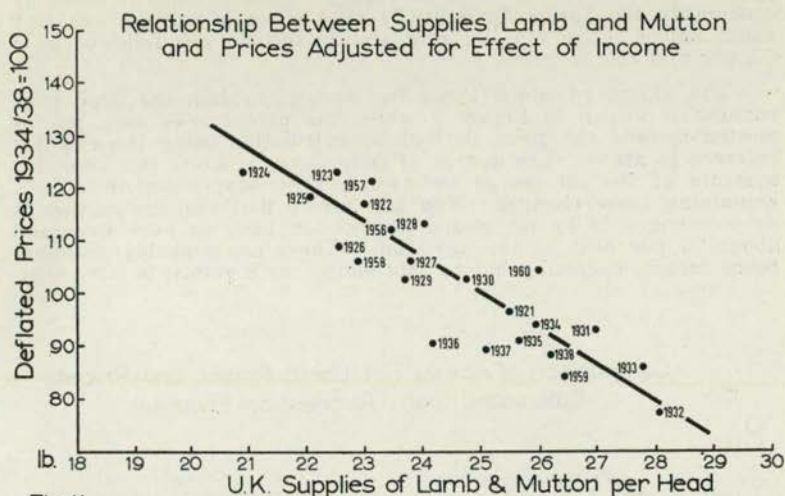


Fig. 11

explaining changes in price. Again there are divergences which we must deal with in a moment.

The line slopes downward to the right indicating that increasing supplies lead to lower prices. The slope of the line is, as we noted before, such that for every 1 per cent rise in the supply of lamb and mutton there was a fall of 1.5 per cent in price.

We can express this fact in an alternative and more usual way. Annual changes in stocks of lamb and mutton are small relative to annual supplies so that we can take supplies as a very close approximation to consumption. The line thus also shows the relation between changes in prices and changes in consumption—lower prices cause higher consumption and the slope of the line indicates that every 10 per cent fall in price leads to a 7 per cent rise in consumption—a relationship called by economists the “**price elasticity of demand.**” By comparison with many other commodities particularly non-agricultural commodities it is quite low—a matter of considerable importance to us as we shall see.

Other Factors Influencing Price

I am not suggesting that changes in supplies of lamb and mutton and changes in U.K. consumers' real income per head are the only factors influencing prices—indeed the fact that these two variables only explain 75 per cent of the variation in prices suggests, as I mentioned earlier, that there are other variables influencing the situation. Some of these I have tested in the course of this research without getting much improvement in the degree of explained variation in prices.

For example:

- (a) When the supply of lamb and mutton is divided up into frozen and fresh and two separate variables introduced explicitly into

the analysis, there is only a very slight improvement in the result—though this analysis is useful in allowing us to measure the effect of changes in imported frozen lamb and mutton alone.

- (b) Supplies of poultry per head of British population exert some influence on lamb prices but a much smaller influence than most people believe. Every 1 per cent increase in poultry meat per head reduced lamb prices by only 0.05 per cent (a price flexibility of 0.05), almost insignificant by comparison with the price flexibility of 1.5 with respect to supplies of lamb which I mentioned before.
- (c) Supplies of beef and pork appear to have had no influence on lamb prices whatsoever.

Other factors which I feel should, and in due course will, be attempted are:

- (d) Analysis of lamb supplies and mutton supplies separately.
- (e) The use of retail prices rather than Smithfield wholesale prices, though data on retail prices for New Zealand lamb are not easy to come by.

The adoption of these, and other approaches, will I am quite sure give us a fuller picture of the forces operating in the lamb market and reduce the unexplained variation which we observed in Diagrams 1 and 2.

Implications of High Price Flexibility or Low Price Elasticity of Demand

The price elasticity of demand for lamb and mutton, we concluded, was 0.7 and the price flexibility about 1.5. These are two measures of the same thing—one is merely the inverse of the other—but the latter is a more useful measure for the purposes at hand.

The implications of this relationship are that when supplies of lamb and mutton rise the aggregate sales revenue of all producers falls by about 0.5 per cent, i.e., 1 per cent increase in quantity less 1.5 per cent fall in price per unit.

Actually things are not as bad as this for New Zealand producers considered in isolation, since we only supply a share, though a large one, of the total market. The price flexibility for imported lamb and mutton is more like 0.8, i.e., every 1 per cent increase in imported lamb and mutton reduces price by 0.8 per cent so that total sales revenue rises by only 0.2 per cent, i.e., 1 per cent increase in volume offset by 0.8 per cent decrease in price. Expressed in another way we could say that every extra ton of lamb sent to the United Kingdom earns for producers and for the country not the price per ton but only one-fifth of the price—if the price is £200 a ton extra revenue earned per ton is only £40.

It is this relationship which accounts for the fact that our export earnings from lamb sold over the last five years or so have failed to match the greatly increased volume, in fact the total earnings have hardly risen at all—hence our very urgent need for new markets.

In this connection I want to make one suggestion. Because the extra supplies of lamb sold in the U.K. only net us about £40 a ton compared with the price, then it is worth while our selling lamb in new markets at any price which, after transport and marketing costs, nets us at least £40. I am not here suggesting that we should in fact sell at such low prices but it would certainly pay us, for example, to offer our lamb or more particularly our mutton to Japan at prices somewhat lower than we receive in the U.K. if such is required to develop a new market. Or alternatively if it is going to cost us a lot of money to develop and maintain a market in the U.S.A. so that we finish up getting net, less per pound there than in the United Kingdom, then it is clearly in our interests to bear such costs since the amount we would receive for the same lamb sold in Great Britain is in any case much less than the current price.

It is not my purpose to discuss the actual marketing arrangements for meat which would permit us to follow such a policy—all I will say is that there is reason to doubt whether the present organisations are adequate.

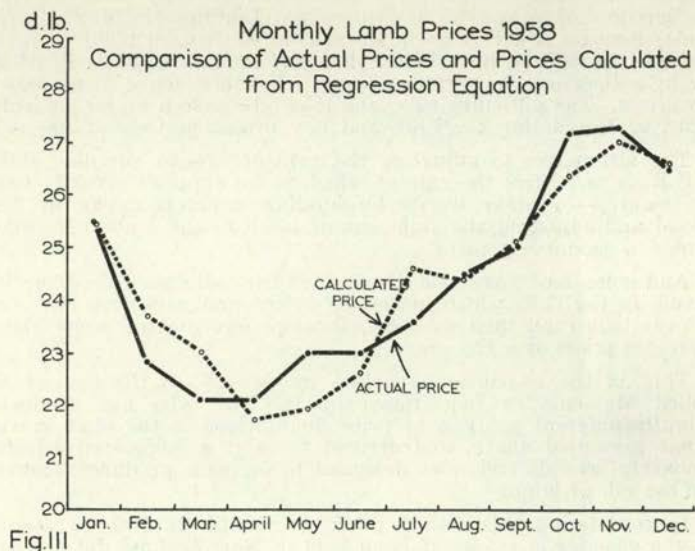
Lastly, nothing that I have said above implies that we should attempt to stabilise our sheep numbers and our production of lambs. It is imperative in the interests of the economy that we press on with more production but equally imperative that we find more places to sell it.

Within Year Fluctuations in Lamb Prices

I turn now to the second part of this research report—the investigation of reasons for fluctuations in lamb prices month by month within the year. This is of much more direct interest to the farmers since the weekly schedule price appears to be based very closely on the current Smithfield price. What factors influence the Smithfield price? Here my report on the research results must be very much a provisional one since the work is still in progress.

We should, I suppose, expect the same major factor to affect the monthly price as that which we've found influences the annual average price, viz., changes in supplies. In fact this is what we find, but changes in supplies month by month over the period 1956-60 explain only a part of the price fluctuation. The reason is not hard to find. All supplies entering the United Kingdom do not necessarily enter into consumption but some varying proportion is held in stock.

We get a much better explanation of price fluctuation, then, if we use as the explanatory variable the supplies actually put on the market, i.e., supplies adjusted for change in stocks or as it is called—in the jargon of the trade—the “disappearance” of lamb. Changes in the disappearance of lamb account for about 80 per cent of the price fluctuation in the year 1958—which is the latest year for which I have so far run this analysis. But we can improve on this when we add, as a further explanatory variable, the level of stocks of lamb in the middle of the month. These two variables explain about 90 per cent of the price variation in 1958 and a comparison of actual prices and prices calculated from the equation of this analysis are shown in Figure 3 (based on data in Table 3).



The statistical equation on which this diagram is based (given in the appendix) indicates that—

an increase of every 10,000 tons in the monthly rate of disappearance of imported lamb reduces price by about 1d pound (and vice versa for a reduction in “disappearance”),

and that—

an increase of every 10,000 tons in the level of stocks of imported lamb reduces prices by slightly more than 1d pound (and vice versa for a reduction in stocks).

We have yet to complete this analysis for the years 1959 and 1960 but preliminary work suggests that the same sort of relationship probably applied in those years. Assuming this to be the case, these results can be of assistance in discussing the question of stabilisation of Smithfield prices over the course of the year.

Stabilisation of Prices and Sales Revenue

In the first place it does not appear as though much upward effect can be exerted on prices by a policy of reduced sales (or disappearances) and increased storage in periods of low prices since the equation given above indicates that prices will fall on account of increased stocks by just as much as they rise on account of reduced rate of disappearance. Similarly when such stocks are released in periods of high prices little downward effect on price is to be expected. This is simply because in setting its prices in the wholesale market the meat trade appears to be influenced not so much by the rate at which lamb is being released for sale on the wholesale market (i.e., disappearance) but on the rate at which it is arriving in the United Kingdom (i.e., disappearance plus change in stocks). Stabilisation of prices by adjustment of the rate of sales in the U.K. would appear therefore to be very difficult.

But stabilisation of prices is not an end in itself (and indeed in some circumstances can be a positive disadvantage). Maximisation of sales revenue is surely the main goal of marketing policy and this could still be secured by a better disposition of sales throughout the year by selling less in periods of low prices and more in periods of high prices. The difficulty here, and it is of course a major difficulty, is that of forecasting the high and low priced periods of the year.

The alternative to adjusting the rate of sale of supplies within the U.K. is to control the rate at which those supplies actually reach that country—in other words by holding greater stocks in New Zealand and adjusting the shipment of lamb to the United Kingdom in order to maximise returns.

And since, as I have said above, it is basically the rate of arrival of lamb in the U.K. which influences prices and, since we have control over that rate, then we have, through our control, some ability to forecast prices over the year.

This is the conclusion reached by Mr W. B. Taylor of the Applied Mathematics Department of D.S.I.R., who has conducted a slightly different analysis of price fluctuations in the lamb market to that presented above, and derived from it a suggested schedule of monthly arrivals and sales designed to increase producers' returns from the sale of lamb.¹

In considering this idea I think we would want to be assured that the changes in stocks of lamb held in New Zealand did not have just the same effect on prices as those in the U.K. We should also remember and allow for the fact that an increasing proportion of our lambs is by-passing the wholesale market and flowing direct to retail consumers at prices which we know very little about; and above all of course there are the great difficulties of administering this sort of marketing control within the framework of our existing marketing set up.

Nevertheless this is an approach which should be assiduously followed up and we intend to do so as part of our economic research programme at Lincoln.

Conclusion

To draw this paper together I might point out the parallelism between the two sorts of analysis I have described this morning. The first one leading to suggestions with regard to raising the proceeds from our lamb by rearranging the disposal of supplies between different geographical markets; and the second, the rearrangement of supplies between different time periods.

Lastly may I repeat again that I've been more concerned this morning to describe the sort of problems we're attacking at Lincoln in the field of marketing economics and the methods used, rather than to present final results.

If the results are provisional, at least they show we are securing a deeper insight into the lamb market mechanism as it operates. And until we know more about how the system operates at present, we've little chance of suggesting improvements for the future.

¹—Taylor W. B. "Short Term Factors Influencing New Zealand Lamb Prices in the U.K." *Economic Record* Vol. 36 No. 76 568-581.

TABLE 1

Year	1 Average Season's Price of N. Z. Down x Lamb 29/36 lb	2 Index Number 1934-38 = 100	3 U.K. Cost of Living Index 1934-38 = 100 (1 - - 2)	4 Ratio of Lamb Prices in U.K. Cost of Living Index, i.e., Deflated Lamb Prices	5 U.K. Per Head Supply of Imported Lamb and Mutton	6 U.K. Per Head Supply of Fresh Lamb and Mutton	7 U.K. Per Head Sup- ply of all Lamb and Mutton (5 + 6)	8 U.K. Real Income Per Head	9 U.K. Per Head Supply of Poultry
	d.	1934-38 = 100			lb	1934-38 = 100			lb
1921 ..	11.52	156.1	151.9	102.8	17.7	7.8	25.5	75.7	2.7
1922 ..	11.40	154.5	123.5	124.7	15.1	7.8	22.9	80.0	2.9
1923 ..	11.32	153.4	117.4	130.7	15.1	7.5	22.6	83.4	3.1
1924 ..	11.42	154.7	118.1	131.0	13.3	7.6	20.9	83.9	3.1
1925 ..	11.88	161.0	118.1	136.3	14.1	8.1	22.1	85.2	3.6
1926 ..	10.03	135.9	116.1	117.1	13.8	8.8	22.6	86.2	3.8
1927 ..	9.53	129.1	112.7	114.6	14.2	9.5	23.7	91.8	4.0
1928 ..	10.06	136.3	112.1	121.6	14.6	9.6	24.2	93.3	4.0
1929 ..	9.19	124.5	110.9	112.3	14.4	9.2	23.6	94.9	4.4
1930 ..	8.77	118.8	106.0	112.1	16.2	8.5	24.7	93.3	4.6
1931 ..	7.46	101.1	99.2	101.9	17.9	9.2	27.1	91.8	4.6
1932 ..	6.08	82.4	96.5	85.4	17.2	10.9	28.1	91.6	4.6
1933 ..	6.62	89.7	94.5	94.9	16.5	11.2	27.7	95.9	4.7
1934 ..	7.23	98.0	95.2	102.9	15.9	10.0	25.9	96.4	4.9
1935 ..	7.16	97.0	96.5	100.5	16.4	9.2	25.6	99.6	4.8
1936 ..	7.33	99.3	99.2	100.1	15.5	8.7	24.2	101.8	4.7
1937 ..	7.54	102.2	103.9	98.4	16.4	8.8	25.2	98.8	4.7
1938 ..	7.62	103.2	105.3	98.0	16.6	9.6	26.2	103.4	4.5
1956 ..	24.21	328.0	266.0	123.3	15.1	8.5	23.6	124.7	7.8
1957 ..	26.98	365.5	275.8	132.5	14.6	8.6	23.2	127.1	9.4
1958 ..	24.71	334.8	284.1	117.8	14.8	8.2	23.0	129.1	11.4
1959 ..	20.30	275.1	285.7	96.3	15.7	10.6	26.3	133.4	13.4
1960 ..	24.86	336.9	288.3	116.9	16.4	9.6	26.0	139.5	13.0
1961									
Jan.-Apr.	21.10	—	—	—	—	—	—	—	—

Regression Equation Used in Diagram 1

$$Y = 263.6 - 6.53X_1 + 0.09X_2 \quad R^2 = .75$$

(0.7) (0.07)

where Y = Deflated Lamb Prices (Column 4 Table 1)

X_1 = U.K. Supplies Lamb and Mutton per head (Column 7 Table 1)

X_2 = U.K. Real Income per Head (Column 8 Table 1)

Other Equations Mentioned in Text for Annual Data

$$Y = 252.7 - 5.61X_3 - 7.11X_4 + 0.10X_2 \quad R^2 = .70$$

(1.6) (2.0) (0.1)

where X_3 = U.K. Supplies of Imported Lamb and Mutton per Head (Column 5 Table 1)

X_4 = U.K. Supplies of Home Produced Lamb and Mutton per Head (Column 6 Table 1)

$$Y = 255.4 - 6.55X_1 - 1.16X_5 + 0.24X_2 \quad R^2 = .76$$

where X_5 = U.K. Supplies of Poultry per Head (Column 9 Table 1)

TABLE 2

United Kingdom Supplies of Lamb and Mutton

	1938	1947	1950	1955	1957	1958	1959	1960
Net Imports from:	(000 tons)							
New Zealand .	184	253	271	247	247	257	295	308
Australia .	95	50	64	52	32	45	36	31
Argentina .	45	103	40	52	47	26	24	30
Other Countries	21	19	17	3	9	9	7	13
Total Imports .	345	425	392	354	335	337	362	382
U.K. Production .	211	117	149	174	199	190	246	224
Total Supplies .	556	542	541	528	534	527	608	606

TABLE 3
Monthly Lamb Prices, Etc., 1958

Month	Average Monthly Price 29/36 Dn. X Lamb	Disappearance of Imported Lamb = Supplies adjusted for Changes in Stocks	Stocks of Imported Lamb Mid Month
Month	d. lb	'000 tons	'000 tons
Jan. ..	25.5	21.5	26.2
Feb. ..	22.8	29.1	33.1
March ..	22.1	25.9	40.8
April ..	22.1	23.1	52.9
May ..	23.0	23.9	51.0
June ..	23.0	37.4	34.4
July ..	23.6	17.8	35.5
Aug. ..	24.5	28.0	28.1
Sept. ..	25.0	23.8	26.2
Oct. ..	27.2	19.6	20.2
Nov. ..	27.3	15.1	19.1
Dec. ..	26.5	17.9	19.9

Regression Equation used for Diagram 3

$$Y = 31.2 - 0.11X_1 - 0.13X_2 \quad R_2 = .89$$

(.03) (.02)

where Y = Monthly Average Price of N.Z. Lamb Smithfield (Column 1 above)

X_1 = Monthly Disappearance of Imported Lamb (Column 2 above).

X_2 = Mid Month Stocks of Imported Lamb (Column 3 above).

TRENDS AFFECTING PRODUCTION AND QUALITY STANDARDS

N. H. Law, Meat Industry Research Institute, Hamilton.

If New Zealand is to retain its place on world markets over the next 10 years it is my opinion that the whole chain of events covering the production of stock on the farm to the supply of our products to the consumer will require the closest scrutiny and examination. There is no room for complacency and for us to assume that what we have done in the past is good enough for the future, will be fatal.

We have been extraordinarily fortunate that the United Kingdom has been our best customer for so long, a market which is traditionally conservative and which, over the years, has been relatively consistent in its demands. Despite other developments I still think it will always be our best market for carcass meats for a long time to come provided we learn to control our supplies and maintain our standards. Nevertheless in recent years it has become painfully evident that this market can no longer continue to give us our best prices. Our surpluses thus must find new outlets. To open new markets without first establishing customer preference, market requirements and standards, is just asking for trouble.

At this point I take the liberty of quoting from a recent report by R. H. Bevin ("N.Z. Beef Production").

"Compared with lamb and mutton, beef tends to offer a broader appeal in the markets of the world, and commands with pork, a preference with consumers other than those of the U.K. where beef, mutton and lamb are freely eaten. This is shown in the consumption per head of the 'western' meat eating countries.

Meat Consumption Per Capita 1959

Country	Class of Meat			
	Beef and Veal	Mutton and Lamb	Pork	Total
1. New Zealand .	99	89	34	222
2. United Kingdom	61	26	44	131
3. U.S.A. . .	87	5	68	160
4. Canada . .	77	3	58	138
5. France . .	60	6	53	119
6. Western Germany	42	1	67	110
7. Denmark .	53	1	91	145

Source: U.S. Department of Agriculture Marketing Service.

This table indicates present consumer preferences taking into consideration the eating habits of people, which are determined in a large part by the types of food available to them. It also indicates potential markets, provided we can persuade the consumer to buy outside their immediate preferences. The North American market is a case in point for lamb, the consumption of which stands in 1959 at 3.4 lb per head. The Asiatic countries with their much lower standards of economic prosperity, offer

but limited outlets for our meat surplus. Japan with which trade has developed so much in the last few years has an average consumption of 8 lb of meat per head, but it has the compensating factors of a rising standard of national income, and a desire to add protein in the form of meat to the diet along western lines. Here the room for expansion is obviously developing and the enlargement of our trade relations has much to commend it. With a population of 90 millions any fractional increase in the national meat consumption soon assumes worthwhile proportions."

To exploit this situation therefore it is not sufficient today to rely solely on indoctrination of the consumer to dispose of New Zealand products as we have done in the past, but rather to try and find out consumer requirements and how to satisfy them. This is even more necessary now the need for opening up new markets is so urgent. In 1957 I made the point that the industry will have to take cognizance of the effects of the following factors in relation to our marketing policy.

1. The increasing standard of living in countries overseas.
2. Cost structure.
3. The fashion for both man and wife to work.
4. The technical development in the fields of plastics and packaging.
5. The appreciation by industry of the efficiency of centralised production, distribution and retailing.
6. The establishment of multi-purpose stores.
7. The increasing use of domestic refrigeration.
8. The need for easy and more speedy selection and cooking of product.
9. Uniformity and range of size of cuts to simplify the housewife's activity.
10. Car parking problems.

The housewife's time is becoming all important and has resulted in what is termed the philosophy of convenience, which, for one reason or another, is spreading throughout the world. Even in New Zealand these effects are already making themselves felt. This evidence more than confirms my contention that some form of market research should be actively undertaken in the very near future.

New Zealand lamb the world over is recognised as a remarkably uniform product. However, changes are taking place, new standards are being set and we, in turn, must change our thinking also.

The meat industry, in my mind, embraces the producer, the processor and the seller. Each has overlapping interest. The action of one can have repercussions on all the others. It is wrong, therefore, to consider in detail individual problems separately, but each as a part of a more complex whole. Furthermore one must not forget that at all times the customer calls the tune. What is good for the farmer may not be good for the processor, and what is good for both farmer and processor, may not be acceptable to the consumer. It is a question of co-operation between all parties concerned with one object only, namely to please the customer. This introduces customer preferences which in turn introduces quality standard.

As far as quality standards are concerned what evidence have we that New Zealand is making any genuine effort? Do the producer, the processor and the seller recognise the need for changes and has any effort been made on their part to meet them?

The producer, for instance, recognises the value of lightweight lambs, the demand for smaller joints, the importance of less fat. He is responsible for producing an animal having these attributes. This is a matter of farm planning, management and economics and how far the farmer is prepared to go to meet industry's requirements. I would only mention to the producer at this point, that the criteria for success in meat production and processing are defined by the retail purchaser. They are the price the consumer is prepared to pay, the amount purchased, appearance and eating quality of the meat—in short that which members of the public like best and will fetch the best price. You will notice in the list of criteria the producer and processor are specifically mentioned. Thus the farmer must take into account when forwarding his beef or lamb for slaughter, that they are in prime condition and in a state which will enable the processor to produce a product in first class condition. For a farmer to send his lambs full and dirty to the works indicates his lack of co-operation. The handling of stock pre-slaughter can affect adversely the quality of the meat. In these days of increasing productivity speedy throughput dominates the scene, and it would seem to me at times, that we are unwittingly deviating from those conditions which, in the past, have been recognised as being necessary to guarantee good meat quality. Stress and fatigue suffered by stock during its handling and transportation to the works for slaughter is harmful and every effort should be made to move stock carefully. The lifting of the ban by the present Government on the movement of stock by road transport has been a good move. I am not suggesting that all lambs should be transported by road. It is merely a question of the time factor. Where rail transport can compete in terms of time with road transport then there is no justification for using road transport. There have been many instances in recent years of stock being held for many hours at rail heads before loading followed by lengthy rail journeys under the most trying conditions of summer heat. Such a state of affairs I hope is past history. The farmer expects stock killed immediately on arrival. If lambs are empty and clean I have no comments. If they are full there is no question the works are presented with extra problems. The stock should be held, otherwise they require special treatment if quality is to be maintained. This is costly to the industry and ultimately costly to the producer.

As far as beef is concerned the producer breeds now for the chiller trade, the frozen trade and for the lucrative boneless beef trade. He has three strings to his bow and in the national interest all should be exploited to the full. Beef cattle are more sensitive than lambs and should be treated very much more carefully. Careful transportation to avoid bruising, calm handling to avoid the effects of fear, is essential. Whereas conformation and thickness and colour of fat has been, and still is of first importance as far as chiller and frozen grades are concerned, the sole criterion for boneless beef would seem to me to be good cutting out percentage and fat level. From this point of view the Ruakura experiment crossing Jerseys with Aberdeen Angus is of particular interest. We are assured that although carcass conformation and fat colour do not conform to normal accepted standards, the eating quality of the beef is excellent. Thus the farming community these days has the opportunity to produce three types of beef for world markets, two kinds of which must conform to normal standards, the other to a new standard. Whereas in the past the producers bred good quality stock on the hoof with all the desirable attributes as recognised by the trade of the day, today he has the opportunity of breeding stock suitable for the boneless beef trade where standards are less rigid, the only criteria being a good cutting out percentage and not too much fat.

Processor:

I have heard it said more than once within recent years that the export industry is doing little to meet the needs of the present situation. This is not true. Such people should take the trouble to make a few enquiries. They would then realise that some very difficult problems have had to be handled by the industry over the last few years, and which have been resolved to a large extent, despite the added difficulty of doing it without reducing throughput. It might be of interest to briefly review some of the significant changes that have taken place over the last 30 years, many of which in themselves have been revolutionary.

Some will remember the days of solo killing when each butcher was an artist in his own right. The increased kill of lambs rendered this system obsolete.

The introduction of the chain system in the early 1930's resulted in radical changes in thinking, organisation and in processing methods. Refinements such as the sticking box for lambs, the breakdown of the overall processing into job units, re-organisation of lamb boards, the use of the humane killer for beef, the re-organisation and adoption of mechanical aids on the beef board have all been introduced to streamline processing.

It is of interest that, apart from chilled beef, standards have remained relatively constant until the recent inauguration of the American beef and lamb trade.

The history of the chilled beef trade makes interesting reading, and the processor knows only too well that the slightest deviation from the standards that were set in the 1930's will result in his product being rejected on arrival in the U.K. It can be said that the chilled beef trade was a technical achievement of a very high order.

The next radical change was the introduction of blast freezing, largely for economic reasons following the cessation of the war in 1945. It always seems to me a pity that such a change takes place before a new system can be properly evaluated. However, it was circumstances outside works' control that were responsible for its adoption and as might be expected, serious repercussions followed.

All new systems have their teething troubles and can be abused, and it was partly due to the lack of technical information and "know how" which were responsible for much of the criticism which was later directed against blast freezing. Blast freezing is capable of freezing lambs in 18 to 24 hours as compared to three days. It reduces shrinkage during freezing to a minimum. It saves space and capital expenditure. On the other hand it posed the industry new problems. During storage more moisture was lost to the evaporator coils. Some considered that the bloom was adversely affected. We know today that carcasses can be case-hardened, resulting ultimately in distortion during transportation to the United Kingdom. Most of these problems progressively have come under control, using techniques which were new to the trade. The use of plastic film has controlled moisture loss in the store and has helped to preserve bloom. Carcasses can be kept clean. The days of a single double stockinette wrap are numbered.

Meanwhile the boneless beef trade to America commenced. Factors of little consequence in handling carcass meat became of importance in cut meats. The standards set by the American importers resulted in the New Zealand industry having to lift their sights. Moisture in the product had to be preserved to maintain appearance and cleanliness was given first priority. The standard of works hygiene had to be markedly raised since cut meat is a very perishable product. The industry is rapidly becoming aware that properly designed cutting rooms are of vital importance when handling pre-cut meats

to prevent shrinkage and spoilage. The time is coming when conditioned rooms for preparing pre-cut meats will be an essential part of each works.

Few realise the amount of technical effort that has gone into the fabrication of the standard pack for exporting boneless meats and the physical studies associated with the problem of freezing boneless meat enveloped in plastic and cardboard. The refrigeration capacity at each works has had to be enlarged to cope with the new situation.

Industry is becoming increasingly appreciative of the scientific approach.

The fact that little is heard of this trade in the press is indicative that the major headaches have been overcome. Even the elaborate inspection system adopted by the Department of Agriculture which has proved its value seldom calls for comment.

It is only natural that new ventures such as these are subject to considerable criticism when first started. But it is a tribute to the industry that these criticisms have ceased in so short a time. Today we produce chilled, frozen, boneless and pre-cut beef; and frozen, chilled and pre-cut lamb. Techniques used in the handling of lamb have been applied to beef. Extra plants have been installed to speed up throughput, and refrigeration capacity has been enlarged to cope with blast freezing of lambs and carton freezing. Special studies have been made of packaging. Inspection systems have been designed and adopted. Hygiene programmes have been worked out and integrated into the production line. Finally, modifications have been made to transportation specifications so that our product can reach each market in good condition.

In the past we have been principally concerned in the sale of carcass meat. Today we are entering a field of pre-cut meats, whole-sale and retail. The customer, in addition to demanding good eating quality, is demanding a product of the highest hygienic quality. More and more will the industry have to interest itself in the climate within the package. Bacteriology is going to play as an important part as chemistry in the control and maintenance of standards within works.

Meat Research:

In recent years the industry has made one further gesture in the establishment of the Meat Research Institute. Its purpose is to close the gap between the producer and the consumer. As it turns out it is rapidly becoming an integrating force within industry.

The aims of the Meat Research Institute are to foster, promote and undertake research in meat and meat industry on all matters appertaining thereto whether in New Zealand or overseas. The Department of Agriculture serves the producer. The Meat Research Institute serves the export industry. The Institute's permanent headquarters were established in Hamilton and were officially opened by the Governor General on March 4th.

To fulfil the broad terms of reference mentioned in the Aims of the Institute, four sections have been established: Microbiology to investigate spoilage; biochemistry to study the chemistry and physical properties of meat, engineering to improve plant operation and efficiency; and technical development to integrate fundamental information with technology. Our object is always to improve quality.

It is proposed that the Institute will carry out research of a more general and fundamental nature than undertaken by the scientific staff of the individual freezing works. It does not therefore

duplicate the service already in existence but provides an organization through which the industry will reap the full benefits of scientific knowledge.

A programme of work on meat can only be considered against the background of the nature of meat and of the meat industry itself. Meat is an extremely variable commodity. As every housewife knows it varies greatly in quality from joint to joint in every carcass. Further it varies from carcass to carcass depending on the species and breed of the animal. This variability also depends on the stage of development reached, the food eaten by the animal and the changes brought about by fear, fasting and fatigue. As the housewife's demands change, so the industry must respond. There is a growing demand for smaller and leaner joints for pre-packaged meat, and for processed and pre-cooked meats of many kinds. Against this changing background any programme of meat research must be envisaged. Not only is the Institute expected to solve problems of today but to attempt to forecast those likely to arise in the next 10 years or so.

There is an overlapping interest between the Institute and the Animal Research institutions particularly in matters associated with carcass quality and carcass evaluation. To the butcher and the wholesaler, quality relies on the level of proportions of various joints and proportions of lean, fat and bone. Much of this work can be done on experimental animals, but ultimately it will have to be extended to the normal line of stock as handled at the works.

The pre-packaged meat trade is a recent development and will expand. It is necessary to study the product within the package. One special field of interest is what has been called product climatology. In short, what does the product require in terms of atmosphere, temperature, lighting and other influences to ensure that it reaches the consumer in the most acceptable condition.

Off-cuts from the pre-cut trade pose another problem—their profitable utilisation. A Home Economic Unit planned for the Institute will undertake a measure of utilisation research as well as undertaking quality evaluation, recipe formulation and cooking studies on selected cuts designed for the overseas markets. There is an increasing need to advise overseas customers as to the best methods of thawing and cooking selected cuts of New Zealand lamb. The Home Economic Unit will have advisory and propaganda responsibilities aimed at helping the marketing of our products overseas.

Water is our most valuable commodity for export, consequently every effort should be made to reduce weight loss in carcasses and cut meats to a minimum. Plastic films help enormously in this problem so long as they are used intelligently. The meat industry's experience in the application of plastic films to its products so far is very limited, but there is no question that this situation will be remedied in the near future. Under moisture conservation comes the important question of controlled climates for cut meats. Cut meat loses moisture rapidly and is highly perishable. Optimum conditions for cutting rooms have still to be established and it is proposed to examine this question at an early date. It will not be long before air-conditioned cutting rooms will be seen in all works preparing pre-cut meats for export.

The evaluation of blast freezing is long overdue. Already fairly comprehensive study on physical aspects of freezing meat in cartons has been completed. Very shortly this will be extended to freezing carcass meat with and without plastic wraps under blast conditions,

the object being to accumulate physical data to guide industry in freezing design and operation.

Bacteriology standards are becoming increasingly important and much has to be learned in this field. It will not surprise me if bacteriological certification is not introduced before long. It is the Institute's responsibility to anticipate the day when standards will be discussed.

Finally, comes plant operation, design and performance. The scope of this field is very wide indeed. It covers power usage, refrigeration and processing. It is closely associated with good and economical housekeeping. It is an invariable rule that where there is good housekeeping the quality of the products is usually good. Instrumentation of processes for control purposes will assist in bringing this about.

The question of effluent disposal and control of trade wastes is becoming increasingly important particularly to those works located on inland waterways. The matter is of some consequence to both industry and the farming community. Much work has already been done but the problem is so extensive that further work is necessary. The industry's effort is limited by the resources at its disposal. There is no question that the Institute will have to undertake the resolution of many of the basic chemical, microbiological and engineering problems that exist.

These are but a few of the interests of the Institute. No mention has been made of fundamental studies which will be undertaken to accrue new information to support the applied studies.

Transportation:

New Zealand's requirements are:

1. Speedy turn round of shipping at the ports to maintain continuity of supply.
2. Efficient loading and unloading.
3. Steady storage temperatures during ocean transport.

New Zealand can help by improving loading facilities at the ports. The Bluff experiment is of particular interest. It is hoped over the ensuing years that much of the back-breaking effort will be taken out of loading at the wharves. This can be achieved by more extensive mechanisation. Quicker handling, particularly under summer conditions will benefit all our products. The practicability of buffer stores at ports accompanied with some form of mechanical loading as practised in the Argentine cannot be overlooked. In practice it has worked out well. It is true such ideas conflict with our present set-up at ports but as an investment for the future it certainly is worth considering.

It is interesting to learn that there is renewed interest in palletization. It has been employed for loading fruit for many years and could be equally applicable to loading cartoned meat. Experiments have recently been undertaken demonstrating that palletization of lamb carcasses is practicable. The system of chutes and slings in these modern days is rather antiquated and the time is near when there should be a more enlightened approach made.

Finally I refer to New Zealand's interest in transportation by air. The practicability of this venture lies in the field of economics. However it would be remiss of me not to warn the industry that if an experimental flight should ever be made it is of the utmost import-

ance that the consignment be given the best technical coverage. The success of the chilled beef trade was largely due to earlier shipments being given the full technical treatment. We cannot afford to have the first experimental shipment by air a failure. The prejudice created by a mistake in the earlier days of a new venture takes years to overcome. I trust I shall not be in office when New Zealand meat is consigned by rocket. I doubt whether I would care to give it technical coverage while it floats in orbit. Should there be any technical hitch at least New Zealand's reputation will not suffer. Burning up in space is a most convenient way of disposing experimental evidence—so sanitary!

From recent reports in the press it would seem my thoughts on this subject may be a little premature.

MEAT PRODUCTION ON THE FARM

David G. Baker, Farmer, Cave, South Canterbury.

Introduction

May I first give you a brief history and description of the country I farm.

It lies in the foothills of the Hunter Hills and is rated as second rate foothill brown-top country. It is twenty miles west of Timaru, ten miles from the nearest rail at Cave, in the Pareora River catchment area. The average rainfall is about 28 inches at the homestead which is roughly in the middle of the farm, and varies a good deal—several inches more on the higher end and several less on the lower country.

The total area of 1180 acres was purchased in three blocks. The homestead block my father bought in 1919—in a completely derelict state—much worse than had it been native. For some years he farmed according to the pattern in vogue in South Canterbury at that time—roughly a quarter of the area being cropped annually, in conjunction with sheep, lamb fattening, and a few store cattle. By 1930 he had almost given up cropping and by 1933 was grassland farming entirely, being one of the first in the area to make a study of pasture establishment, top-dressing and grazing management.

In 1941 we purchased an abandoned Government property of 430 acres, two miles distant. This block faces south, is badly drained, with a light covering of soil over puggy yellow and blue clays on the easier land, and over iron stone, sandstone or just stone on the higher ridges. About a third of the area was covered in dense gorse and a good deal more with scattered gorse. The area that had been worked, had reverted largely to rushes, cutty grass, sweet vernal and brown-top.

In 1943 a block of 350 acres bounding the home place was purchased—a farm also in poor condition, with a long history of over-cropping. We concentrated for the next few years on the development of this block, re-fencing, grassing, top-dressing, etc., and used the rough block more or less as a dumping ground for cattle in the winter, and carrying 300-400 ewes and lambs in the summer. Some of the easier country was top-dressed with lime and super, with little improvement, until 1951, since when we have first worked then resown out all the area that had even been previously cultivated. Having established pastures on the ground previously worked, I have since cleared and sown to grass most of the gorse area. The limited uncultivable area we spray when we have time.

General Management:

The area is not well suited climatically to small seeds, apart from the last several exceptional seasons. We are prone to wettish late summer months. Grain crops can also be risky. We are subject to north-west gales, and on the other hand mostly the heavy clay lies over an ironstone pan and the ground occasionally gets too soft to carry machines. Consequently for some years we have concentrated on pasture farming; the least productive pasture irrespective of age being ploughed in late winter or spring every year to be sown in turnips and Italian rye in January, and either into green feed or back to pasture the following February after as long a fallow as possible. Generally the pasture mixture has been 10-15 lb perennial rye, 6-8 lb H1, 2lb white clover, 4 lb Montgomery clover, with cocksfoot up to 6 lb on the drier paddocks and timothy up to 5 lb on the heavier land. A little dogstail has been sown particularly on the rough block.

Several other mixtures have been tried over recent years but I have come to the conclusion that in spite of its weaknesses in some

respects, as yet, on this country, there is nothing to replace the predominantly rye-white clover pasture. There is nothing else that will stand the punishment of continual hard grazing that our pastures have been subject to, during the last five droughty seasons, and come back if anything, better than ever. On the other extreme it has far greater bearing capacity than say timothy-cockfoot-white clover. I would like, however, to stress that I feel Montgomery clover is, in the initial stages of development of these clay soils, a most valuable soil conditioner and improver if it is allowed to reach maturity or nearly so, in the autumn. Also that in spite of what I have just said in regard to rye-white clover pastures, there will be, on highly developed farms, an increasingly important place for special purpose pastures in the future.

It has in the past been our general practice to put down a pasture with one ton lime and two hundredweight super, followed with half ton lime and two hundredweight super the next autumn and thereafter every other year. I feel that this practice is no longer necessary and am reducing considerably the annual expenditure, particularly on lime.

Supplementary Seed Crops:

The position as regard this has changed rapidly. Up until now, we have had large areas that we have been breaking-in in turnips and Italian rye or turnips and grass. This no longer applies, so we have gone back to growing an area of swedes and chou. Whereas we had for some years fattened the lambs left at weaning on grass, with ever-increasing stock numbers, I feel that although we can still fatten that way, it is too slow, and it means few of the pastures ever get a good spell from grazing with sheep which is an essential to good management. Consequently we have gone back to growing rape. We now therefore have a rotation of approximately 40 acres swedes and chou; 40 acres rape; 40 acres wheat; 40 acres green feed and 40 acres of young grass.

We have reverted to growing an area of wheat. While harvesting this in some seasons is risky, it is being done to cash in on the great build-up of fertility over the last 20 years and to give each block a further spell from grazing by any stock. We have been finding it increasingly difficult to get a good quick establishment of pasture and I hope that this rotation may help.

Generally we make about 6000 bales of hay and attempt to keep about half that quantity in reserve each year so that generally at this time of year we have about 9000 bales under cover. We also use between 600-1000 bales of lucerne hay each year which we buy in.

Autumn saved pasture is playing an increasingly important part as the years go by, but I find it is a difficult proposition, as seasonal differences alter the management of this so greatly.

No other cash crops are grown though an occasional catch crop of ryegrass, etc., has been harvested.

Stock Sheep:

The position here also has changed considerably over the last few years. Until seven years ago, all ewes were bought in as annual draft ewes and put to Down rams. As we were finding it difficult to buy good types of suitable ewes at reasonable values in any sized lines and our numbers were increasing rapidly we then decided to breed our own replacements.

For four years we put a Cheviot ram over the best of the ewes in the lines we bought. I do not propose here to go into any detail as to why we chose the Cheviot. (Professor Coop and I have previously agreed to disagree on this point.) Since then we have been putting the better Romney/Cheviot ewes to Perendale rams. Those ewes that have reared twin lambs reasonably well and those with

single lambs off fat have first preference irrespective of anything else. We go through the rest as weaned if we require more for the flock rams and take out those that still have a good udder, and are sound in wool, mouth and feet. The remainder are put to Down rams. Most years all sheep's feet are inspected and no sheep that has any sign of trouble is bred to flock rams.

The picture therefore at present is that since 1949 our sheep numbers, as we developed more country, have risen from 2400 ewes in 1949 to the last two seasons when we have had 3100 ewes and replacements. In all, with ewes, hoggets, rams, wethers, etc., there were approximately 4000 sheep last season.

In the five years prior to crossing our ewes, with all full mouth ewes and Down rams we had an average lambing of 122 per cent. In the past five years with a mixed age flock including an average of 700 two-tooths, we have averaged 132 per cent even though last year we had only 126 per cent. I hope this is partly seasonal, though a good deal may be due to lack of shepherding.

We also put the tops of our hoggets to a Down ram but not with much success. At the best, about 70 per cent of those put to the ram rear a lamb—at the worst only 20 per cent. I am completely at a loss as to why this should be.

So far we have kept all ewe lambs bred, but have only put those with better performance to flock rams. Little or no attention has been paid to wool either for quantity or quality. Nor do we intend to do so until we have a flock that will reproduce abundantly and consistently do the progeny well. It is interesting to note that we shear from a mixed age flock of this cross just about the same weight of wool per ewe as we did previously from caste-for-age Romney ewes. I am convinced that four of these sheep will do well on poorer type soils where three of another breed would give trouble. That being so, the difference in wool production would be well on the side of the cross. They are active and easy to handle.

The pattern on this property follows closely that of others with a similar history of pasture improvement, extensive top dressing and increasing stock numbers. While our weight of meat per acre has increased no end by sheer weight of numbers, individual lamb weights (and very often grading too) are on a definite downward trend. An answer to this problem is difficult. Perhaps the scientists may soon be able to tell us if it is—

- (1) Merely the old story of a sheep's worst enemy being another sheep.
 - (2) The problem of pH—it would appear that the ideal pH on one soil type may be quite different from that of another.
 - (3) An unbalance caused through forced feeds and constant pasture land farming,
- or some factor not connected with any of these.

Cattle:

We have a herd of 160-180 Hereford breeding cows mated to Polled Angus bulls. For the past few years owing to the dry conditions calves have been sold as weaners. Prior to that our practice was to run 100-odd cows; keep the progeny and fatten them by the following autumn. In many ways the cows suit me better. Most winters I put them out on rough grazing for some weeks and never hesitate to do so, for it is a much cheaper way of wintering them than on hay and saves much pugging of pastures in the winter. Sometimes I felt that the calves, which must be wintered well to be worth while, were being well done at the expense of the sheep, and when the spring growth got away they didn't eat anything worth while anyway.

However, it is essential to have cattle and this season we have reduced the ewe flock to 2850 and have less ewe lambs (by accident,

not design), and will keep the calves through, do them well, and see how it works out. My intention is to keep the ewe flock to that number and increase the cattle numbers considerably.

Last winter we had our cows out grazing but the winter being an open one, we sold surplus feed for lighter cattle which saved much pugging and we more than recouped our expenses on the cows, which were themselves far better off for a good long walk and rough grazing.

General Stock Management:

I have already mentioned how we select our ewes for the flock rams. This is done as the lambs are drafted fat or weaned.

We shear as soon after weaning as possible, generally starting at New Year. We start with the ewes to be sold out and finish up shearing the ewe lambs. This year we also shored the wether lambs, which we had not done for several years. This I'm sure is a paying proposition but time and labour are vital factors at that time of year. I have toyed with this idea of pre-lamb shearing with a view to spreading the work and relieving the pressure in December-January. As yet I feel that the risk in our climate is too great with the limited amount of shelter we have. Another factor which deters me, is that it has been fairly definitely proved that the nearer tugging shearing is done, the greater the chance of ewes taking the ram.

I do not agree with the practice of putting ewes on bare maintenance from weaning until flushing though of necessity we have had to do this for several dry autumns. We make a practice of putting the whole flock through the foot bath every week or ten days from shearing through until near lambing.

Rams are put out about 20th March with a little variation according to the outlook for spring feed. For a number of years (until this year) we have raddled the rams at tugging time. This is much work but has several great points in its favour.

(1) It is possible to divide the flock into lambing mobs fairly accurately and saves work then.

(2) The flock has to be brought into the yards every fourth day or so for those raddled to be dotted and drafted-out, and while doing so they go through the foot bath regularly at a vital time of year.

(3) It is much easier on the rams and less rams can be used as those ewes dotted are drafted off and put away with an old ram or two to catch those that come back.

(4) In a period of fodder shortage it has the added advantage that the mobs that have to be fed well for tugging are rapidly reduced as those taken out raddled can straight away be put on poor rations.

In my opinion it is much better practice to do ewes hard the first 8 to 10 weeks of pregnancy than after weaning. In fact I feel that it is essential to do so on a developed farm with heavy stocking, or it is impossible to give the improving plane of feeding, so essential in the latter stages of pregnancy.

We try to keep the flock even in condition after tugging, drafting out the older and poorer doers and running them ahead but keeping the whole flock reasonably short, until such time as we begin to step things up, firstly with meadow hay, then roots and hay, until by lambing they are on green feed and lucerne hay or autumn saved grass and hay if they will eat it. This way we have little trouble with sleepy sickness, bearings, etc. We are fortunate in having roads on two sides of the farm and it is only a matter of the time involved to give the ewes plenty of exercise. We try to give them at least a mile walk every day for the last month or more.

Hoggets are inoculated with triple vaccine before they go on winter feed and the ewes with pulpy kidney vaccine prior to lambing. Lambs are done for tetanus at docking time.

As near as possible, dropped ewes and lambs are set stocked, those with twins and singles being separated. We endeavour thereafter to leave them set stocked controlling the surplus grass with cattle, shutting up for hay, and if necessary topping.

We usually find it convenient to put the hoggets which were not put to rams out to feed in September. Even if we have the feed, which very often we don't, we need the extra scope to lamb 3000-odd ewes on the 750-acre block as there is little growth until late September on the cold block even in a favourable season. We find that the early ewes and single lambs do well in biggish mobs on turnips and grass or even swedes. They are shifted on to the other farm at about three weeks. This is one of several reasons why we separate twins from singles.

We draft first the early singles about the end of November and, of recent years, we have generally weaned as the various mobs have been drafted.

My father and I have picked our own lambs and shipped them on our own account since the market was freed, a policy that has paid handsomely over the years, and one which is enlightening as to how the freezing industry pays such handsome dividends even in the years when they profess to run at enormous losses.

Unfortunately I am not a fan for figures nor have I the time to keep extensive records. However, the following may be some indication of what is now happening on this property. In the 1959-60 season we shipped 3190 lambs at an average weight of 31 lb with 22 per cent of seconds. That is 84.6 lb of lamb per acre. In addition there were 61 rejects, a truly disturbing feature. These comprised a little of everything—no particular case being predominant. Also 840 ewe lambs were kept. We sold 800 old ewes—mostly fat.

From the cattle we sold 167 calves and kept 18 heifers and culls sold in December for £32. Ten cull cows and two bulls were sold fat.

In the 1960-61 season we have shipped 3170 lambs at an average of 32.5 lb with 22 per cent seconds; that is 87.75 lb of lamb per acre. We had 62 rejects. 680 ewe lambs have been kept and 950 ewes sold—mostly fat.

Apart from lambs' wool, we sold approximately 30 lb wool per acre. This I would think a little more than on an average of the last five seasons. The cows have 176 calves and we have sold 20 fat cull cows.

During recent years we have been getting between 50-60 per cent of the fattening lambs off the mothers by the first week of January. The bulk of them in early December.

Conclusion.

When I was asked to give this paper it was suggested that I may have some general views I would like to express about meat production in New Zealand. I have some views I would like to express and trust I will be forgiven if they are not necessarily about meat production.

The general apathy or rather the lack of any real concern for the future, the "She'll be right" attitude among farmers in particular, was the first thing that struck me on my return from overseas. I'm only too convinced and concerned that "She'll be far from right" in our industry and therefore in the country as a whole if we as farmers take the future for granted and make no effort to do anything constructive about it.

Of six months in Great Britain I devoted at least a month to the various aspects of our meat trade, the docks, the cool stores, the markets (both Smithfield and Stanley at Liverpool), traders and butchering concerns both large and small. I am convinced that we and the smaller freezing concerns are but pawns in the hands of the international combines, who deal in our produce indiscriminately to

engineer the market to suit their own ends. This could have been overcome to a large degree had farmers generally been interested enough in their own future, and really taken advantage of the open door policy, by shipping "Owners Account" or through our producer organisations when the market was freed. Unless something is done soon the day may not be far distant, with ever-rising costs, when our lamb, which, when all is said and done, is a luxury article, has reached the price that consumer countries will no longer afford to buy it, or drop to a price at which we can no longer produce it. While on the subject of lamb it was several times mentioned to me while in Britain, the noise that has been made here over the processing and quality of lamb for the American market. It is obviously and rightly resented there, that they who have been our main market for so long should be expected to accept lesser standards.

Of beef, any enquiries I made, without exception, drew the same comments. New Zealand beef was excellent, but until such time as continuity of supply could be guaranteed, the trade was not really interested. I came home convinced that the opinion of many of our leading men and one which they have endeavoured to impress upon us so often is correct. To put it in my own words, I feel that, nationally the racket of continually increasing the ewe flock by millions is suicidal until such time as new markets are found. We should aim at the same production from a reduced flock and build up cattle numbers quickly. One doesn't need to travel far to realise that it is a beef-eating world, as indeed our own figures of home consumption prove.

Few can realise who have not had the opportunity to see first hand just what we as wool producers are up against. I visited one concern, quite unofficially, which has since the war spent several hundreds of millions on extension and research in terylene, nylon and such synthetic fabrics. The wool producing countries of the world together, according to an economist of the International Wool Secretariat with whom I spent a morning, have spent but a minor fraction of the sum on wool research, that this one firm has spent. It would appear from this, and as it is food rather than woollen clothing that the undeveloped countries need, that meat will pay an increasing part in our economy at the expense of wool. Let us not forget that our position is anything but secure if we continue to live in a paradise with over-population and hunger on our doorstep.

We hear such a lot about increasing production and cutting down costs. In my opinion this is a physical and financial impossibility. There is one cost however, in particular, that to my mind is absurd and unnecessary. Have you stopped to think how much it is costing us to keep innumerable fat stock drafters in a job and a car? Doing a job which surely we should be able to do for ourselves.

A system of bulk buying has been developed by groups of farmers in Great Britain which could have value here, as our Farm Co-ops are no longer true co-operatives. I met the organiser of one such group who buys for them, all their fertilisers, feeding stuffs, and even farm machinery in bulk, direct from the manufacturers at wholesale prices. We have here an awful number of "middle men" getting a cut out of everything we produce, and everything we use to produce it.

Finally there is one other thing I would like briefly to mention. I do not wish for one moment to belittle in any way the grand job veterinary clubs and veterinary surgeons, both club and otherwise, are doing, but it would appear that there is a danger of the system becoming too highly organised. Would you like to be in a position of farmers in the United Kingdom where no drug, and few remedies are available, even in an emergency, without a veterinary visit and prescription?

BEEF CATTLE ON CANTERBURY PLAINSAND FARMS

P. M. Falconer, Adviser, Lauriston Farm Improvement Club.

Reduced prices for both fat lambs and wool have made many farmers consider the possibility of running beef cattle in place of some of their ewes and lambs. Beef prices remain comparatively favourable and the outlook for the world trade in beef is encouraging.

Farmers have been urged to make this change to beef from many quarters. Representatives of the Meat Trade and the Producers Boards, overseas visitors of all kinds and many prominent farmers are saying "Grow more beef."

In 1961 this suggestion catches many Canterbury farmers in a receptive mood, for apart from low lamb and high ewe prices there has been weather damage to small seeds, virus in the wheat—and probably a surplus of potatoes. A change might be as good as the proverbial holiday!

In earlier times the ownership of cattle was considered to be the hallmark of a good farmer and even today many people hold this view. Because of high costs, however, it is necessary for us to look carefully at the profitability as well as the aesthetic side of our farming. Most people, who are now considering the running of beef cattle, would do so in the hope that cattle were more profitable than the sheep that could be carried in their place.

The purpose of this paper is to try and establish the price levels under which it will become profitable for farmers to change from fat lamb and wool production to beef production.

Coverage of Survey.

Physical and financial records covering the 1956-57 to 1959-60 seasons were obtained from some 20 farms in Mid-Canterbury. These farms covered a wide range of soil types and different cattle policies varying from wholly fattening to breeding stores and including farms which did both.

The study covers only farms where all the feed grown could be utilised by sheep, and I suggest that this qualification covers most of our Canterbury Plainsland where the rainfall is under 30 inches annually.

There is no doubt that there is much South Island country (particularly the wetter hill country) on which beef cattle do not compete with sheep—indeed they complement them. There is a huge potential in these areas for beef cattle as a payable proposition and what I have to say in comparing the relative returns from cattle and sheep does not apply there.

I would also suggest that many of the larger plainsland farms could carry small numbers of cattle without interfering with sheep production.

Cattle Systems on the Plains.

The two main systems employed by Plainsland farmers are:
(1) the fattening of purchased weaner calves to chiller or heavier

weights. (2) Maintenance of a breeding cow herd producing calves for sale as (a) weaners, (b) vealers, (c) 18 to 20 month old chillers.

I would place most emphasis on the calf to chiller policy as I consider this the most likely system to be successful under plainsland conditions. It has been the most payable for the last few years and would best fit in to our livestock stratification if adopted on a large scale.

Let me clear up a further point.

In any comparative economic study of systems of farm management it is necessary to take a long term view. I can site many cases where short term cattle policies different from those I have mentioned have been highly remunerative in one or other years. Similarly many sheep dealers have made higher returns than the farmer with the standard fat lamb flock. For any useful comparison on district or national scale we must consider only policies which the majority of farmers could follow—not special systems which would break down if more than a few farmers were to adopt them.

Thus I have little to say about the opportunist cattle farmer whose success depends largely on his ability at the saleyards—or his contacts in the industry.

Stock Rate Comparisons.

Before discussing the relative profitability of different types of stock farming, it is necessary to establish what relationship there is between the feed requirements of different classes of stock. In short, how many ewes do we replace if we put on one cow or one steer? How many chillers can we fatten if the ewes are reduced by 500?

I have already said that this study is confined to properties where sheep can make use of all the feed grown. In these Canterbury Plains of ours there are tremendous variations in the country that answers this description, with soil type, climate and irrigation as three critical factors.

You are familiar with the Ashley Dene idea of managing the farm to suit the seasonal feed supply. Essentially this entails early lambing, high percentages of lambs fat early in the season so that there are minimum stock numbers over the dry part of the year. The whole pattern of management fits in well with the natural growth of the land I am speaking of.

When we come to discuss the feeding of the cattle, however, a wide difference between the supply by the pastures and demand by the cattle is evident.

The chiller fatteners seldom get cattle away before February—certainly not in any great number. Even when cows calve in July (which I commend) few farmers are weaning before March. This means that cattle numbers or rather feed demand under these two systems is at a maximum during the dry time of the year. What happens of course is that they are fed on hay and/or roughage conserved in the flush of the season when they cannot keep pace with the growth. On some farms the ewes are done very hard after weaning to give the cattle free range. May I point out that hay is made at a cost, that standing feed deteriorates and disappears—particularly in our normal Canterbury summer, and that starving ewes produce less wool.

The lighter and drier your farm is the more sheep you will have to forego to produce 50 chillers. Of course, if you have irrigation,

you can keep the growth going over the whole of the summer period. You can irrigate over Christmas and New Year while your dry land neighbour is at Picton. At any rate you will need to give up less ewes than the dry land farmer—just as you have less holidays and better sleep.

Adjusted Conversion Ratio.

Most of you are familiar with the expression "Ewe Equivalents" and the idea of rating carrying capacities or feed supplies in terms of so many breeding ewes. The most common and generally accepted conversion rate is 5 ewes to 1 cattle beast. This agrees with feeding standards laid down by several authorities but these standards are largely determined by experiments with stall-fed animals. But we are dealing with grazing animals under farm conditions.

Meat Production Trials at Ruakura and Winchmore.

Meat production trials at the Ruakura Animal and Winchmore Irrigation Research Stations have shown that it is possible to produce similar weights of meat per acre using sheep, cattle or sheep and cattle together. Let us have a look at the stocking rates in these trials.

At Ruakura five 50 acre farmlets were stocked at the following rates:

- (1) 8 ewes per acre.
- (2) 6 ewes per acre plus $\frac{1}{3}$ cattle beast per acre bought in in the spring.
- (3) 4 ewes per acre plus $\frac{1}{3}$ cattle beast per acre.
- (4) 30 breeding cows plus replacement heifers plus 12 yearlings and 12 fattening steers (say 1 cow to the acre).
- (5) 40 bullocks wintered plus 20 to 30 bought in in the spring (say 1.1 bullocks to the acre).

If we compare the other stocking rates with systems (1) (8 ewes to the acre), we find that in systems (2) and (3) one beast replaces 12 ewes. In system (4) 1 cow replaces 8 ewes, and in system (5) 1 bullock replaces 7 ewes.

However there is no doubt that these farmlets were stocked at different intensities and these figures are not a true guide. Miss D. E. K. Walker, who conducted these trials, has suggested to me that after making allowance for the difference in stocking intensity one would conclude that:

- 1 chiller equals 7 ewes.
- 1 cow equals 7 ewes.
- 1 mature bullock equals 8 ewes.

If we substitute these values in the Ruakura trial we get a very fair picture of the stocking intensity on each farmlet and the suggested conversion rates seem quite real in this case.

Let us come nearer home and refer to work done at the Winchmore Irrigation Research Station. Stocking rates in the meat production trial here have changed since it was started in the 1956-57 season but for the 1960-61 season just concluding the stocking rates have been as follows:

- (i) 7.5 ewes per acre ($\frac{1}{2}$ ewe per acre below Ruakura).
- (ii) 4 ewes plus $\frac{1}{2}$ cattle beast per acre.
- (iii) 1.1 chiller beast per acre.

If we compare (ii) with (i), we find that 1 beast replaces 7 ewes. If we compare (iii) with (i) we find that 1 beast replaces 6.8 ewes. I have quoted these Winchmore and Ruakura figures in detail but the information I have from farmers fully supports my contention that the accepted conversion ratio of 5 ewes to 1 beast is too low.

On one farm which is now running nearly as many cattle as sheep, comparisons of stocking rate were made before the change-over and also with stocking rates on several adjoining farms. The cattle farm is stocked at the rate of .9 per acre of summer grazing. The sheep farms alongside stock at the rate of 6 ewes per acre or better, which gives us 1 beast to 7 ewes. On most properties the cattle and sheep were grazed together over the spring and summer, but in winter it is usual for the beasts to be run separately. On one property where accurate details were available, both cattle and sheep were wintered on hay and autumn saved grass.

Each cattle beast had the same amount of hay as 7.3 ewes and the hay was fed mainly from the same stacks although the cattle had some poorer quality hay early in the winter. 2,400 ewes were fed 5,669 bales of hay or 2.4 bales per ewe. 108 calves were fed 2,245 bales or 20.8 bales per calf. Thus each calf had as much hay as 9 ewes.

I would comment here that during at least one year at Winchmore there was twice the hay fed out on the cattle-alone block as on the sheep-alone block; and most farms I visited fed cattle at about a quarter of a bale per beast and sheep at 2½ bales per 100, when both had similar pasture pickings. In other words, each beast ate the same amount of hay as 10 ewes after more hay had been made because the cattle could not eat their share of the spring feed.

On every farm where I made comparisons like these, I got an answer of between 6 and 7.5 ewes per chiller and between 7.5 and 8.5 ewes per breeding cow.

I suggest that if you are changing over from sheep to cattle that you must divide your ewe numbers by 7 to find out how many chillers you can fatten and by 7.5 to 8 if you are considering a breeding cow herd.

Cost of Running Cattle.

The first thing which comes to mind when one mentions cattle on a sheep farm is fencing. There is no doubt that cattle are harder on, and require better fences than sheep. If you have only sheep fences, then you must budget for expenditure on barb-wire, more posts and heavier gates—or electricity.

Let us consider a farm of 400 acres carrying 1,500 ewes where the farmer is considering changing over to 1,000 ewes and cattle (72 chillers). There will be about 600 chains of fencing on the farm and it will cost about 20/- a chain to make it cattle proof—a total of £600. Interest on this money plus repairs and maintenance and depreciation is going to cost £60 per annum. This is 16/8 per chiller or in other words a cost of 2/5 per ewe per annum to fit the fences for cattle.

Cattle yards will also be needed if only for trucking cattle and although there is a wide variation in the yards which you might build, most farmers would spend about £150 in the materials and labour. On the same basis as above, this represents a charge of 7d per ewe per annum.

As I mentioned earlier there is more hay fed to cattle than to sheep on an acreage basis. This would amount to at least half a bale of hay per ewe annually at a further cost of 1/3 per ewe.

Provision of adequate water, and damage caused by cattle to water races and irrigation channels can be significant items on all properties. Cattle pugging can also cause serious pasture damage in the winter time.

Savings in Running Cattle.

One man can look after more acres stocked with cattle than with sheep, and many people use this way of trying to overcome awkward labour situations.

Not only do cattle provide less work, but they are more flexible than sheep. The main cattle jobs can be fitted in between urgent sheep work to avoid the same peak demands for labour that there are on a wholly sheep farm.

Every property will be affected differently by the labour complications of cattle but I suggest that one man can look after twice the area stocked with cattle than he could handle with a fat lamb flock.

The total labour costs (wages, housing, etc.) on Mid-Canterbury fat lamb farms amount to approximately 20/- per ewe. Where cattle are run I believe this cost is reduced to 10/- per ewe equivalent on a farm fattening chillers, and to 12/6 per ewe where a breeding cow herd is involved.

To this saving of 7/6 and 10/- per ewe must be added a further 2/6 per ewe saving in shearing and crutching costs.

Additional stock and veterinary expenses in the form of wool-packs, drench, dip, inoculation, footrot control and possibly Selenium occur on sheep farms. These amount on the average to approximately 2/- per ewe which is a further saving on the chiller farm.

Pregnancy diagnosis and inoculation against contagious abortion would cost about 4d per ewe equivalent in a cow herd so that the saving in stock expenses here would be 1/8 per ewe.

A Summary of Annual Difference in Expenditure per E.E. on Chiller Farm.

Saving		Extra Expenditure	
	s. d.		s. d.
Permanent labour	10 0	Fencing	2 5
Shearing-crutching	2 6	Cattle yards	7
Stock expenses	2 0	Extra hay	1 3
		Nett saving	10 3
	<hr/> 14 6		<hr/> 14 6

On this basis there is a saving of 10/- per ewe in expenses with chiller production and 7/6 per ewe when running a breeding cow herd.

Returns from Sheep and Cattle in 1956-57 to 1959-60 Season.

Table I shows the gross profit received per beast from beef, and per ewe equivalent from the sheep and wool accounts on three farms for the 1956-57 to 1959-60 season. These farms were breeding their own replacements and buying calves which were sold 10 to 14 months later as chillers.

TABLE I
Profits per Beast and per Ewe 1956-57 to 1959-60

		Purchase Price of Cattle	Sale Price of Cattle	Gross Profit per Beast Bought	Gross Profit per E.E. from Sheep & Wool	
1956-57	Farm A	9.5	30.9	21.4	4.1	} Ill Thrift
	B	21.9	37.0	15.1	4.3	
	C	13.0	28.4	15.4	5.9	
1957-58	Farm A	17.0	31.0	14.0	4.3	
	B	16.8	46.8	30.0	4.3	
	C	15.3	36.3	21.3	4.4	
1958-59	Farm A	20.1	33.5	13.4	3.5	
	B	25.9	42.8	16.9	3.7	
	C	17.3	30.6	13.3	3.9	
1959-60	Farm A	20.0	33.8	13.8	3.5	
	B	19.6	41.5	21.9	4.0	
	C	14.2	34.4	20.0	4.2	

Although these farms were following the same policy great variation in their results is evident. However, I am sure that these three farms represent a reasonable picture of the comparative returns in these four years.

Table II shows the average figure from these three farms together with an adjustment for the different expenditure of 10/- per ewe as established earlier.

TABLE II
Adjusted Gross Profit per E.E. from Beef and Sheep from 1956-57 to 1959-60

	Av. Gross Profit per Beast from Beef	Av. G.P. per Beast from Beef per E.E.	Av. G.P. from Sheep and Wool per E.E.	Adjusted Av. G.P. from Sheep per E.E.	Additional Profit from Sheep per E.E.
1956-57	17.3	2.5	4.8	4.3	1.8
1957-58	21.8	3.1	4.3	3.8	.7
1958-59	14.5	2.1	3.7	3.2	1.1
1959-60	18.3	2.6	3.8	3.3	.7
Average for four years	£18	£2.6	£4.1	£3.6	£1

This shows that for the four years under consideration these farmers were reducing their nett profit to the extent of £1 per ewe equivalent by running cattle. In other words it was costing them something like £7 per beast per annum for the satisfaction of running cattle.

Figures from five farms which ran breeding cows and sold calves over the same period show an adjusted gross profit of only £2 per ewe equivalent from cattle. This means that there was a margin of over £1/10/- per ewe in favour of fat lamb production over breeding cows on these farms. It means also, that the calf breeders on fattening country would have been better to fatten their steer calves than sell them as weaners during this period.

1960-61 Season.

At this stage you are all thinking of the £30-£33 calves that have been sold this year so let us look at the season just concluding. Unfortunately the farm records are not yet completed and we must estimate the position. I have prepared three partial budgets to show

the position of the farmer who has improved his property so that he can support a further 500 ewes or their equivalent. He could use the increase by:

- (i) Carrying more ewes.
- (ii) Fattening chillers.
- (iii) Breeding calves for sale.

The details of these estimates are included as an appendix but the adjusted gross profits per ewe equivalent are as follows:

(i) Fat lamb farm	=	£3 5 0
(ii) Fattening chillers	=	£3 1 0
(iii) Breeding cow herd	=	£3 3 0

We see that this year the calf producers are showing a profit of 2/- per ewe more than those fattening chillers but they could be still losing money compared to the fat lamb producer. All the same the gap is very narrow.

Marginal Prices.

How far can lamb and wool drop before these cattle policies will show a true profit? As a help to solving this problem I have prepared tables made up from a series of partial budgets similar to those in appendix A.

The tables which are included in appendix B show the adjusted gross return per ewe equivalent from these three stocking systems at different price levels.

If good steer calves are going to sell for £25 for the next few years and beef remains at £7 per 100 lb for chiller grade, lamb can drop to 15d and wool to under 2/6 per pound before it will pay Plainsland farmers to produce beef in place of lamb.

Similarly if prices such as 17d for lamb, 3/- for wool and 130/- for chiller beef are the rule, you will need to purchase calves at about £17/10/- to run cattle profitably.

Conclusion.

Most cattle farmers give one of the following four reasons for their carrying cattle:

- (1) To ease labour demand.
- (2) To benefit sheep health and control growth.
- (3) To make more money.
- (4) To satisfy themselves.

(1) Cattle can be a most useful but usually a temporary expedient in easing labour difficulties.

(2) Two farms I have visited with the highest cattle-sheep rates also have the poorest sheep health.

(3) Returns are surely dependent on relative prices and costs which I have attempted to cover in this paper.

(4) This is a free country and I sincerely hope that many people will be able to continue running cattle for the fourth reason—because they like it.

Without further falls in the prices we receive for sheep products, it seems that this is the only sound reason for running cattle in significant numbers on Canterbury Plainsland farms.

Acknowledgement.

This study was commenced while I was on the staff of the Farm Management Department, Lincoln College, at the instigation of Prof. A. H. Flay. I am greatly indebted to him for assistance and to the Executive of the Lauriston Farm Improvement Club for allowing me to proceed.

Many others have given me assistance—particularly the farmers who have supplied much confidential information. Also Mr Walker of the Winchmore Irrigation Research Station and Mr F. L. Ward of the Meat and Wool Boards Economic Service. To these and many unmentioned, I am most grateful.

APPENDIX A

SHEEP AND WOOL ACCOUNT

500 E.Es. as Self Replacing Fat Lamb Stock

Numbers:

430 ewes	@ 1	=	430 ewe equivalents
100 ewe hoggets	@ 2/3	=	66 ewe equivalents
7 rams	@ 1	=	7 ewe equivalents

503

Stock Performance:

Lambing	=	100 per cent survival to sale
Wool weight	=	10 lb ewes, 9 lb hoggets, 9 lb rams
Deaths	=	5 per cent overall
Age	=	ewes last 4 to 5 years

Income:

Lambs—220 prime	3,316 @ 17d	=	514	
110 seconds	32 @ 16d	=	237	
(100 ewe lambs retained)				751
Cast Ewes—40 1 year ewes	@ 30/-	=	60	
35 to works	@ 20/-	=	35	
				95
Wool—415 ewes	@ 10 lb	=	4,150 lb	
98 hoggets	@ 9 lb	=	882 lb	
6 rams	@ 9 lb	=	54 lb	
				<u>5,086 lb</u>

5,086 lb . . @ 38d nett = £806

Gross income from sheep and wool = £1,652

Purchases:

Two rams @ £16	=	£32
Gross profit from sheep and wool	=	£1,620
	=	£3/5/- per E.E.

CATTLE ACCOUNT

500 E.Es. as Chillers Fattening

Numbers:

72 chillers purchased @ 7 E.Es.	=	504 E.E.
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Stock Performance:

Deaths = 3 per cent (2) with bloat and misadventure.

Sales:

68 chillers @ 580 lb @ £7 per 100 or		
£41 on place	=	2,788
2 carry overs @ £30 value	=	60
		<u>£2,848</u>

Purchases:

72 calves @ £22	=	£1,584
Gross profit from chiller fattening	=	£1,264
	=	2.53 per E.E.
Adjusted gross profit per ewe equivalent	=	£3/1/-

CATTLE ACCOUNT

500 E.Es. as Breeding Cow Herd 1960-61

Numbers:

58 cows to calve	@ 7.5 E.Es.	=	443 E.Es.
9 yearling heifers	@ 5 E.Es.	=	45 E.Es.
2 bulls	@ 8 E.Es.	=	16 E.Es.

504 E.Es.

Stock Performance:

Calving 93 per cent.

Deaths 3 per cent (2) with bloat and misadventure.

Sales:

24 steer calves	@	£30	=	£720
15 heifer calves	@	£25	=	375
6 months cull calves	@	£15	=	90
1 fat heifer	@	£40	=	40
6 fat cows	@	£35	=	210

£1,435Less commission on calves 3 per cent on 1,185 — 35£1,400**Purchases:**

Bulls: Cost 100 gns each and last for 5 years

Sold @ £50 each.

£110

Annual cost = $\frac{5}{110}$ = £22

Gross profit from breeding cow herd = £1,378

= 2.76 per E.E.

Adjusted gross profit per ewe equivalent = £3/3/-

APPENDIX B**Gross Profit per Ewe Equivalent from Fat Lamb Production**

Lamb Price for Prime 29-36 lb Grade	Wool Price Nett per lb	Gross Profit per Ewe Equivalent		
d.	d.	£	s.	d.
18	48	3	15	0
18	42	3	10	0
18	36	3	5	0
18	30	3	0	0
17	48	3	13	0
17	42	3	8	0
17	36	3	3	0
17	30	2	18	0
16	48	3	11	0
16	42	3	6	0
16	36	3	1	0
16	30	2	16	0
15	42	3	4	0
15	36	2	19	0
15	30	2	14	0
15	24	2	9	0
14	41	3	2	0
14	36	2	17	0
14	30	2	12	0
14	24	2	7	0

Gross Profit per Ewe Equivalent from Chiller Beef Production

Calf Price (Good Steer Calves)	Chiller Beef Price Per 100 lbs	Beef Price Per Beast	Margin Per Beast	Adjusted G.P. Per E.E.
		£ s. d.	£ s. d.	£ s. d.
£15	100/-	29 0 0	14 0 0	2 7 0
£15	110/-	31 18 0	16 18 0	2 15 0
£15	120/-	34 16 0	19 16 0	3 4 0
£15	130/-	37 14 0	22 14 0	3 12 0
£15	140/-	40 12 0	25 12 0	4 0 0
£20	110/-	31 18 0	11 18 0	2 1 0
£20	120/-	34 16 0	14 16 0	2 9 0
£20	130/-	37 14 0	17 14 0	2 17 0
£20	140/-	40 12 0	20 12 0	3 5 0
£20	150/-	43 10 0	23 10 0	3 14 0
£25	110/-	31 18 0	6 18 0	1 7 0
£25	120/-	34 16 0	9 16 0	1 15 0
£25	130/-	37 14 0	12 14 0	2 3 0
£25	140/-	40 12 0	15 12 0	2 11 0
£25	150/-	43 10 0	18 10 0	2 19 0
£30	120/-	34 16 0	4 16 0	1 0 0
£30	130/-	37 14 0	7 14 0	1 9 0
£30	140/-	40 12 0	10 12 0	1 17 0
£30	150/-	43 10 0	13 10 0	2 5 0
£30	160/-	46 8 0	16 8 0	2 13 0

Gross Profit per Ewe Equivalent from Calf Production

Price of Top Calves	Adjusted Gross Profit per Ewe Equivalent
£12	£1 15 0
£15	£2 1 0
£20	£2 7 0
£25	£2 15 0
£30	£3 3 0

N.B.—General average quality cow beef is estimated at 100/- per 100 lb and boner bull at 130/- per 100 lb in all cases.

EXTERNAL PARASITES OF SHEEP

L. K. Whitten, Parasitologist, Wallaceville Animal Research Station, Wellington.

In New Zealand all sheep should be dipped once a year as required by the Stock Act. This dipping aims primarily at controlling the body louse or biting louse. On some properties there may be other problems, the greatest of which is probably blowfly strike in some areas. In other areas it may be itch mite infestation and on other properties—particularly those selling stud rams—it may be scrotal mange.

In the time available to me today I propose to discuss the various parasites that occur on sheep in New Zealand and later, if time permits, to consider some aspects of control.

The most important parasite, in the view of the Department of Agriculture, is the biting louse and as I have mentioned the Stock Act and its regulations aim to control this pest.

The parasite itself spends its whole life on the sheep: its eggs are laid attached to the wool fibres and when the young lice hatch they usually remain on the host animal. Of course lice will transfer from one sheep to another but this is usually achieved only during periods of close contact—such as occurs in crowded yards or trucks. It is conceivable that lice could transfer from one sheep to another via some inanimate object but as they can live only for short periods away from the sheep, this mode of spread is quite unimportant. Heavy louse infestation results in considerable irritation and the fleece is damaged by the constant rubbing, biting and scratching.

The ked is also a common parasite in New Zealand. It is considered to be of less importance than the louse because it appears to cause less irritation. Keds however do stain the wool and such wool has a lower value. As a general rule measures designed to control lice also control keds.

Another parasite that is quite common, though generally little notice is taken of it, is the leg louse or foot louse. This louse differs from the biting louse, in that it is classified as a sucking louse and it lives on blood rather than material from the skin surface. The leg louse is larger than the biting louse, it is bluish in colour and may be found on the feet, or fetlocks, but in some cases heavy infestations may be seen on the scrotum of rams. Leg lice tend to be more difficult to control—possibly due in part to their lower susceptibility to insecticides but also in part, due to the fact that the retention of such materials on the feet is less certain.

Another parasite that infects similar regions of the body is the chorioptic mange mite. This mite causes itchy heels in horses, mange in cattle, and while it also infests the legs of sheep it is seen more frequently on the scrotum of rams where it causes a thick, scabby incrustation of the skin. There is some evidence that it reduces fertility and this might be expected since sperm production proceeds normally only at temperatures lower than body temperature and severe lesions of the scrotum would almost certainly reduce heat loss. This parasite too, is fairly difficult to control and more work is necessary before we can make confident recommendations.

Itch mite infestation occurs mainly in fine-woolled sheep and Mr Doyle will be discussing it in detail later.

Another parasite which we have seen recently is *Demodex*. This is a small, elongated mite that lives in the wool follicles. We know

very little of its importance or its distribution, but we do know that no satisfactory treatment for it is available at the present time.

Blowfly strike should really be considered as two separate diseases, one is crutch strike and the other body strike. They tend to occur under two sets of conditions and only rarely are they seen in the one flock at the same time. Crutch strike occurs when the wool of the crutch is rendered attractive to the fly by prolonged wetting—usually with urine. The skin becomes inflamed and bacterial growth occurs in the soiled wool. For this reason ewes are much more frequently struck than wethers. Body strike usually occurs during periods of repeated showers, when the high humidity prevents the fleece drying out. Bacterial growth in the fleece and mycotic dermatitis may precede body strike. Most fly strikes seen in this country are primary strikes, and may be caused either by one of the brown flies or by the green fly, *Lucilia*. The latter appears to cause most of the strikes. On rare occasions a primary strike is followed by a secondary strike and these are always caused by a bluish-green fly, *Chrysomya*. This fly is unable to set up a strike by itself but only lays its eggs on a primary strike that is already well established. The maggots of the secondary fly are hairy maggots in contrast to the smooth ones produced by either of the primary flies. In recent years there have appeared in various parts of the country strains of flies that are highly resistant to dieldrin and aldrin. In strains that have been tested at Wallaceville, doses about 400 times greater have been required to kill these flies. Resistance of this order makes further use of dieldrin on those properties quite out of the question.

We are fortunate in the fact that of all the resistant strains so far tested have been fully susceptible to the organo-phosphorous insecticides so that with these compounds good control can be achieved.

EXTERNAL PARASITES OF SHEEP

H. Doyle, Livestock Superintendent, Department of Agriculture, Christchurch.

Of the external parasites affecting sheep in New Zealand the body louse *Damalinia ovis* and the ked *Melophagus ovinus* are the most common. The majority of farmers are well aware of the existence of these two parasites and have for a great number of years been adopting measures for their control. The maggot stage of blow-flies *Lucillia sericata* and *Calliphora stygia* can be included in this category.

The parasitic condition due to Itch Mite infestation is not so widely known in New Zealand and it is with this which I propose to deal more fully.

The Itch Mite of sheep has for many years been known to occur in Australia. It was first described by Wormersley in 1941 and by Carter in the same year, but evidence collected by Graham in 1943 showed that symptoms of infestation by this parasite have been known in Australia for almost forty years.

It is only within recent years that this mite has been recognised in New Zealand. The first recorded case in this country was in Mid-Canterbury in 1953. The next cases diagnosed were in 1958 when the condition was found to be effecting sheep on two properties. Since that time Itch Mite has been diagnosed on over forty properties. While the majority of cases have been in South Canterbury, infested sheep have been found on properties in Mid-Canterbury, Marlborough and other districts. The relatively high number of cases diagnosed to date in South Canterbury is probably due to the fact that more investigations have been carried out in that area by the Department of Agriculture's Veterinarian at Timaru, than has been done in other areas. As investigations proceed in other districts where fine wool sheep are grazed it may well be found that the incidence is equally high.

The causal agent is a very small mite called *Psorergates ovis* which can be detected only by the use of a microscope. Diagnosis can be made by microscopic examination of skin scrapings.

The life cycle appears to consist of six stages and is completed from egg to adult in about five weeks. All stages of the mite are found on the surface of the skin or under its superficial layers. It is well to remember this fact when considering treatment.

Symptoms generally shown are those of skin irritation. Biting or rubbing of fleeces is frequently observed. On some properties excessive sanding of fleeces due to rubbing has been quite noticeable. Sheep in the yards may be seen biting at their sides or thighs or may rub against posts or fences. The fleece damage caused by biting is mainly confined to the areas along the sides and thighs as these are parts that the sheep can reach. Signs of the condition may also be seen on the flanks and rump but rarely on the back. The reason for symptoms not being evident on the back is due to the sheep being unable to chew the wool of that part. As a result of biting and rubbing, small tufts of wool may be pulled from the surface of the skin. Loose tassels of wool may hang from the sides or thighs. Where wool damage is severe the sheep presents a rugged appearance and the fleece may become badly cotted and difficult to shear. These symptoms are not always shown, as in some cases an excess of dry scurf in the wool and on the surface of the skin may be the only sign of the condition.

Spread is from one sheep to another by contact and takes place more readily from freshly shorn sheep. Spread from a woolled sheep to other sheep is not frequent and may take a considerable length of time. The disease is only slowly progressive and spread of mites over an affected sheep and through a flock is usually slow.

The sheep affected in New Zealand have been fine wool breeds. Merinos appear to be more easily infested than halfbreeds and stronger wool breeds. Sheep of all ages are affected. As evidence of infestation on an infested sheep usually develops slowly the most serious cases tend to be seen in the older age groups, young sheep may, however, become heavily infested and suffer considerable fleece damage.

Although Itch Mite infestation has been observed in New Zealand only during the last few years, it is very probable that the parasite responsible has been present in our fine wool sheep for many years previously. No doubt the mite was kept in check by arsenical dips which until a few years ago were commonly used for the control of lice and keds. With the swing over to some of the more modern dipping materials which are effective against lice and keds but not effective in controlling Itch Mite, infestation with this mite has become obvious.

In countries like Australia where the condition has been known to exist for a greater length of time than in New Zealand, more work has been done on methods of control than is the case in this country. We can benefit considerably from the work of overseas scientists who have carried out extensive trials to determine which insecticides are most effective against the Itch mite.

Lime-sulphur appears to be the most effective material available to control Itch Mite. For total eradication of the mite the only effective method seems to be plunge dipping or showering in lime-sulphur solution containing 1 per cent of polysulphides within a few weeks of shearing.

Arsenical dips apparently reduce the mite population but do not kill all the mites. Rotenone has also been shown to reduce Itch Mite numbers but is not considered as effective as arsenic.

Gammexane, dieldrin, aldrin and diazinon appear to be ineffective in controlling Itch Mite.

Lime-sulphur although highly effective against Itch Mite is ineffective against lice and keds. It is unpleasant to use and is comparatively expensive. As this dip is irritant to wounds, sheep should not be dipped off shears but time given to allow such wounds to heal. Care must be taken that sheep do not inhale or swallow the dip.

While arsenical dips do not totally eradicate Itch Mite they appear to effectively control the parasite and keep infestation sufficiently low that damage to the fleece is not evident if dipping is carried out each year. Arsenical dips are effective against lice and if the dip also contains rotenone keds also can be controlled. They have the added advantage that they are cheaper than lime-sulphur.

Irrespective of which effective material is used in treatment it is essential that the fleece be wetted down to the skin. This can be done by the use of a plunge dip, it can also be attained by the use of a shower dip provided the sheep carries not more than about one month's wool growth and all precautions are taken to ensure that the sheep are thoroughly wetted.

As a precaution against the introduction into New Zealand of sheep affected with Itch Mite, the Department of Agriculture require that sheep imported from Australia be accompanied by a certificate showing that they have been shorn and dipped in lime sulphur solu-

tion not more than 30 days before the date of shipment and that after dipping they have been kept in isolation until shipped.

Before concluding I would like to say a few words on control of lice and keds.

As you are aware it is compulsory under the Stock Act that all sheep be dipped or dusted between 1 August and 30 April. Materials such as arsenic, derris, gammexane, dieldrin, aldrin and diazinon have proved very effective for the control of lice and keds. With the introduction of easier methods of application a greater majority of sheep are now dipped than was previously the case, this is evident by the reduction in the number of lice infested sheep observed in sale-yards.

While most farmers carry out their obligations and dip their sheep annually, the period allowable in which dipping must be carried out is quite extensive and it may well be that in problem areas considerable benefit would be got if farmers in such areas could arrange to dip their sheep within a more limited space of time and combine in an effort to ensure that all sheep in the area were actually dipped. This would do much to ensure against re-infestation from stray sheep.

As an example of what can be achieved in this respect I would like to quote briefly a scheme which was carried out in a problem area in the vicinity of Christchurch.

The scheme was successful only because the farmers in the area were right behind it and adhered to the resolutions carried out at the first meeting.

The main points of the scheme were:

All sheep in the area were dipped between certain dates, in this case between 1 and 28 February.

All sheep coming into the area were dipped immediately even though they had been purchased as dipped sheep.

The area was divided into five blocks with two farmer representatives from each block. These farmers made up the executive.

The dipping operations were commenced at block 1 and continued along the line until dipping was completed in the area.

All stragglers were dipped before returning them to their owners. All hermit sheep were destroyed.

While one block was being mustered adjoining blocks were patrolled to stop stragglers from passing from one property to another.

This scheme was carried out for three years and the district is no longer a problem area. Its complete success was due to the fact that farmers pursued the scheme with vigour and enthusiasm and a determination to overcome all problems associated with such a scheme.

FARMING IN BRITAIN

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Government Support and the Development of British Agriculture

In order to get British agriculture in the right perspective it is revealing to look at its recent history. In 1840, with a population of 20 million, the U.K. was largely self-sufficient in food, and during the period of great industrial expansion until 1875, agriculture thrived until some 18½ million acres were under the plough—the highest ever. That figure is now approached today, as can be seen in Table 1. From the late seventies onward, a decline set in, and

TABLE 1
Approximate Acreages of Crops and Grass, June, 1960
United Kingdom

	Thousand Acres
Cereals	7,680
Potatoes	830
Sugar-beet	440
All other crops	2,240
Total arable crops	11,190
Temporary grass (leys)	6,870
Total arable land	18,060
Permanent grass	12,820
Rough grazing	18,000
Total arable + p. grass + r. grazing	48,880
New Zealand	
Sown pastures	18,000
Montane tussock, etc.	13,000
Fern, scrub, trees, market gardens, etc.	12,000
Total occupied land	43,000
Acreeage of cereals	250
Acreeage of potatoes	24

apart from a pronounced stimulation in the First World War, the bottom of the trough was not reached until 1933. The main reason was due to cheap food flooding the market from America and Oceania, which halved the prices of farm produce because Britain adhered rigidly to its policy of free trade and refused to protect its farmers. In 1933 various Acts were passed affording some protection, particularly for cereal growers, and the first subsidies were paid for lime and basic slag. The Second World War began with only a slightly rehabilitated agriculture, low arable acreages, much tumbled down grassland, degenerated drainage systems, dilapidated buildings and hedges, and much dog-and-stick farming. Labour forces were low and most farms were undercapitalised. Cheap, imported feeding-stuffs were the basis of intensive production of milk, pigs and

poultry. There were few tillage implements and in some areas the techniques of arable cropping had been largely forgotten.

With the threat of war hanging heavily over the country in 1939, the Agricultural Development Act passed in June, provided a ploughing-up subsidy of £2 an acre for grassland which had been down at least seven years—now reduced to three years—and this initiated the ploughing up of six million acres of grassland. By 1943 the net output of human food had increased by over 70 per cent. in terms of calories and protein, and made possible a reduction in volume of food imports of 50 per cent. More wheat, potatoes and sugar-beet were grown, pig and poultry numbers were slashed, dairy cows increased because of the nutritional value of milk, beef cattle and sheep numbers fell slightly. Many subsidies were introduced; guaranteed prices were fixed for the major products; distribution of fertilisers, feeding-stuffs, machinery and labour was controlled and compulsory orders were issued. The total volume of farm products rose to 125 per cent. of the pre-war level.

These war-time policies were continued for some years after the war because of world shortages of food, dislocation of trade, balance-of-payment and exchange difficulties. Rationing did not end in Britain until 1954 when meat was the last foodstuff to be derationed. It was generally agreed that Britain must grow more of her own food even if prices were above world levels. The government set out to regulate, control and protect agriculture by the passing of the 1947 Agriculture Act. This aimed at promoting "an efficient and stable industry, capable of producing such part of the nation's food as was considered desirable and to produce 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". Annual reviews were to be undertaken between the Minister of Agriculture and the N.F.U. for fixing guaranteed prices and assured markets. There was great flexibility in the nature of the guarantee. Subsidies could be given in the form of acreage payments, and for promoting better farm practices, for example, by subsidising nitrogen and phosphate fertilisers. Quantitative limits could be put on the amount of any product for which a market was guaranteed. Targets for net output were set and have been consistently raised and reached, until now it is near 170 per cent. of pre-war production—the highest in history. Acreages and stock numbers are contrasted with New Zealand in Tables 1 and 2, and the net output (forecast) for 1959-60 is shown in Table 3.

TABLE 2
Stock Numbers 1959

	(Thousands)	
	U.K.	N.Z.
Dairy cows in milk	3,300	1,900
Total cattle	11,290	5,970
Sheep	27,600	47,000

Carcase Meat Produced 1957-58

	(Thousand Tons)
United Kingdom	1,775
New Zealand	688 (442 exported)

TABLE 3
Net Output of Agriculture. U.K.
Forecasts 1959-60

		£ million		
Output			Input	
Farm crops			Feeding-stuffs 427	
Wheat	78		Machinery, fuel, etc.	206
Barley	75		Fertilisers	69
Potatoes	70		Livestock	52
S. beet	34		Seeds	33
Oats	12		Others	151
Others	11			
			Total input	938
Total crops	280			
Livestock			Value of net output =	
Pigs	186		Total output — Total input	
Cattle and calves	184		= £744 million.	
Poultry	89			
Sheep and lambs	77			
Total livestock	536			
Livestock products				
Milk and products	343			
Eggs	234			
Wool	18			
Other	9			
Total livestock products	604			
Horticulture		186		
Sundries	76			
Grand total output	1683			

It is worth noting that the pattern of expansion has not always been as planned. Certain products, particularly wheat, milk, pigs and eggs have been over-stimulated, and the cost of maintaining prices against cheaper imports has been excessive. In spite of switches in the subsidies designed to expand production of beef, mutton, home-grown fodder and particularly grass, as the potential savers of most foreign exchange, it appears to be easier to stimulate general rather than selective expansion and much easier to stimulate expansion rather than contraction, except by more drastic reductions in subsidies than allowed by yet another Agriculture Act of 1957. The main aim here was to offer long-term guarantees to stimulate production of beef and sheep, and the Government agreed not to reduce the total guarantees by more than 2½ per cent. in one year and on any individual commodity by more than 4 per cent, and for any livestock product by more than 9 per cent during any three-year period. It looks to me as though the N.F.U. under the able leadership of Lord Netherhope could see the writing on the wall, and were extracting from the Government all they could while the going was good, because as world conditions began to improve, the N.F.U. demanded and obtained pretty adequate guarantees for the future, and furthermore the same Act provided that substantial grants,

amounting to one-third of the cost of approved schemes, could be paid to help farmers and landlords improve buildings and fixed equipment.

The Minister of Agriculture got little in return for these subsidies except the power to evict unsatisfactory farmers and landlords, but this has been so ineffective that it was repealed in 1958. Remarkably enough this was opposed by the N.F.U. because they thought they might have to pay in other ways. The result is that the main instrument now possessed by the Government for controlling production is the manipulation of prices and subsidies, and as they can only drop the total exchequer support by 2½ per cent. a year, you can calculate how long it will take to do away with subsidies, at this rate of decrease. Some of the guaranteed prices for 1960-61 are shown in Table 4 and the total cost of Exchequer support in Table 5.

TABLE 4
Guaranteed Prices U.K. 1960-61

	s.	d.
Fat cattle (per live cwt)	157	0
Fat sheep and lambs (per lb dressed carcase weight)	3	3
Fat pigs (per score deadweight)	45	10
Hen eggs (per dozen)	3	11
Wool (per lb)	4	5½
Milk (average per gallon)	3	1.45
Wheat (per bushel)	14	5
Potatoes	260	0

TABLE 5
Estimated Costs of Exchequer Support to Agriculture 1959-60

	£ million
I. Implementation of Price Guarantee	
Cereals	58.2
Potatoes	1.0
Eggs	36.5
Fat stock—	
Cattle	3.4
Sheep	25.9
Pigs	21.3
Milk	8.5
Wool	3.0
Total I	157.8
II. Farming Grants and Subsidies	
Fertiliser subsidies	29.0
Lime subsidy	11.0
Ploughing grants	9.3
Drainage grants	2.3
Calf subsidy	16.4
Grants for farm improvements	6.3
Others	20.3
Total II	94.6
Totals I and II	252.4
Administrative overheads	5.5
Total	257.9

This total of £258 million is now about two-thirds of the net national agricultural income, and merits one or two comments at this stage. The £58 million paid out to support the price of cereals is the largest item, but remember that some 7½ million acres (more than one-third of the arable land) are grown, and the guaranteed price for wheat at 14/5 a bushel, is less than is paid to the North Island farmer, although it is about 1/- more than what the South Island farmer gets. This hides the fact of course that nitrogen and phosphate fertilisers are subsidised and ploughing-up grants may have been made. The major trouble is that prices fixed to act as an incentive to high-cost producers inevitably mean that low-cost producers make a substantial profit. High prices and complete security can militate against technical progress just as much in agriculture, as we know they do in industry in New Zealand. There has been a definite trend, and I think it will continue, for indirect subsidies such as fertilisers, lime and drainage subsidies, to increase at the expense of guaranteed prices, because they have the advantage that they cannot be obtained without carrying out the work they are designed to promote. (A thought that might be worth injecting here is that if ever New Zealand agriculture needs a shot in the arm, and a clear sign was the drop in consumption of fertilisers in 1957-58-59, the Government could subsidise the use of fertilisers. It would only cost about £6 million to pay half the fertiliser bill for the whole country.)

A New Zealand farmer might rightly ask if these subsidies are justified. Without them, Britain would be growing much less food than she does now, which at present is about half the food eaten compared with one-third before the War. However, if Britain went into the world markets for a higher proportion of her food, then prices would almost certainly move against her. Less home-grown lamb and milk, for instance, would mean higher prices for New Zealand farmers, and perhaps little if any overall financial gain for Britain. Her agriculture might just survive at the expense of considerable suffering by the human resources and the deterioration of the material resources. I have little time for those who advocate the continuation of the subsidies on strategic grounds. If there were another war, it would probably be over so quickly that the preparedness or otherwise of British agriculture would be unimportant. If sanity prevails and ushers in a long peaceful era, then no political party, in my opinion, will long continue to prop up British agriculture, although without repealing the 1957 Act the support can only decline slowly. Finally, it might be noted that New Zealand subsidies—call them consumer subsidies if you like—are about the same percentage of the national income as in Britain.

Farm Output

Whether subsidies are justified or not, there is no question that farming is big business in Britain today, as can be seen in Table 3. The total output (forecast) for 1959-60 was nearly £1700 million. The two largest items are for milk and eggs, followed by pigs and beef, with poultry exceeding mutton and lamb in value. Among the crops, wheat, barley and potatoes are the most important. On the input side, the figures for feeding-stuffs, livestock (e.g., store cattle from Eire) and seeds are for imported products. The outstanding figure is for feeding-stuffs, of which some £180 million goes to dairy cows, and the rest mainly to pigs and poultry. This is about six or seven times the cost of fertiliser in New Zealand.

Farm Income

The average net farm income which includes payment for manual or managerial work and interest on farmers' own capital was estimated at £160 per annum in 1937-38 and £880 in 1955-56. The great number of farmers have small businesses and they live only slightly better than farm workers. Net incomes may be less for these people, whereas larger farmers and specialised groups do much better. A Farm Management Survey in 1955-56 showed that one farmer out of ten incurred a loss and one in 25 made profits over £5000.

While farm incomes have risen and in 1952-53 were on a par with the average outside agriculture, they are now falling behind. After allowing for inflation, farm income has fallen 12 per cent., while others have risen on an average by 24 per cent. In other words, like the Red Queen in Alice, farmers are having to run faster and faster merely to stay still. It is worth commenting briefly on this phenomenon. People have got inelastic stomachs and when they get an increase in income, most of it is spent on things other than food. There is usually a change of emphasis,, mainly shown by a lowered intake of carbohydrates and an increase in animal products—fewer potatoes and more beef, thicker layers of butter on thinner slices of bread. Another factor is that in competition with one another, farmers increase their efficiency and this results in a total output of food at a rate faster than demand increases. Hence the price of food tends to fall in relation to the price of other things and farmers' incomes tend to lag behind those of others in the community. Guaranteed prices tend to aggravate this problem, as to benefit from these high prices, output is pushed up even further, tending to lower the prices consumers are prepared to pay for the increased output and thus causing the subsidies to rise. This has applied particularly to pigs and eggs, where there has been over-production under good prices, and mounting subsidies, which are eventually cut by the Government reducing the guaranteed price. Milk is slightly different in that the price to the consumer has been controlled; instead of a fall in retail price there has been a surplus of milk to dispose of in the manufacture of cheese and butter—a factor influencing prices paid for New Zealand produce.

The real crux of the matter, however, is that if farmers were to move out of farming when their incomes fell below those in other occupations, the position would be corrected, because if people and capital moved out more quickly, this would mean lower output, higher prices and thus an increased income for those who remain. Somehow farmers, farmers' sons and labourers have got to be encouraged to quit the land and future policy must surely concentrate on increasing farm size. Economists should be pointing to Sweden, where small uneconomic farms which become vacant are bought by the Government, amalgamated and re-sold on the open market as a larger unit. A case might even be made out for special retirement pensions for old farmers! Larger farms should mean greater efficiency, lower cost production and inevitably, in the case of livestock products, lower output per acre. Unfortunately Britain has recently singled out small unprofitable farms for special aid and advice, and in the interests of long-term efficiency this cannot be good.

Machinery, Labour Buildings

There has been a very rapid increase in the development of mechanisation. Tractors, for instance, which numbered only 64,000 in 1938, were near 500,000 in 1956 (78,000 in New Zealand in 1960), and there has been a corresponding increase in other machines. Total

output of farm machinery was worth £3½ million before the War, and today the export value alone of farm machinery exceeds £73 million. The small size of many farms has limited the use of machinery, but during the war, machinery pools organised by County Committees played a useful part, and more recently farmers themselves are forming machinery syndicates of not less than two and not more than twenty farmers. The principle has been extended to include fixed equipment such as buildings for drying and storing corn. The number of labourers, which reached a peak in 1947, is now back to pre-war levels of about 600,000 and declining rapidly.

Wages of farm labourers have risen rapidly and the minimum wage is now £8/9/0 for a 46-hour week with overtime at 5/- an hour, so that a good cowman earns £12-£13 a week and perquisites. Labour for farm livestock amounts to about half the total labour used in farming, and there is no question that new or improved buildings would greatly reduce labour costs. A survey in E. Anglia showed that an average of 135 man-hours are needed per cow-year for cows housed and milked in traditional cowsheds, whereas the more efficient farmers keeping their cows in open yards and milking them in parlours use only 59 man-hours. Such improvements usually involve considerable capital expenditure and capital for development still remains a major problem. The breaking-up of large estates to pay death duties has encouraged the selling of individual properties and nearly 50 per cent. of all farms are now owner-occupied, so that many more farmers now have to find capital to purchase a farm as well as to run it. Many well qualified men now fail to get farms because of lack of capital.

It remains to comment on some present trends and practices.

Use of Fertilisers

Britain now uses five times as much nitrogen and potash and twice as much phosphate as before the War. Potash fertilisers are not subsidised and potash (60% K_2O) costs about £20 a ton. Super (20% P_2O_5) costs £16 a ton reduced to £8/10/- by a subsidy of £7/10/-. Sulphate of ammonia costs £21/10/- a ton reduced to £11/10/- by a subsidy of £10. There is little doubt that these quantities of fertiliser or even more are needed, as Belgium and Holland both use more per acre and get higher yields. A modern four-course cash-cropping rotation (potatoes, barley, peas, wheat) removes enormous quantities of nutrients compared with the old Norfolk four-course rotation, as shown in Table 6. Yields are higher due to better varieties, weed-killers, and fertilisers. New varieties of French wheat and Proctor barley respond well to nitrogen and resist lodging. They can get as much as 3½ cwt. per acre sulphate of ammonia and give extra profits of £10/acre. Average pre-war yields of wheat have risen from 30 to 50 bushels/acre, with the best farmers expecting more than 80. The best farmers produce wheat at costs removing their fears of competition from abroad.

Very heavy rates of fertiliser are now used on potatoes and sugar-beet—on the average potatoes get per acre, 5½ cwt. sulphate of ammonia, 6 cwt. super and 3 cwt. muriate of potash in England and 20 per cent. less in Scotland—with great uniformity from area to area. The 830,000 acres of potatoes get £15 million worth of fertilisers which is more than is spent for all crops and grass in New Zealand. There is little modification of fertiliser applications due to soil deficiencies, climate or place of a crop in a rotation, which is

TABLE 6

Losses of Plant Foods in Old and Modern Rotations

	lb per acre		
	Losses over 4 years		
	N	P ₂ O ₅	K ₂ O
Norfolk four-course . . .	57	18	7
Modern cash-cropping . . .	390	128	453

very unpalatable to agricultural scientists. There is little rational use of fertilisers based on scientific findings. But why worry much about fertiliser costs? Fertilisers are cheap relative to the value of crops and grass, and costs do not greatly affect the appropriate optimum levels.

In the drier Eastern areas there have always been some farmers who carry no stock and grow no grass. This practice has spread a little due to profitability of intensive crop production. Fears are regularly expressed that this will ruin the soils, and there are certain silty soils, now containing such little organic matter that structure has so deteriorated as to lower yields. In spite of rotary cultivators needed to beat some of these soils into temporary submission, and the heavier dressings of fertiliser needed, it is becoming increasingly difficult to maintain yields. On the other hand many soils shows little sign of physical deterioration, and crop residues from higher yields due fertilisers, seem just able to maintain the soils in reasonable physical condition.

There is unquestionable scope for considerable improvement in herbage production, and much effort is being expended in this direction. I was disappointed with the general picture, and I think it is because of the utter confusion among the various "experts"—agrostologists, soil chemists and fertiliser firms. For instance, at the International Grasslands Congress in Reading, Dr. W. Davies, Director of the Grasslands Research Station, in one and the same breath, called white clover a weed, said we must rely on grass/white clover associations and that he wants to see British farmers using the equivalent of a ton of sulphate of ammonia/acre on their grass. The last two objectives are hardly compatible. A few farmers are relying on clovers as their major source of nitrogen: an increasing number, particularly of small dairy farmers, are forgetting clovers and using heavy dressings of nitrogen fertilisers; the majority are making little use of either. There is a lot of nonsense talked in Britain about the climate not suiting clover and that clover will not fix as much nitrogen as in New Zealand. In some of my own experiments in Britain clovers have fixed some 200 lb. of nitrogen per acre which is very similar to the best Canterbury figures. One of the troubles is that much of the grassland is so devoid of clovers that nitrogen fertilisers are really necessary; there are certainly very few people who would suggest introducing clovers into such grassland, correcting any deficiencies, and making the clovers do the job. Leys are often poor in clovers because they are sown down under a cereal crop, and clover establishment is frequently so poor that nitrogen has to be used the following spring to ensure reasonable production. This further discourages clover and the farmer finds himself in a vicious circle. There is no question that nitrogen will stimulate production where clovers are weak and unfortunately most experiments to test the value of nitrogen are carried out on such swards. In some cases this is because the experimenters have never grasped the first principles, and in others because fertiliser firms want to

promote the use of nitrogen. It was heartening to meet a few research workers who have "seen the light", and who are showing what clovers can do if given the chance. The results of one such experiment in Northern Ireland, given in Table 7, demonstrate a point I have been pressing for a long time, namely, that to us 2-3 cwt./acre of a nitrogen fertiliser on a really good grass-clover sward merely pushes up grass yields, depresses clover yields and scarcely affects total yield. Yet these quantities of nitrogen, where it is used

TABLE 7

Average Annual Yields of Dry Matter on a Newly Re-seeded Pasture
Getting Basal Phosphate and Potash

Nitrochalk	(All values as cwt./acre)		Total
	Grass	Clover	
0	38	31	69
2	47	24	71
4	54	19	73
8	71	8	79
12	84	2	86
20	102	1	103

at all, are probably the commonest levels applied. What most advisers and farmers have not grasped is that to greatly improve herbage production they must either use much more nitrogen or learn how to grow clovers. In this respect it is unfortunate that so much grass has to be cut for silage or hay because of the long winter, and clovers are inevitably suppressed by shading. In my opinion, Britain will go the way of Holland and use nitrogen more heavily. The only consolation for me is that it will keep up costs of production in comparison with New Zealand. Grass is so much cheaper a food than imported concentrates, that the use of nitrogen might even be profitable.

There has been remarkably little improvement of the moorlands and hills of Britain and no signs of any move back to the hills, in spite of large annual losses of land (estimated at $\frac{1}{2}$ million acres in the next 20 years) for roads, urban development, etc. These soils are desperately poor and costs of improvement by traditional methods are high; much will depend on whether new techniques prove useful, such as chemical ploughing, sod-seeding, pelleting and inoculation of clovers and aerial topdressing. Much of this class of land will probably be afforested or used for recreation.

Mention must be made of one important stock problem, namely, hypermagnesaemia—low blood magnesium—which is particularly serious and increasing in dairy cattle, but may also affect beef-cattle and sheep. A major contributory factor is the more intensive use of nitrogen fertilisers on grassland, as this automatically suppresses clovers which contain more magnesium than grasses. Potash fertilisers when used with nitrogen also lower magnesium uptake by grasses, and indiscriminate use of a new fertiliser supplying nitrogen and potash, proudly introduced by one of the big fertiliser firms, can almost be guaranteed to increase the incidence of hypermagnesaemia. I used the increasing incidence of this disease to press the case for more dependence on clovers, but the usual retort was that it could easily be prevented by feeding magnesium to the animals, whereas bloat was a more difficult problem. My usual reply was that it costs more to induce hypermagnesaemia than it does bloat, and if they were going to have trouble they may as well buy it cheaply!

Livestock

Dairy Cattle: The handling of cows has shown some improvement. There are increasing numbers of milking parlours, open yards for wintering, and I saw slatted floors in use, which help to reduce bedding costs. Grass-drying has almost disappeared during the last ten years, and more and cheaper silage is being made, particularly with the forage harvester. Self-feed silage is growing in popularity. I saw one example of zero-grazing, where grass is cut and fed to housed cattle; the major problem on this farm was that the area round the yards and farm-house would soon be covered with mountains of muck, as the farmer had not worked out how he could get the stuff back to his paddocks without it costing too much.

Beef: There are still a lot of farmers who winter beef to get muck, or summer beef to manage leys and merely keep the stock for their muck and company without looking for profit. Where beef has to make a profit, the trend is to run a single suckling herd, calving down in December or January. The aim is to sell the calves at about 8 cwt., off self-feed silage and intensively managed early grass during late winter to early spring in the following year at about 15-16 months old. A good many more Friesians are providing a lot of beef. The butchers like them because they carry less fat than beef cattle, and I shall not be surprised to see dual-purpose Friesians being bred!

Fat-lamb: Breeding ewe flocks—Welsh and Scotch half-breds, Clun and Kerry—giving $1\frac{1}{2}$ to $1\frac{3}{4}$ fat lambs per ewe when crossed with Suffolk or Hampshire Down rams—are fitting well into the more intensively managed ley-farming systems. I know of one farmer practising set-stocking who has carried six ewes and nine lambs on the average of three years, turning out 363 lb. of dressed carcase meat per acre, and grossing over £71 against costs of £15 for growing the grass. More silage is being fed just before and after lambing. Creep-grazing is proving very useful on these mixed cropping farms, particularly where parasites such as *Nematodirus* have been a problem in the past. The most progressive farmers do not now fear competition from New Zealand or the European Common Market.

Conclusion

In the early stages of a country's development, history teaches us that agriculture by exploiting soil resources provides the capital to develop industry, but that later, industry becomes so productive that it begins to support agriculture by pumping in capital, increasing soil fertility and promoting a more productive agriculture. In Britain at the present day we can see industry paying some of its debts to agriculture in the form of subsidies. (One cannot help wondering if industry will ever be in a position to pay its debts to agriculture in New Zealand.)

Nevertheless British farming is at the cross-roads. During the war and immediately after, the emphasis was on increased production. Now it is on more economic production. At each succeeding price review there is now considerable under-recoupment for increasing costs of production, and the gap must be bridged by more efficient production. The impact of the European Common Market, because Britain must surely join it if only for political reasons, will depend on what conditions can be negotiated. New Zealand and the rest of the Commonwealth will also be affected, but until some of the details to be negotiated are known, it is too early to forecast whether British and Commonwealth agriculture will gain or lose. What is certain is that the most efficient producers will weather the storms, and we may see some drastic upheavals before long-term stability is achieved, which must surely depend on good general monetary management affecting economic conditions throughout the world.

THE ECONOMICS OF MIXED ARABLE FARMING IN CANTERBURY

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I will attempt to assess the current position of mixed arable farming by judging some of the technical and economic possibilities and difficulties which face farmers in Canterbury under this system of farming. This is not an easy task as I discovered in preparing this paper, for, even if one were able to evaluate all the effects of changing supplies and demand of primary produce, both here and overseas, and could translate them into a series of supply and demand schedules, the answer could easily be contradicted by Government action.

It should be noted here, too, that this is but one of three papers prepared in loose collaboration with Messrs Hadfield and Morrison on various aspects of the subject under discussion. These latter two papers cover very adequately many features of Canterbury mixed arable farming in which this paper is so glaringly deficient.

All that can be done in this paper is to discuss:

1. Some technical advances in cropping and recent economic background notes.
2. Costs of production and relative profitability of crop and live-stock products.
3. Current performances of standard mixed arable farms and premium farms on medium fertility soils on which the bulk of our cropping farms are located and some observations on relevant managerial practices.
4. Some reasons why there is not a greater maximization of net profits.
5. Trends and prospects in the immediate future.

These to act as five pegs on which to make some observations and comments.

If one must define a "Canterbury Mixed Arable Farm" it could be a unit where income is, or could be, derived in equal or varying proportions from the production of sheep products, beef, cereal and pulse crops and pasture seeds without depleting soil fertility or harming its structure. I might add here that I have resisted the temptation of reviewing the historical aspects of this system of farming in Canterbury, particularly during the post-war years when sheep farming assumed complete dominance, reaching a peak in 1957. Suffice to say that since that year, particularly during the immediate past two years, farmers on our medium to heavy soils and downlands have quietly changed gears into a more intensive mixed system of farming. By capitalising on efficient managerial practices, not only has the fertility cycle been easily maintained but cash crop acreages, their yields and livestock production have been increased simultaneously.

These statistics give added emphasis to this observation.

CANTERBURY ONLY (A. & P. STATISTICS)

		1952	1957	1960-61
Breeding ewes	.. Number	3,903,479	5,185,591	5,744,497
Total sheep	5,700,867	7,305,360	7,862,399
Wheat Acres	60,387	41,864	116,000
Oats (threshing)	24,764	31,858	*19,113
Barley (threshing)	33,998	44,168	*39,717
Peas	14,863	13,570	*16,532
Potatoes	6,282	9,432	9,628

*1959—Latest Statistics available.

Thus it may be said that some farmers are apparently moving towards a mid-way stage between pure grassland farming and intensive mixed arable farming, where one would expect to see at least one half of farm income derived from cash cropping and pasture seed production. The speed and limits of this momentum will undoubtedly be governed by the prices prevailing for wool, lamb and, to a lesser degree, beef. A return to the remunerative wool and lamb returns of the early 'fifties would undoubtedly presage a re-emergence of all grassland farming dependence.

1. Some Technical Advances in Cropping and Recent Economic Background Notes.

We are apt to forget the many aids to higher production of crops which the farmer of fifteen or twenty years ago did not have at his command.

The Plant Breeder has provided in the past few years a series of discoveries in strains and varieties of plants which have not only improved yields, but are more resistant to diseases and respond more profitably to fertilisers and stored up soil fertility. This has been particularly the case with cereals where the average yields for wheat and barley in the drought year of 1958-59 were surprisingly high, and even in this erratic summer, the yields have been on a par with 1958-59.

The control of many pests and weeds by the application of chemicals to the soil, the seed, or the crop, has eliminated or controlled weeds and pests which previously depressed yields or perhaps necessitated costly cultivations. The number of different chemicals now available is bewildering, to say the least, but no doubt it is asking the impossible for the introduction of composite dressings of sprays that would guarantee overall protection or control.

The soil scientist in conjunction with the crop experimentalist has improved the methods of assessing plant food requirements, and the fertiliser industry has expanded the production and range of fertilisers. There is possibly still much to learn, particularly in the field of trace element relationships and deficiencies.

Mechanisation. We have entered the era of exploiting mechanised power in many different ways and with the current alleged farm labour shortage there will be even greater developments in the "further mechanisation of the farm worker." Certainly a farmer is in a much better position to cultivate the land, sow crops and harvest them at greater speed, at lower cost and, in most cases, more efficiently. There is a wide range of makes of machines on the markets, and one wonders whether the hard school of economic laws will one day

force a greater degree of standardisation and fittings of many machines.

Atomic research has opened up a new field to the agricultural scientist in that the workings of plants may be studied by using radioactive tracer isotopes. Atomic radiation gives a new technique to plant breeders.

Irrigation applied not on our typical light Lismore soils but on the higher fertility silts and clay loams could open up excellent new possibilities. A measure of this technique is, that whereas New Zealand's average production for cocksfoot seed is under 200 pounds per acre, under irrigation, yields compare with overseas production at nearly 800 pounds dressed seed per acre. Apart from the fact that most existing and projected schemes embrace soil types where the main crop under irrigation is, or would be, grass, the difficulty of super-imposing irrigation on an already existing economic system of farming is recognised as a major obstacle in any accelerated development of irrigation in Canterbury. In the near future, flood irrigation is unlikely to play a major part in mixed arable farming, although the benefits of sprinkler irrigation associated with high priced crops may gain wider acceptance.

Advisory Service. Farmers have at their command a wide range of advisory services backed, in most cases, by a large programme of agricultural research which has produced and disseminated much useful information, and could pay greater dividends in the future.

Advances in Grassland Management. Possibly to a greater extent than by any other means at present available, the arable farmer is poised to exploit to the maximum the pasture as a basis of fertility for arable crops. Many are doing this and increasing, not only aggregate crop production, but also total livestock production at no cost to soil fertility or soil structure.

In view of these aids to increased production, it is doubtful if they have been fully exploited by the farming industry—only a limited number are taking full advantage of them. Yet it is certain that Canterbury farmers, on the areas which can be legitimately referred to as suitable for mixed arable farming, are progressive and fully aware of the many aids available so we must look elsewhere for this reluctance to diversify and intensify still more. Before jumping to this obvious conclusion that the reasons may lie in lack of economic incentives, it should be realised that:

Although it has been proved that the areas under discussion are capable of supporting a wide range of crops, the market, with few exceptions, is an internal one. Thus there is a very definite economic limit to the production of arable crops and pasture seeds if gluts are to be avoided.

Pasture seed receipts have played a not unimportant part in farm income and farm development but, as overseas countries satisfy their requirements from internal sources, grass and clover seed production tend to assume less significance and become more of a gamble.

Increased arable cropping really boils down to a greatly expanded acreage of wheat. New Zealand's estimated wheat acreage in 1960-1961 was estimated at 170,000 acres with Canterbury contributing 116,000 acres. This acreage, at the average yield of 50 bushels per acre, could provide 8.5 million bushels of our total estimated requirements of 15 million bushels.

Canterbury farmers could provide a large proportion of the 6.5 million bushels, and, allowing for the expanding population, this could be equivalent to at least another 130,000 acres of wheat.

In 1959 when the price of wheat was raised to 13/6 per bushel it coincided with two closely inter-related events.

Fat lamb and wool prices eased.

Arawa and Aotea, two new varieties of high yielding wheat, were commercially released.

When one considers these points, particularly the obvious increased economic incentive to grow more wheat, in conjunction with all the increased technical aids available, it is rather surprising that wheat, in particular, is not playing a more dominating role in Canterbury's land utilisation pattern.

Perhaps a closer look at some of the economic and managerial facts and factors relevant to typical mixed arable farms, after a brief consideration of those nebulous computations, "costs of production" and "relative profitability," may shed some light on this apparent paradox.

2. Costs of Production and Relative Profitability.

It is not the purpose of this paper to construct a detailed cost structure (with all the attendant pitfalls) for each crop, but relative profitability hinges partly on costs of production. And having gauged relative profitability, the optimum combination of crop and livestock enterprises becomes clearer. It is rather striking when one examines some costings, to note how little the cost of growing an acre of any particular crop varies, despite the size of the farm or the degree of mechanisation. This is either a reflection on the system of costing or a reflection on some of the merits of mechanisation.

The cereal crops, wheat, oats and barley, involve similar costs within the range of £15-£18 per acre for a 45-50 bushel yield. Although it is some time since any potato costings have been requested, they would range somewhere between £80-£100 per acre although variations will occur due to such factors as different cultivation practices in different districts. What does vary is the yield.

Taking potatoes, for example, at an estimated cost of £90 per acre for a 6-ton yield, a yield of 10 tons per acre (a not uncommon yield), markedly reduces the fixed costs and presents a much healthier proposition if they can be sold. The same principle applies to other cash crops, other than pasture seeds, which, with few exceptions in Canterbury, are regarded largely as catch crops.

In physical terms, in order to cover the average costs of production, yields of approximately 30, 40 and 50 bushels of wheat, barley and oats respectively are necessary. Every bushel produced over and above these yields is straight profit apart from variable costs.

What makes costing so difficult is that cash crop production in Canterbury is complementary to other farm enterprises, particularly as regards fertility build up and maintenance, and supplementary crops for stock. To satisfactorily allocate overhead costs to various crops can never be other than arbitrary.

Turning to the chief alternative source of production, sheep, in order to simplify comparisons, the practice of purchasing four and five year old ewes and keeping them for two or three years for fat lamb production is considered. Naturally, the returns from buying younger sheep or breeding replacements will vary, but will not affect the issue greatly.

The probable profit per ewe today on fat lamb farms after allowing for all fixed and variable costs, is 30/- to 35/- per ewe—say 32/6 for comparative purposes.

To compare sheep against cropping returns, take an example where the estimated production from an acre is 50 bushels of wheat,

60 bushels of barley or carrying four ewes. On the foregoing basis, the net return from these various uses are approximately:

Wheat: £12 per acre.

Oats-Barley: £8 per acre.

Sheep: £6/10/- per acre.

There may be some hidden factors that cannot be evaluated in making the above comparisons, particularly as regards spring sown crops, but on the whole, I consider that I have erred on the conservative side as regards cropping, particularly wheat.

Naturally a farmer will be influenced by other factors as to the ratio of cropping to livestock (e.g. labour), but such comparisons do aid managerial decisions and other factors will not affect relative profitability. Potatoes have not been included for obvious reasons.

Reasoning along the above lines should help determine the most profitable mixture of enterprises on a farm and one might expect the general position on Canterbury mixed arable farms over the past two years to have been:

With wheat as the main crop, the maximum acreage under crop at the sacrifice of some sheep numbers but not incompatible with the maintenance or soil fertility and soil structure

or

If it was considered undesirable to reduce flock numbers, then arable cropping at the expense of small seeds

or

The increase in, not only arable crop acreages but, as described earlier, also in sheep and beef numbers accompanied by a reduction in the areas saved for pasture seeds.

3. Current performances of standard mixed arable and premium farms on medium fertility soils on which the bulk of our cropping farms are located and some observations relevant managerial practices.

What in fact has actually taken place may be gauged from an extract of the Department of Agriculture's Farm Recording Scheme which is to be utilised for the publication of district farm standards and performances throughout Mr Dingwall's superintendency. The farms included in this medium fertility group for 1959-60 are regarded by the local Farm Advisory Officer as above average for this system of farming and I will very briefly summarise the results to the nearest pound.

Land Utilisation:: Of the total area of 386 acres, the area in wheat was 8 per cent, other cash crops 4 per cent, and saved for seed 2 per cent. Carrying capacity was 2.2 ewe equivalents per acre, production of wool 23 pounds per acre, and fat lamb meat output 56 pounds per acre.

This turnover was worth £17 per acre and total farm expenditure, including depreciation (but excluding interest) was £10. This left a farm surplus of £2803 per farm, or approximately £7 per acre, to meet living expenses, taxation, interest and mortgage repayments, and any capital expenditure.

Another yardstick of farm management efficiency is to use the common denominator of Investment Return—what the farm is worth, or earning, as a business investment.

The total amount of capital sunk in the farm is assessed at Government valuation for the land and improvements, plus the book value of plant and machinery, plus market values for livestock. On this group of farms, the average investment totals £23,000, or £60 per acre (which you may consider low).

After allowing all farm expenditure (except interest) and a managerial reward there is an investment return of £4/2/- per acre equivalent to 7 per cent. Please remember that this group **does not represent our high fertility soil type farms** which are showing greater cropping intensity and higher returns, but these farms are typical of more than half our mixed cropping districts.

What is really surprising is the small area in arable crops and the rather low overall carrying capacity (2.2 ewe equivalents over the whole farm) leading one to reflect on the apparently low intensity of farming carried out on the medium to heavy soils of Canterbury during most of the 'fifties. As one example, this, to some extent is borne out by the last full Agricultural and Pastoral Statistics for Ellesmere County.

ELLESMERE COUNTY

Total sheep per acre	1.01	1.6
Per cent of cultivable area in:		
Wheat	5%	3%
Other cash crops	15%	13%

The foregoing observations are no reflection on the farmers concerned in the group for after all, they are making a return on their investment at 7 per cent and, taking into account their wages of management and depreciation, there was a cash surplus to meet living expenses, capital expenditure, mortgage repayments, interest, taxation and return on capital of £2750.

In the previous seasons, on two typical Canterbury Downland groups, with a total farm investment ranging from £55 to £62 per acre, the investment return for both groups was just under 3 per cent.

Naturally, there are the very progressive farmers and I should like to quote the returns of one farm in the foregoing group for the same season (and there are others in every group) to give you some idea of what is possible under today's conditions. Thirty-five per cent of the farm area was in cash arable crop, 11 per cent saved for pasture seed and 1½ per cent in winter forage crops. The carrying capacity over the complete season was 3.0 ewe equivalents per acre and wool production at 30 pounds per acre and fat lamb meat at 100 pounds per acre compared with the group averages of 23 pounds wool and 56 pounds fat lamb meat respectively.

Gross returns were £30 per acre, expenditure £13 per acre and farm profit at £16 per acre was almost equivalent to the groups gross profit. Farm investment return, calculated as explained earlier, was 12 per cent and could be 14 per cent for this season (1960-61). Note that on this farm 70 per cent of gross return was derived from cash crops and pasture seeds compared with 40 per cent in the group.

I will add no further details here, but Mr Morrison in his paper will give you a detailed description of his farm at Sheffield which is farmed at still greater intensity and earning greater returns.

It should be observed at this stage that these progressive farmers on the medium to heavy soils throughout Canterbury offer considerable guidance and comfort to the mixed arable farmer. They implement the true meaning of the term "farm management." His may be defined as "a science which deals with the proper combination and operation of production factors, including land, labour and capital, and the choice of crop and livestock enterprises to bring about a maximum and continuous return to the most elementary operation units of farming."

How have they accomplished this?

Firstly, they are fully aware of basic concepts of successful farm planning, particularly:

To be successful there must be a rational combination of farm resources—land, labour and capital.

There must be a balanced pattern of the highest priced commodities which will produce the highest net returns. This optional proportional combination of enterprises at any time hinges partly on experience and partly on the success and mistakes of others.

The trap of overdiversification must be avoided and, of course, soil fertility and mechanical structure maintained.

There is a very close relationship between farm gross output and farm net profit.

Under prevailing economic conditions, apart from some postponement of farm expenditure, there is very little farm expenditure within the control of the farmer.

The net return from an acre of crop is ultimately determined by yield, price and ability to produce cheaply.

The actual implementation of the above concepts will be covered by Messrs Hadfield and Morrison, but the following features are noteworthy on what may be called premium farms.

The wheat acreage has been increased. Stored up fertility has been judiciously exploited. All enterprises have a definite complementary relationship.

The minimum of land has been utilised for the production of winter forage.

Livestock numbers have been maintained or increased and there is no apparent loss of fertility or deterioration of soil structure.

4. Some reasons why there is not a greater maximisation of net profits.

Why then is there not a greater intensity of farming on Canterbury's mixed arable farms, when there is the managerial elasticity to do this?

Admittedly new ideas and changes in management take time to gain acceptance, and rightly so in view of the risk involved in farming, but I suggest that the following may be some of the reasons why the average farmer located on soils of medium to heavy fertility does not achieve the production he could:

Lack of Capital: Any method involving increased output inevitably means more money to be sunk into the business. It is not so much a fact that farmers are unwilling to borrow money but rather the inability to find credit for capital expenditure as opposed to seasonal accommodation.

Labour: The position here is rather confused at the moment and varies from district to district, but it is acute in some cropping areas. Increased mechanisation can help, particularly the widening field of hydraulic equipment. However, farmers realise that the labour position is not improving and they will perhaps tend to take up any slack in production by turning to beef—or else revert to a lower intensity of farming. Farm work is skilled work and perhaps one day it will be rewarded as such in real terms and a recognition by the giant farming industry that something concrete and constructive could be done about:

Farm Labour Superannuation Schemes.

Guarantee the savings for eventual home ownership from the detrimental effects of nibbling inflation.

Work opportunity for farm employee families by a greater dispersal of secondary industries to country areas.

These last two factors are the basic causes of the drift to towns.

Servicing: A number of farmers might conceivably revert to the more traditional mode of farming, but hesitate at the apparent difficulties involved in the transport and storage of dead stock. This difficulty is encountered too, by livestock producers (killing space for older sheep and beef) but the risk of loss is greater in the case of crops. Farmers naturally wish to minimise handling and any additional outlay for storage, transport and possibly drying plants rather discourages them from any greater crop intensification.

High Land Prices: The present situation, in Canterbury, at any rate, of high land prices can have two opposite effects:

1. Many keen men in the younger age groups, who know the business of true arable farming, are prevented from getting farms. The energy and drive of these young men would do much to raise the standard of productivity.
2. On the other hand, if they do buy in, there is too little capital left to finance their farming adequately. But the inordinately high half yearly interest and mortgage repayments, plus a young family, is an ideal combination to ensure maximum gross output as cheaply as possible.

Finally, despite the lower net returns from wool and fat lamb meat, the majority of farmers on the soils under discussion continue to obtain a satisfactory standard of living with chief dependence on grassland farming plus surprisingly high proportional returns from the minimum area of arable crops. This is the chief reason why cash crops, and wheat in particular, are not playing a more dominant role in Canterbury's land utilisation pattern.

Possibly too, although evidence is lacking, there may be a tendency on the part of some to reduce inputs and achieve lower costs by lowering the intensity of farming. This could be done, but at the sacrifice of national output which is not so much in New Zealand's interest as increased production at reduced costs. And talking of national interests, it is not infrequent that a national policy on agriculture may clash basically with an individual farmer's immediate interests. For example, a few years ago, during a period of depressed butter prices brought about by surplus supplies, an appeal was made to farmers to substitute beef for butterfat. This fell on deaf ears, where farmers were convinced that the quickest way out of individual economic problems was simply to produce more butterfat. But on Canterbury mixed arable farms to maximise net returns by increased arable cropping, particularly wheat, frequently at the cost of fat lamb production, is in the national interest.

5. Trends and prospects in the immediate future.

The projection of any line into the future is always a hazardous operation for it implies a gradual improvement which will continue at a similar speed for the next decade. This is seldom true in a mixed farm economy for progress tends to be erratic, first in one direction then in another, interspersed with rather lengthy static periods.

Before making any forecast, certain assumptions must be made—particularly as regards prices. Indeed by the manipulation of prices within the control of New Zealand economy, it would be possible to channel development in almost any direction. At the moment, lamb prices are unlikely to improve and, in view of the strong synthetic competition, wool will have to remain at a reasonable price to the buyer. Experts agree on the long term desirability of increasing beef output, which, like wool, is an international commodity and the difference to the farmer in net returns between wool and fat lamb as against beef is yearly narrowing. Exceptionally good prices for pasture seeds, in view of overseas advances, are likely to be the

exception rather than the rule, whilst the past few years price movements offer sufficient guide as to grain and pulse crops which save overseas exchange.

From this base, and taking into account previous technical and economic observations, one might venture to predict along these lines:

Barley: Local production is usually satisfied although the keen demand for feed barley could cause periodic shortages. The impact of the new gin industry remains our unknown factor.

Oats: Again, New Zealand is normally self-sufficient except in feed oats and the possibility of an expansion of the contract system entered into by the manufacturers of breakfast foods, and by the breweries for barley, might be justified. There is a definite growing local demand for oats for greenfeed purposes. The prospects of export outlets are not bright, but should be fully explored.

Linseed: This acreage has fluctuated greatly over the past decade as the economics of linseed oil production are closely related to the demand for oil and oil cake as a by-product. Under the New Zealand farming system there is a limited demand for oil cake, so the future of the industry remains uncertain.

Maize: Varying amounts up to £100,000 in value have been imported over the years but stock feed requirements have been satisfied. It was suggested some years ago that the local product could possibly be utilised for the manufacture of cornflour and cornflakes—at present imported.

Potatoes: The demand being extremely inelastic, I visualize a reduced acreage producing the required tonnage. This year may see the virtual disappearance of the very small grower and convince those, who follow a fashion dictated by previous years' returns, that they are just one year out of date. I think one must be a regular grower to come out in the black over a number of years.

Sugar Beet: Although the total production of human and animal feeds is extremely high and sugar beet has done more than any other crop to raise the standard of farming in many countries, it has no immediate future in Canterbury. Apart from international considerations, it could bring about a reduction in cereals and other crops.

Vegetables: Expansion here may be largely dependent on the future growth of the Australian market and would probably appeal more to the dairy farmer.

Peas: These are widely grown under systems of contracting which help to relate the total acreage to the country's needs, either for local use or export. Future overseas demand is uncertain.

Pasture Seed: Earlier it was mentioned, that as overseas countries tend to satisfy requirements peculiar to their environment, so seed producers will depend more on the local market. Pasture seed production will continue a catch crop and any trend towards specialisation in some seed crops, like cocksfoot, will bring economic factors into play and force the more casual grower out of the market. Adverse seasons overseas will periodically give an impetus to the industry and no doubt, if our price is right—that is, cheap enough, there will always be an overseas market if the growing shadow of agricultural protectionism does not intervene. Notwithstanding all I have said earlier, the present generation of Canterbury farmers is steeped in the seed production tradition and no doubt pasture seed receipts will continue to go "unbudgeted" for, but accepted as a due right to mixed arable farmers when they materialise.

Wheat: A common depression crop, certainly, but the one crop which can be grown more intensively without glutting the present

market or causing any drastic change in present managerial patterns. Our present consumption is at least 15 million bushels, and is increasing annually. If we estimate this year's yield, at say, even 9 million bushels there is a balance of 6 million bushels to be imported. This is equivalent to 12,000 acres at an average yield of 50 bushels per acre.

In the next paper Mr Hadfield deals more fully with this future farming phase and I am inclined to think he may be somewhat conservative in estimating Canterbury's grain growing potential. My own opinion is that, if necessary, Canterbury could grow, in addition to present overall output of other cash crops, 200,000 acres of wheat and maintain or even increase livestock production.

What is more, although wheat may be classed as a depressed crop, the price paid to the farmer for it has no note of depression about it.

Livestock: Apart from the assertion that livestock numbers should be maintained or increased, the future place of beef on mixed arable farms is difficult to forecast. Some young beef stock on most farms strikes one as fashionable today, but until there is a better balance of store country in Canterbury, beef will be some time before it assumes any great significance.

With the fertility factor now solved on millions of acres of Canterbury's previously very lightly stocked hill and foothill country, the day must be fast approaching when Canterbury can boast a better balanced farming pattern than elsewhere in New Zealand.

It is most unlikely that the immediate future will see any trend towards the large scale growing of grain crops for increased meat production. It will be cheaper for many years to come for New Zealand to adhere to grassland farming but it is a strange paradox in today's hungry world to observe that, whereas the price of livestock once controlled the economics of feed grains, today the roles are reversed.

Finally, it must be conceded that our farmers who depend on a mixed arable economy, or whose farms are geared for such a system, are today in a most fortunate position. Specialisation is all very well, and has paid off since World War II, but the loss of flexibility is a serious handicap in a price recession. The average dairy farmer is an efficient producer of butterfat but is too small for a sheep cum beef unit and climatically unsuitable for cropping. The store sheep farmer faces similar problems as his resources are equally immobile.

This is not to suggest that an attempt should be made at varying intervals to change the pattern of production to short term market demands—our markets are too distant. But it does underline the fortunate position of many Canterbury fat lamb farmers, who are the only farmers in a position to devote greater attention to cropping that would conceivably provide a major part of farm income. The relative balance of improved pastures and arable crops will be decided by factors largely outside the control of the farmer (e.g., world prices and demand, dietary changes, technological advances, and agricultural protectionism) but the balance of payments position will always ensure encouragement of arable cropping commensurate with internal demand.

CROP ROTATIONS

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Introduction

The purpose of this paper is to discuss crop rotation mainly in relation to the management of Canterbury's mixed cropping farms. Existing crop rotations will be examined to see what modifications, if any, are necessary to bring about better use of the land.

Lincoln College and the Department of Agriculture are both in full accord regarding the necessity for adequate farm planning; one of the main requirements of which is a carefully planned rotation of crops. Due attention to this aspect of farming must place the farmer in a better position to see where he is heading—be it into or out of the red! Furthermore, with adequate planning farmers are better placed to make modifications to existing programmes as circumstances dictate, and as farmers are all too well aware, this is frequently necessary.

In this paper I intend to describe briefly the history of crop rotations, outlining the main principles involved in the rotating of crops. An attempt will be made to outline the main systems of farming as they apply to three broad classes of cropping soils, classified according to their state of soil fertility. Factors which influence the nature of crop rotations will be discussed and the place in the rotation of our major "Cash Crops" will be described. Finally an attempt will be made to evaluate some of the types of rotations in use in various parts of Canterbury.

Historical

The history of crop rotation goes back over 200 years and its introduction into farming practice marked, at that time, a revolution in agriculture. Prior to this it was customary to grow crops on the same plot of land, making use of the fallow to rest the land periodically. It is little wonder that "Club root" and "clover sickness" became widespread. Earlier observers had noted that cereal crops, for some unaccountable reason, did better after a clover crop. However, it was not until 1730 that Townshend, a name well known to students of agriculture, introduced into the farming system, two comparatively new crops, namely turnips and clover. The system whereby these crops were integrated, became known as the "Norfolk Four Course Rotation." Basically it consisted of following the turnip crop with barley which in turn was followed by the one year clover ley, with wheat completing the cycle. This simple alternation of crops embraced the main principles of crop rotations which are as follows:—

1. It was so arranged that deep rooted crops were alternated with shallow rooted crops to make full use of available soil nutrients. In this rotation, barley, a shallow rooted crop, followed the deep rooted crop—turnips.
2. The rotation included a cleaning crop. In this case, turnips which were grown in wide rows and intercultivated, helping to keep down weed growth.
3. The turnip crop which was sometimes folded with sheep, resulted in a return of nutrients to the soil, to the benefit of the succeeding crop—barley.
4. Spring sown barley, the second crop in the rotation, followed the turnip crop very conveniently. Furthermore, the barley crop was undersown with clovers, thus minimising cultivation operations.

5. The undersown clover crop—the third crop in the rotation—was used basically for hay purposes but indirectly helped to restore humus and provide nitrogen for the wheat crop which followed.
6. After the wheat harvest and in preparation for turnips, it was customary to “muck out” on the wheat stubble prior to ploughing. In this way full use was made of accumulated farm yard manure from the housed livestock to the benefit of the turnip crop.

This new approach to arable farming made full use of the land and its natural fertility. It also provided cleaning crops and fertility restoring crops. The Norfolk Four Course Rotation is still used today and it forms the basis of most of our present day rotations.

Although the principles of the Four Course Rotation still hold good today, nevertheless the application of some of them may not be of the same relative importance as in Townshend's day. For example, the 1 year clover ley has been replaced by a more persistent grass and legume pasture which is grazed. In addition we have the advantage today of the use of weedicides and better cultivation techniques for controlling weeds. Soil nutrients can to a large extent be replaced with artificial fertilisers.

As a consequence it has been possible to modify and extend the old Norfolk system to suit the ever changing pattern of farming.

Farming Systems

Throughout the course of this paper, reference will be made to crop rotations as they apply to mixed cropping farms on soils broadly classified as being of high, medium and low fertility. Before attempting any discussion on appropriate rotations it is necessary first to outline briefly the systems of farming employed on these three classes of cropping land.

In the following table is an estimate of the area of these three groups of soils considered suitable for cropping. An attempt has also been made to allocate to these groups their respective areas of cereal and other “cash crops”:

	Soils of high fertility (Ac.)	% of total	Soils of med. fertility (Ac.)	% of total	Soils of low fertility (Ac.)	% of Total
Area suitable for cropping	230,000	13%	940,000	54%	580,000	33%
Area in cereals other “cash crops”	55,000	22%	142,000	62%	33,000	14%
% of group in “crop”	24%	15% +		6%		13%

High Fertility Soils: The high fertility soils fall into groups, namely, the heavy textured soils and the free working soils. Both have in common, a relatively high degree of inherent fertility. The heavy textured soils include the Temuka, Wakanui, Kaiapoi and Tai Tapu series. The extent to which these soils require draining may limit the range of crops which can be grown. Wheat and barley crops are capable of heavy yields, while satisfactory crops of peas and potatoes may be restricted to areas that have been adequately drained.

The second group—the free working deep silt loams comprise the best of the Waimakariri, Templeton and Paparua soils as well as the Barrhill, Willowbridge, Morven and Waikakihi series. These are versatile soils capable of heavy yields of wheat, barley, peas, potatoes and small seeds.

The high fertility soils of Canterbury total little more than 230,000 acres or approximately 13 per cent of the land area of 1½ million acres capable of growing cereal crops. Nevertheless they account for about 22 per cent of the area in cereal and other "cash crops".

Farms on the high fertility soils vary in size from 150 to 300 acres. These farms have on the average about 24 per cent of the farm area in "cash crops". They are, however, capable of considerably more cropping without depleting soil fertility. On many properties over half the grass area is saved each year for ryegrass and clover seed. In general, cropping takes precedence over the fattening of lambs, and ewe flock numbers tend to exceed 500 only on the larger properties.

On these properties, returns from livestock are only secondary to those from cereals and small seeds. These account for 65 to 70 per cent. of the farm income.

Depending on locality, the majority of these properties do not find it necessary to grow winter forage crops or lamb fattening feed. In general, good lucerne hay tends to replace the root crop. The carrying capacity is not as high as one would expect—being little more than 3 to 4 ewes per acre of grass.

Pastures on these high fertility farms are required to last from 3 to 5 years and it is here that short rotation ryegrass finds a ready place.

Medium Fertility Soils: The medium fertility soils comprise an area of approximately 940,000 acres—just over half the area of Canterbury's cropping land. This group is the most important one, for on it is grown approximately 62 per cent. of Canterbury's cereal crop. These medium soils can also be separated into two groups, namely, the soils of the Plains and the soils of the Downlands.

The Plains soils include some of the Paparua, Templeton and Hatfield soils along with the more fertile of the Lyndhurst and Chertsey soils. They are soils capable of growing most of the crops of the high fertility soils but are more subject to droughts. The Downland soils located mainly in North and South Canterbury have a clay subsoil, giving them better moisture holding properties. Soil types of the Downlands include the Timaru, Claremont and Kauru soils of South Canterbury and the Waipara, Cheviot and Glenmark soils of North Canterbury. As a group the soils of the Downlands are a little more restricted in the range of crops that can be successfully grown but like the Plains soils they yield good crops of wheat, oats, barley and linseed. Peas and potatoes are not grown to any extent. Along with the soils of the plains they produce reliable yields of grass and clover seeds.

Farms on the medium soils vary in size from 300 to 500 acres and on the average about 15 per cent. of the farm area would be confined to cereal crops, and at least two paddocks would in addition be saved for small seeds, one for ryegrass and one for white clover. The flock would consist of 700 to 1000 ewes and returns from wool and fat lambs would represent approximately 50 per cent. of the farm income.

Low Fertility Soils: Of the large area of low fertility arable soils in Canterbury, only a relatively small proportion—estimated at 580,000 acres—is considered suitable for wheat crops and this would be limited to little more than one “cash crop” in the rotation. Soils coming within this category are the best of the Lismore, Eyre and Mayfield soils and a proportion of the Mairaki, Oxford, Ashley and Opuha soils of the inland downs. The Chertsey and Lyndhurst soils are shared by both the medium and low fertility groups of soils.

In their unimproved state the low fertility soils are generally unsuitable for cropping but after a build up through improved pastures, heavy stocking and irrigation, many have now reached the stage where they can support a limited cropping programme.

Essentially these soils are best suited to fat lamb production and under irrigation an economic unit would consist of 350 to 450 acres. Dryland farms vary in size from 600 to 1,000 acres and where cereal cropping is practicable, about 5 per cent. of the farm area would be in “cash” crop. The limit would be around 10 per cent. on a fully improved unit.

Only about 14 per cent. of Canterbury's cereal crop acreage is grown on the low fertility soils.

Factors Influencing Type of Rotation:

There are quite a number of points that have a bearing on the type of rotation to be employed. Some of these will now be considered:

1. Of first consideration is the capacity of the soil and suitability of the climate in relation to returns from crops of the farmers' choice.
2. Market demand and profitability of the crops in question will play a leading part in the selecting of these crops.
3. The cropping programme must come within the capacity of finance, labour, power and equipment available.
4. The area under crop must be balanced to allow adequate provision for livestock requirements.
5. The size of the farm can have a bearing on the proportion in crop. For example, on economic grounds there may not be the same necessity for the larger property to have as high a proportion of “cash” crop as is usually necessary on the smaller property.
6. The state of a farmer's finances may necessitate a heavy cropping programme after the first few years of acquiring a property—particularly under today's excessive land prices.
7. The prevalence of certain crop diseases and pests may require an alteration to the cropping programme.
8. The extent of cropping and the needs for supplementary feed crops will decide whether a long rotation is used or two shorter ones employed.
9. Finally, the method of grassing down has a bearing on the rotation. For example, it may be after a cereal crop, a fallow or with a food crop.

Most of these points are quite elementary and ones that the farmer normally takes into consideration. Others, however, are deserving of further consideration.

Soil Fertility: The first of these points to be considered is the question of soil fertility. Over the past two decades a marked change has taken place on the arable farming soils of Canterbury. This period could well be described as a “fertility building” area. Prior to the 1940's—particularly during the “depression” years—cereal

cropping appeared to offer the best remuneration. Its intensification lead to overcropping, with progressively lower yields. Soils became depleted in fertility and soil structures impaired. Relief came with the advent of improved strains of grasses and clovers. This along with the greater use of lime and fertiliser enabled more stock to be carried and over the past 20 to 25 years we have seen a gradual though marked restoration of soil fertility. Sheep numbers, particularly over the last 10 years, have soared beyond all expectations while the acreage of wheat showed a corresponding decline to the lowest on record in the 1956-57 season. The past three years have seen yet another change with the farming pendulum swinging back to a more balanced system of arable farming. Wheat has shown a threefold increase over the past four years without any apparent decline in overall sheep numbers.

An example of the type of rotation employed on the medium fertility land during the period of fertility building was—

Turnips — Rape — Wheat — Fallow — Autumn Sown Grass.

A long fallow after the wheat crop was essential for good pasture establishment and the anticipated small seed crop. This type of rotation played an important role in building up fertility of the soil at a time when returns from wool and fat lambs were at a relatively high level. In the light of economic changes that have taken place over the past few years, it is essential that we have another look at crop rotation to ascertain what modification and extensions are desirable.

Plant Disease: Cases do occur where crop diseases and insect pests can be of sufficient moment to warrant changes in cropping programmes. One does not see successive crops of potatoes or peas in the rotation. Successive crops of linseed can also cause disease problems. Where "club root" disease is known to be present farmers would avoid successive crops of susceptible brassicas, and adjust rotations accordingly.

Today, with wheat as a preferred cash crop, one finds wheat after wheat being fitted into many rotations. Here a note of warning should perhaps be sounded. If the first crop of wheat should be infected with the fungus "Takeall", the yield of the second crop could be quite considerably reduced by this and other associated root fungi. For the same reason, precautions should be taken when wheat is the first crop in the rotation following pasture as grass is a carrier of "Takeall". Where wheat follows grass and this sequence is common to most districts, early cultivation with adequate surface working is recommended. Should grass grub be present in the pastures this too could be harmful to the wheat crop and a dressing of D.D.T. may be warranted after the wheat crop has been sown.

These are but a few examples where plant diseases and the presence of insect pests may necessitate a revision of an existing rotation.

Nature of Crop Rotation: The desirability of one long rotation or the employment of two shorter ones will now be discussed. Assuming that the farm is divided into 16 to 18 paddocks, the long rotation would involve the ploughing up of one grass paddock each year and the sowing down to grass of one paddock, thus keeping cultivation and regrassing costs to a minimum. It has the desirable attribute too of maintaining a maximum area of pasture. If the paddock is out of grass for too long, however, soil structure could suffer and a further disadvantage would be the relatively high proportion of older pastures on the farm. In general, the long rotation is best suited to the farm where the area of cash and supplementary

feed crops is not too extensive. Where this exceeds 25 per cent. two paddocks would probably have to come up out of grass each year.

The use of two rotations—for example, two paddocks coming up out of grass each year—is desirable where the aim is to transform an undeveloped or “run down” property into high producing pastures as soon as possible and at the same time include some cash crop to finance further development. Two separate rotations may have to be followed too, where a proportion of steeper arable land or lower fertility soil necessitates a modified rotation which may or may not include cash crops.

The rightful place for two rotations is on the high producing property where 30 to 40 per cent. of the farm is under the plough for cash and supplementary feed crops. Here pastures of relatively short duration lasting from four to five years, replaces eight to ten year pastures of the other system.

On the medium to high fertility cropping land it is obviously wasteful if full use is not made of the two rotations. To justify the ploughing up of two grass paddocks, at least four cash crops should be grown and these should be allocated as evenly as possible to both rotations.

The use of both these systems was adopted by Mr W. C. Stafford on his farm at Timaru. On taking over a neglected property on medium class soil he adopted two rotations in order to get the property back into high producing pasture as quickly as possible. One paddock came out of grass into Linseed — Wheat — fallowed for new grass. The other paddock went into Turnips — Rape — Wheat — Fallow — Grass. Having been round the farm once, during which time sheep numbers had been greatly increased and fertility restored, he combined both rotations as follows:—

Linseed—Wheat—Turnips — Rape — Wheat — Fallow — Grass. This long rotation has worked out very well and with the extra grass paddock available it was possible for sheep numbers to be even further increased.

Place of Crops in the Rotation: The place of wheat in the cropping rotation will be considered first. On high fertility soils it frequently follows peas, potatoes or a preceding crop of wheat. On the medium soils it can follow these crops and in addition may follow rape, linseed or grass. On the lighter soils, wheat invariably follows rape or grass.

Spring sown cereals can conveniently follow a winter feed crop and therein probably find their best place. Where spring sown cereals follow a wheat crop, cereal greenfeed can be used to separate the cash crops and provide useful feed. Greenfeed, however, usually follows wheat at the end of the rotation preparatory to sowing back to pasture.

Peas, potatoes and linseed are crops which usually take pride of place in the rotation, being the first crops after grass. They can be conveniently followed by a wheat crop. Wheat also fits in well after rape which may be the first crop out of grass while the sequence of turnips — rape-wheat is common to many rotations.

There is no simple formula, nor are there hard and fast rules governing crop rotations. Normal precautions have to be taken and some of these have already been fully discussed.

The last crop in the rotation, namely, grass, is probably the most important crops in the rotation, yet the one which frequently suffers the most abuse. How often do we see new grass sown down about a month too late on a badly prepared seed bed following a cereal

crop. Admittedly, maximum land use can be achieved by sowing new grass immediately following a cereal crop, but a late harvest such as was experienced this year could make this a doubtful proposition. To my mind, this method has little or no place on medium and low fertility soils. Where cereal greenfeed is required it would be preferable to sow this crop in the autumn—for winter and spring feed—and delay sowing down to grass until the following year. On these soils a fallow is desirable if good pasture establishment is to be achieved, and a small seed harvest expected. On the high fertility cropping soils it is common practice to grass down immediately following a cereal crop and this practice appears to be reasonably satisfactory. This method could possibly be extended to include the best of the medium fertility soils provided the farmer is prepared to take the risk. Today some farmers have adopted the practice of including with the superphosphate about $\frac{1}{2}$ cwt of a nitrogenous fertiliser to assist in getting quick pasture establishment. This practice is worthy of consideration more particularly on the medium class soils.

Grassing down with a "nurse" crop such as spring cereals, rape or winter feed is not recommended on mixed cropping farms. Invariably it results in a poor pasture.

Examples of Crop Rotations

Consideration will now be given to various crop rotations as they occur on the three major classes of soils:

Rotation on High Fertility Soils: Where it is not essential to grow winter forage and lamb fattening crops it should be possible to fit into the rotation from four to five cash crops each year. This would represent approximately 30 per cent. of the farm area. At this level of cropping it would be necessary to plough out of grass each year two paddocks and two separate rotations would be followed.

(a) The following rotations includes six cash crops and this is about the maximum cropping one could expect on the high fertility soils. They are as follows:—

(a) Potatoes — wheat — barley — grass.

(b) Peas — wheat — barley — grass.

This represents about 33 per cent. of the farm in cash crop, and to my mind typifies maximum land use. It is in line with the programme which Mr Morrison follows on his farm and this will be described by him in the next paper.

(b) Where it is necessary to grow supplementary feed, maximum land use can be achieved with the following type of rotation. It is one that is followed in North Canterbury:—

(a) Potatoes — wheat — wheat — grass.

(b) Turnips — rape — wheat — barley — grass.

In this rotation about 28 per cent. of the farm area is in cash crop, with nearly 40 per cent. of the farm under the plough each year.

(c) The following rotations, with adaptations, are in use in various parts of Canterbury. They are both rotations which include cash crops with only one paddock coming up each year.

1. Peas or potatoes — wheat — wheat — barley — grass.

2. Potatoes — peas — wheat — barley — grass.

In both these rotations approximately 22 per cent. of the farm area would be in cash crop. In most of these rotations of high fertility soils at some stage barley follows wheat. If a cereal greenfeed is required it could well be fitted in between the two cash crops.

2. Rotation on Medium Fertility Soils: On these soils, fat lamb production plays an increasingly important part. It is therefore an

advantage if rotations can be arranged where only one paddock comes up each year. Crops are usually grown for winter feed and for fattening lambs. Two and three cash crops are included in the rotation and only occasionally does one see four cash crops included.

(a) A rotation now widely used is:—

Turnips — rape — wheat — wheat or barley — greenfeed — grass or barley.

In this rotation approximately 13 per cent. of the area would be in cash crops.

(b) A rotation providing approximately 16 per cent. of cash crop is:—

Linseed		Greenfeed	
	wheat — wheat		— grass
Rape		turnips + Italian	
		(Feb. sown)	

This is an interesting rotation used in North Canterbury. Its main weakness is that the winter feed requirements are dependent on the sowings of York Globe turnip in February. A late harvest could seriously prejudice the chances of the winter feed crop.

(c) A rotation previously referred to which has proved successful in South Canterbury is as follows:—

Linseed — wheat — greenfeed — turnips — rape — wheat
— fallow — grass.

In this rotation 18 per cent. of the farm is in cash crop. It maintains a maximum area of grass but demands that pastures remain down for eight to ten years.

(d) One rotation used in Waimate is:—

Wheat — rape — wheat — barley — turnips and grass.

The sowing of grass with turnips is not a recommended practice on medium land and furthermore this rotation suffers from two long fallow periods which are barely justified.

(e) Where reliance is placed on lucerne hay for winter feed this rotation has proved satisfactory.

Peas

wheat — barley — greenfeed — grass.

Rape

(f) A rotation widely practised in the Fairlie district is:

Wheat — wheat — greenfeed — chou and swedes — grass.

This rotation does not provide lamb fattening feed.

(g) In some cases two paddocks are ploughed up each year and the following type of rotation used:—

(a) Turnips — rape — wheat — greenfeed — grass.

(b) Linseed — wheat — fallow — grass
or peas.

This combination of rotations provides only three cash crops and is more costly to operate by virtue of the fact that an extra paddock is cultivated and an extra paddock sown down each year, and one less pasture is available for grassing. The same crops can be fitted into one long rotation as in (c) thus eliminating the disadvantages of this programme.

(h) To justify the ploughing up to two paddocks, at least four cash crops should be included in the programme and an extra crop

of wheat or barley could be fitted into the previous rotation which would then be as follows:—

Turnips — rape — wheat — wheat — fallow — grass
or
barley.

Linseed
or — wheat — greenfeed — grass.
Peas

Such a programme would provide four cash crops representing 25 per cent. of the farm areas. Approximately 37 per cent. of the farm would be under the plough each year and this would represent the limit to which one should go on medium class land. It should only be attempted on the better class of medium soil.

3. Rotations for Low Fertility Cropping Soils: On improved light land it is possible today to include a limited amount of cash crop. This is land, the best of which is today carrying from two to two and a half ewes per acre. One cash crop or two at the most could be included in the rotation as follows:—

Turnips — rape — wheat — fallow — grass.

Where lucerne hay replaces a winter feed crop then the rotation:

Rape — linseed — wheat — fallow — grass
or
Peas

should be feasible. This rotation would represent approximately 9 per cent. of cash crop on the light land farm.

Conclusion:

In this paper I have endeavoured to outline some of the principles underlying crop rotations. I have discussed some of the factors influencing the type of rotation to be adopted, and I have concluded by giving the advantages and disadvantages of certain rotations employed on the three main types of arable cropping farms.

I have indicated as a safe optimum that 30 per cent. of the high fertility cropping land could support cash crops, and up to 20 per cent. of the medium cropping land. Improved light land could support on the average around 7 per cent.

If these percentages are related to the area of the three classes of cropping land in Canterbury the figure would approximate 300,000 acres. Wheat would occupy approximately 185,000 acres of this total, assuming that the area of other crops remains at the present level. In other words, on these calculations, Canterbury's wheat area could in the foreseeable future be increased by more than half and to my mind this could be achieved without any decline in sheep numbers.

A MIXED FARM AT SHEFFIELD

P. G. Morrison, Farmer, Sheffield.

I have been requested to describe to you how we manage our farm so as to make a continuous maximum net profit, whilst maintaining or improving soil fertility.

Location and Size of Farm:

We are approximately 35 miles due west from Christchurch in the Sheffield district.

The farm consists of 320 acres and, in addition, we have some very rough riverbed, but our farm is flat.

Soils:

About 250 acres is classed as a Waimakariri silt loam and the balance is a lighter soil with some stones. Of the 70-odd acres of lighter land, 35 acres is in one block, the remainder being shingly ridges through the farm—the 35 acres is ideal for lucerne.

The riverbed block's contribution to farm output is negligible. It is subject to frequent flooding and so far we have not developed it in any way. In the future we may do some oversowing.

The farm is situated where the river leaves the foothills, and over the years it has left some shingle ridges along the top of shallow gullies. On the good land there is 8 to 12 inches of friable soil and then a sandy type of clay for 10 inches before reaching water. On the ridges there is good soil among the shingle and providing the year is not too dry, crops are not affected. We like to see the ridges needing rain from November-March, as this suits the good land. With white clover, for example, unless the ridges are dry the remainder of the paddock will be too bulky for a good seed crop.

Climate:

We are 850 feet above sea level and the average rainfall is about 40 inches. Although the rainfall is higher than most of the mixed farming areas in Canterbury, it is less effective because of the number of strong north-westerly winds experienced—I say usually, because they are like our rainfall—very unreliable. We expect these winds in January-February to condition our harvest. If we don't get them, as happened this year, harvesting is very difficult.

Because of altitude and closeness to the Southern Alps, we have a fairly long winter with frosts up to 20 degrees plus the occasional fall of snow.

History:

The history of the farm is typical of Canterbury mixed farms. Between 1920 and 1945 wheat and oats were grown extensively with some small seeds and about 400 fat lamb ewes were carried. Pastures were not as productive as they are today, income low, and thus top-dressing often impossible. Consequently, fertility was barely maintained. After the war the scene began to change. World demand for food increased, prices rose, and research and extension men discovered new techniques. Improved pastures enabled more stock to be carried resulting in better soil fertility and structure, and consequently, higher crop yields.

Land Utilisation and Crop Rotations:

Because we consider there is more profit from crops and small seeds than from sheep, we harvest as many of these as practicable, whilst maintaining maximum sheep numbers for their part in the fertility build-up. On this unit, farmed as a partnership, we consider this a sound economic policy.

consider this worthwhile because costs are low and the grass paddock is no longer required.

You will notice that our pastures are only down for about five years—the paddock ploughed and cropped for say three years, and sown down again. Although this is a fairly tight rotation, it gives maximum areas of crops and small seeds, with heavy stocking as pastures are young and vigorous. The whole success of this programme is based on high producing pastures with vigorous white clover. The resulting improved soil fertility and structure gives higher crop yields and cultivation costs are reduced.

Comments on Crops:

Peas. Garden peas are grown after grass and partridge peas after a cereal. We find partridge peas grow too bulky after grass in a good season. Garden peas are drilled in mid-October and partridges during September if grass is to follow in the autumn. Yields vary from 25 to 60 bushels per acre.

Potatoes. Like peas, potatoes respond to good soil structure. To obtain this, the old pasture for potatoes has all the flock ewes on it from May until mid-August. There, they are fed hay and transfer additional dung and urine from the turnips and green feed crops. The paddock is grubbed twice, starting in August, double disced and harrowed before ploughing as deep as possible. By late ploughing we keep the soil open. We plant in 30-inch rows with 10-inch spacings between tubers—the aim being seed production. Yields vary from 11 to 22 tons per acre.

Wheat. Aotea wheat is grown and yields over the three seasons have varied from 68 to 92 bushels per acre. Drilling has been done in early June using 100 lb of wheat without superphosphate. This has given good yields. If sowing is late, we use one hundredweight super believing that the wheat emerges quicker. The biggest difficulty is to provide a good seed bed and yet retain some small clods.

Barley. Either Kenia or Carlsberg are grown with yields varying from 60 to 105 bushels. Research has not been grown for some years because of its tendency to lodge. Many in the district drill earlier, but we like to wait till the soil is warm in mid-October and sow at the rate of two bushels per acre.

Cocksfoot. I have listed this as a crop because it is not grazed—or very little. This is sown on a fallow between Christmas and New Year at the rate of 3 lb cocksfoot and 3 lb white clover per acre with 2 cwt reverted super. The subsequent topdressing is normally 1 cwt nitrolime in March, and 2½ cwt the third week in September. I am doubtful whether the March application is justified, but the spring one certainly is. Sowing when we do, under our rainfall, gives a good yield the following year. Yields vary from 150 to 800 lb M.D. per acre. The crop is reaped, stacked, and left for about three weeks before heading. A platform is mounted on the front of the header and six men are required for a full gang.

All crops are sprayed for weeds when necessary, particularly Californian thistles. During the past few seasons some crops have been treated for army worm.

Pasture Establishment, Maintenance and Management:

The pasture mixture for the past twelve years has been one bushel of short rotation ryegrass and three pounds of white clover.

This mixture suits very well for producing ryegrass and white clover seed, and gives good production of palatable feed for the sheep.

Government Stock, if available, or Pedigree seed, is always sown—after a fallow or peas, 1½ cwt of superphosphate is sown with the seed. Following grain crops ½ cwt of nitrolime is added to the super-

phosphate. All grass is sown in 7-inch drills. This gives quick feed, and after the ryegrass seed is harvested and the clover has stooled out, one cannot tell whether the paddock has been broadcast or drilled. A ton of lime is applied to all ground before grass is sown—D.D.T. super is applied after the ryegrass seed is harvested and subsequently 1½ cwt superphosphate each autumn.

After a straw crop, ryegrass seed areas are shut up about the 10th of October, but after a fallow on peas shutting up is postponed two weeks. The paddock is allowed to freshen up for about a fortnight and then nitrolime is applied at the rate of 1½ cwt after a fallow or peas, and 2 cwt after a straw crop. We find that these applications give us high yields of ryegrass seed without smothering the white clover.

Grass seed is usually mown and heading commenced five days later if the weather is favourable. We would prefer windrowing but the crop is usually too flat. If the straw is bright, it is baled immediately behind the header for stock feed. If not, it is swept into heaps and burnt. During the following autumn months "off and on" grazing is employed to encourage white clover growth. In the winter, the paddock is kept bare to suppress ryegrass, and until the area is shut up for white clover in November, it is kept short. Just when to close up for white clover seed is like going to the races. However, pastures are closed during the second or third week in November. With modern machinery I would sooner shut up too late and get a short crop with plenty of flowers, than too early with the resulting leafy growth and poor flowering.

When the clover is harvested the paddock is only grazed lightly. This permits the short rotation grass to re-seed. During March the paddock is shut up for lambing feed and this management gives us a good ryegrass-white clover sward for the next two or three years.

Marlborough lucerne is grown for hay and grazing—it is used for lambing on, and grazed with ewes and lambs when necessary. Two cuts is the minimum hay taken annually.

Sheep Management in Relation to Small Seeds Production:

I will endeavour to explain our sheep management and its relation to small seeds production. For our fat lamb flock we purchase five-year-old Romneys and mate them with Southdown rams. Between 700 and 900 of these ewes are mated, depending on their cost and the winter feed available. Incidentally, we have a Border Leicester stud of about 50 ewes. When ewes are purchased they have their feet trimmed and are put through formalin. Then all ewes are treated thus every two or three weeks until lambing. After tupping they are confined to the paddock which is going to potatoes. In the early winter they either get good ryegrass straw or poor lucerne hay, later supplemented by turnips, and as lambing approaches, they get young grass. For eight years we wintered solely on ryegrass straw, lucerne hay, and green feed. This was quite satisfactory, but with turnips less hay is required and the ewes will probably benefit in terms of wool growth at least.

By confining the ewes during winter there is ample feed at lambing time. Until some are sold all-counted in October, two young paddocks of ryegrass, the white clover area, the lucerne and the older pastures are available for grazing.

The number of ewes and lambs sold all-counted varies from 30 per cent to 60 per cent, depending on the inquiry for them and small seeds prospects. The last few years, by lambing earlier, and shutting the white clover up later, it has been possible to keep a greater percentage. About the second week in November the first draft (50 per cent) of fat lambs is sold at approximately 30 lb average. Lambs are weaned and another draft sold before Christmas.

This ewe flock management is very flexible and is often varied. I feel, however, that with a wide range of machinery for harvesting small seeds, it pays us to harvest all suitable areas in preference to grazing. We winter ewes in preference to hoggets to sell in the spring, because they eat more rough feed.

Providing we have a reasonable supply of hay we purchase in the autumn sufficient cast-for-age ewes to enable us to run six ewes per acre on all grazing which will be available in the spring—including lucerne, ryegrass, and white clover seed areas.

Labour and Machinery:

The present labour complement is three men, but, of course, casual labour is hired for the potato and cocksfoot harvest. One must regard plant and machinery as a substitute for labour and we possibly have a wider range of machinery than found on the majority of similar farms. The rather heavy outlay in machinery is considered a must for correct timing and some may regard our labour and machinery costs rather high. On their own, yes, but looked at in relation to turnover they are our cheapest inputs.

Economics:

No doubt you are wondering how this policy pays off—if at all. The following summarises (to nearest £) our position over the past five years (1956-1960) and I leave it to you to draw your own conclusions.

Farm income ranged from £48 to £60 with an average of £55 per acre. On an average, 42 per cent was derived from grain crops and small seeds, 26 per cent from potatoes and 28 per cent from sheep products.

Farm expenses (including depreciation) ranged from £28 to £33 with an average of £30 per acre.

This left a surplus ranging from £20 to £31 per acre with an average of £25 to meet living expenses, taxation, interest and mortgage repayments, if any, and capital expenditure.

I have used the Department of Agriculture's standard computations for arriving at a Farm Investment Return—that is, assessing what our farm is worth as an investment. The value of our land and improvements, plus stock, plant and machinery has been calculated to range from £85 to £105 per acre with an average of £95 per acre. We find that, after making an allowance for my father's and my own wages of management averaging £2,056 per year—I repeat £2,056—there was an Investment Return per acre ranging from £13 to £21 with an average of £18. Converting this to a percentage basis the range is 13½ per cent to 26½ per cent and the average is 19 per cent.

These figures, I consider, underline some of the observations and findings commented on by Messrs Stuart and Hadfield and certainly justifies the policy.

Future Policy:

As on many mixed farms, future policy will depend largely on market movements. I, too, consider the flexibility of the mixed farm the major advantage in that it is possible to have a few eggs in many baskets. If necessary, we could concentrate on more grain, swing to increased fat lamb production or specialise to a still greater degree on pasture seed production in the true sense of the term. The planning of a mixed farm is indeed fascinating, and the successful execution of such planning year in and year out is a stimulating challenge.

HIGH PRODUCTION PASTURE IN RELATION TO ANIMAL THRIFT

P. D. Sears, Director, Grasslands Division, Department of Scientific and Industrial Research, Palmerston North, New Zealand.

Introduction

There is no doubt about the fact that high production New Zealand pasture is a really high producer, not only of animal products but also of increased soil fertility. But there is also little doubt that skill is needed to attain and hold this top production level, and to avoid several sorts of animal thrift problems at both the early developmental stages, and at the final top pasture production levels.

It is, however, a first essential in discussing such problems to appreciate the whole background of pasture in our New Zealand environment, not only in terms of climate, topography and soil type variability within the country, but also our general picture of all-the-year grazing, little or no use of artificial nitrogen or of concentrates, as well as the general pattern of seasonal production for exportable products.

It is because of these several factors that ryegrass/white clover pastures are our typical best pastures of high production—and of course why the bulk of our stock thrift problems and studies revolve around these species. In this paper a brief review is made of some points in the New Zealand pasture development pattern, and also to offer a very simplified outline of the occurrence of some stock problems, together with some suggestions for their minimisation by grazing and cropping practices.

Largely because of our excellent pasture growing climate, a generous use of mineral fertilizers and the availability of certified seed of suitable pasture plants, New Zealand obtains great value from perennial legumes. White clover is the most important but red clover, lucerne, strawberry clover and *Lotus* spp. are also used. The temperate winter also favours annual clovers as pioneer legumes on drier soils. The annual nitrogen fixation by certified New Zealand white clover ranges from 400-500 lb N per acre in the warmer northern areas, to 200-250 lb in the colder south (Sears, 4). The climate is likewise conducive to losses of nitrogen; obvious nitrogen deficiencies are common, particularly in winter and early spring. Artificial nitrogen is expensive and difficult to apply in such a way as to hold a balance of grass and clover. It is used mainly for grass seed production, or to obtain special early grass growth in cold situations.

The climate also favours weed growth, and loss of balance between grass and clover can rapidly lead to reversion. Climate likewise largely determines the all-year outdoor grazing system of New Zealand, with its economic advantages of low housing costs, low feed conservation needs, and a continual turnover of nutrients in the soil/pasture/animal grazing cycle. However, there are many real problems from such a practice, not only winter poaching, but also utilization at other seasons.

Variability of species performance and seasonal growth within a farm is greatest on hill country. Between sunny and shady slopes overall differences in temperature, light and soil moisture are almost as great as the climatic extremes over the whole country (Suckling 6). There are additional differences induced by the variability of animal treading, defoliation and manure return. Then there is the variability due to the regional temperature differences between north and south, and rainfall differences between east and west.

Experiments on Soil Fertility

Overriding this variability is the pattern of pasture development through clovers, mineral fertilizers and the grazing animal. New Zealand data on this development cycle have been presented previously (4), but more are now available from current trials. At Palmerston North two parallel series were commenced in 1955 to measure (a) soil fertility increase under pasture, and (b) soil fertility loss under cropping.

For the increase series, a 6-inch layer of the fertile top-soil was removed from a flat alluvial area, the subsoil bulldozed out, mixed and redistributed to a depth of three feet, giving a soil very low in nutrients and of poor structure. Treatments were: combinations of grasses, white clover, nitrogen (urea at approximately 12 cwt per acre/year), mineral fertilizers (superphosphate 8 cwt, muriate of potash 10 cwt, magnesium sulphate 4 cwt per acre/year), and the simulated return of animal manure (by drying and milling herbage from each plot and returning 80 per cent at each cut). Pastures are mown to 1 inch after growth to 4.5 inches, and volunteer grass or clover is handweeded.

Table 1 shows: (a) the very low yields of grass alone without nitrogen, but the early and sustained high yields of clover alone, and the grass/clover associations; (b) that although nitrogen applications were very high, the grass (+ N) yields were not so great as those of the best of the grass/clover swards. This was due to nitrogen shortage, even at this high rate of application, and also to summer grass yield being lower than that from clover; (c) the strong early response to the mineral fertilizer which was shown by subsidiary plots to be due to phosphate while the later response by both ryegrass and clover is due to sulphur, potash and phosphate; (d) although ryegrass yields have increased under the treatments with the highest dry matter yields, there is also, in these mown plots, some development of a bottom mat. Browntop is now very evident in the low-fertility plots, while *Poa trivialis* is increasing in the high-fertility areas. In other similar mowing trials *Poa trivialis* has become vigorous only where nitrogen and phosphate are high in the surface layers. Argentine stem weevil (*Hyperoides griseus*) is believed to be the cause of lowered ryegrass yields in the second and third summers.

Invasion of *Poa trivialis* into ryegrass-clover pastures is important. Not only is this species of low palatability but also it can rapidly form a dense mat over the clover, which in turn leads to a rapid loss of nitrogen. However, as seen in practice and also well illustrated by recent field trials at this centre by Edmond (2), *Poa trivialis* is more sensitive to winter treading (along with cocksfoot and Yorkshire fog) than ryegrass, timothy and *Poa pratensis*. Heavy all-year grazing is practised in New Zealand, as a result of pasture improvement. This inevitably leads to a pasture of ryegrass and white clover. Exceptions to this trend can, however, be induced by such obvious things as insect damage, climatic or edaphic extremes, and also through extremes of grazing or resting.

Each year on this plot series, a pair of plots from the final treatment was cultivated and sown with rape, to measure increases in soil fertility. Compared with yields recorded in the same season on areas ploughed directly out of good old pasture, rape yields were: after one year of pasture 28 per cent, two years 34 per cent, three years 45 per cent, four years 65 per cent.

In contrast to this trial, the rapid loss of fertility under cropping is illustrated by the results obtained from the parallel exhaustion trial. Adjacent areas which had been under good pasture for at least 10 years were taken at random and continuously cropped in maize, kale, or potatoes. In each year there was a randomized lay-out of combinations of N, P and K (heavy applications) with Italian ryegrass grown each winter between the summer crops. Over the past four years the crop yields (without fertilizer) relative to those obtained directly after good 10-year-old pasture were:

	1st crop	2nd crop	3rd crop	4th crop
Maize	100 (36 tons)	68	70	59
Kale	100 (30 tons)	61	47	40
Potatoes . . .	100 (13 tons)	70	54	34

Fertilizer cross-treatments show that the primary induced deficiency was nitrogen, but that mineral (P, K, S and Mg) deficiencies also restricted the third and fourth crops, while loss of soil structure and the resultant poor drainage appear to be the cause of an almost complete failure of the fifth potato crop, even in the highly fertilized plots. Such fertility losses are to be expected from the large amount of nutrients abstracted by such crops, but the speedy decline in these trials, compared with the very rapid build-up under good pasture, illustrates the very active soil fertility cycle at Palmerston North.

Phases of Pasture Development

This type of experimental work, and field observations, show the pattern of pasture development in New Zealand, together with the associated animal feeding problems. Possible improvements on some current practices are suggested by a division of New Zealand pastures into five broad classes. The main division is in terms of actual evapo-transpiration, phase 1 being all those regions limited by soil moisture to low production, while phases 2-5 are those in the regions not so limited by soil moisture. The boundaries between phases are, of course, not clear-cut.

PHASE 1. Low productivity grass on land of low actual evapo-transpiration due to severe climate, soil type, topography or lack of irrigation. The aim here must be to preserve the cover by minimal grazing to balance with erosion and fire hazards—not easy in practice because of rapid loss of palatability as leaf and stem increase in age. Grazing control must also include control of rabbits, deer and other pests. Improvement in less severe instances depends on short-season crops, plus appropriate fallow, while the pasture approach is to establish and hold resistant species such as *Danthonia*, *Phalaris* and cocksfoot, with perhaps an admixture of ryegrass, subterranean clover and lucerne.

PHASE 2. Low productivity pasture or scrub on low-fertility soil, with a high potential for improvement through drainage, mineral fertilizers, pest and grazing control, and introduction of legumes and, later, more productive grass species. Ploughing for land levelling or scrub or weed elimination is an appropriate starting point, but cropping is usually not worth while because of low yields at this stage.

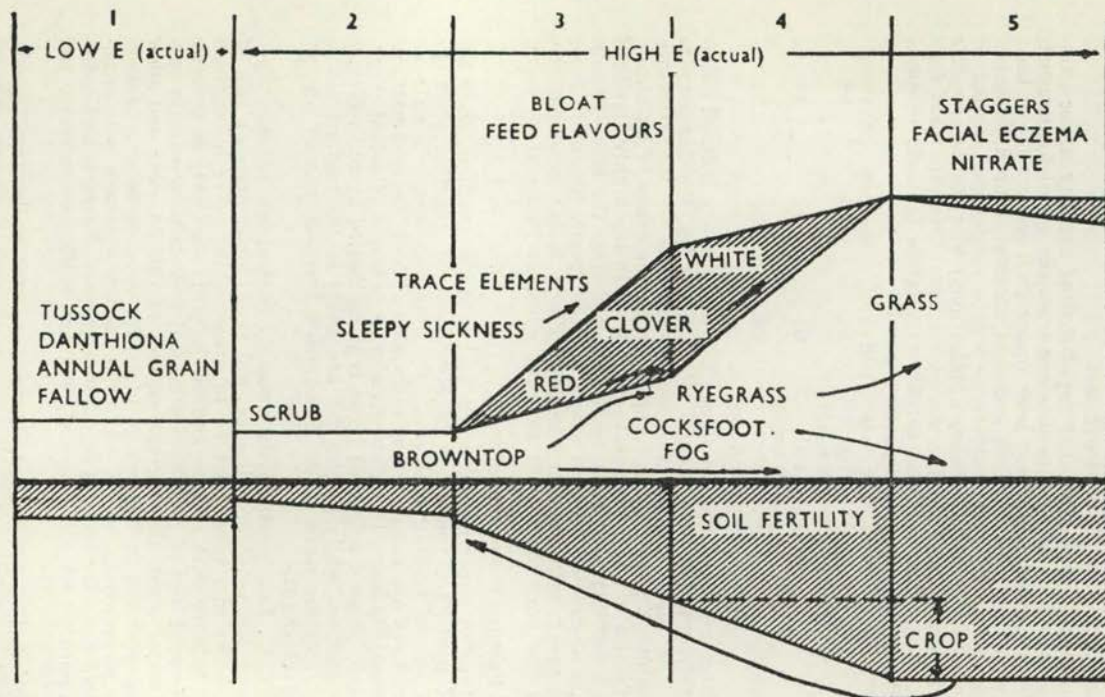


Fig. 1—Diagrammatic representation of pasture development, soil fertility and occurrence of some animal problems associated at different stages of pasture development. Annual pasture production is shown as height above, and soil fertility as depth below base line. Arrows show trends in amounts of the species, and the arrow below the base line shows transfer of nutrients by feeding or soiling of pasture herbage or crop.

Pasture development by oversowing or direct reseeding is more logical. At this unproductive stage animal troubles appear minimal, due to low numbers. However, improvement is impossible without rectifying primary nutrient deficiencies in the animal (e.g. cobalt, copper) as well as plant nutrient deficiencies.

PHASE 3. The improvement from phase 2 to phase 3 involves the development of a pasture dominated by clover until the soil nitrogen is increased, both by underground transfer, and by animal manure, to a point sufficient for grass growth. Such development is not easy. It is essential to apply sufficient mineral fertilizer, not only to promote pasture growth vigorous enough to compete with weeds, but also to provide for the essential increase in soil organic matter (Jackman, 3). A current example of this can be seen at the Grasslands Station, Kaikohe. With very heavy initial dressings of lime, P and K, a vigorous pasture developed after only two years out of scrub, and carried some eight ewes and lambs on a weed-free sward; but with light initial fertilizer applications only, the carrying capacity is low (two ewes) and there is considerable re-establishment of scrub and rushes.

On the animal side there are also many difficulties. Because of greater numbers, animal trace-element deficiencies become obvious, while, because of a greater faith in the winter-producing ability of these clover pastures than is warranted, sleepy sickness in ewes becomes a major difficulty. Bloat is prevalent on such clover-dominant pastures—red clover, subterranean clover and other annuals are all vigorous and even more conspicuous in the pasture than white clover, which continues further into the development cycle. Feed flavours in milk are also prevalent, as are animal ailments from clovers high in oestrogen content.

It is, however, essential to graze such clover-dominant pastures, mainly to obtain the benefit of the turnover of animal manure, but also to prevent shading of grass. Topdressing should also be continued to provide sufficient minerals for the grasses at the higher nitrogen level. Control of grass-grubs and encouragement of earthworms are important factors in the transformation to a mixed pasture.

Because of the grazing problems on these clovery pastures, they are often harvested for silage, or ploughed for cropping, sometimes fertilizer may be withheld. Such action will only perpetuate the situation and crop yields will still be relatively low. The endeavour to evade such early clover problems, by leaving clover out of the mixture, or by sowing very heavy rates of grass, are likewise ineffective. The best method is to get active nitrogen fixation by clover as soon as possible, and for this a light grass seed rate, heavy topdressing, and early grazing control are all essential.

PHASE 4. Grass and clover with an increasing proportion of grass, and with steadily improving soil fertility and structure through the added nutrients, plant and animal residues, and earthworms. There appear to be no animal problems peculiar to this phase, and given appropriate fertilizers and control of insects and weeds, pasture improvement is relatively easy. However, much depends on the strain of plant used and its performance under the local conditions. For example, at Palmerston North it has been shown that both H.1 ryegrass and cocksfoot are susceptible to excessive summer defoliation by stock and/or close cutting for silage or hay (Brougham, 1). By contrast, skilled winter management is needed to hold a balance between ryegrass and clover and to prevent invasion by *Poa trivialis* or Yorkshire fog. On many farms winter stocking does not keep pace with the improvement of pasture by better varieties and fertilizer. Also, on many farms endeavours to "autumn save" pasture are carried

to extremes, and low winter stocking leads to dominance of *Poa trivialis* and Yorkshire fog which depletes the clover. In general, on these farms the practice has developed of light winter grazing plus heavy summer defoliation, either by cutting or grazing. For most effective development of high production ryegrass and clover, the opposite trend in management is more appropriate—although not so attractive to the eye. A major factor against such lenient summer grazing is lowered palatability, but the latest varieties of ryegrass and cocksfoot offer advantages in this respect. The new machine-choppers for silage, hay and topping, also aid considerably.

PHASE 5. Pastures developed to a high stage of productivity after several years of phase 4, which are probably ryegrass dominant after continued heavy stocking, with high soil fertility, particularly in the top layers. Productivity is not always satisfactory, however, due to low summer growth and palatability, particularly of perennial ryegrass, and also there are stock-feeding difficulties from the rapid flushes of growth in the spring and autumn. Staggers, facial eczema and some forms of ill-thrift or mineral imbalance appear to be associated with the rapid ryegrass flush on such areas. Many of the past and present efforts of Grasslands Division are directed towards achieving greater palatability and summer persistence of ryegrass in this high fertility phase and also towards more direct control of such pasture problems (Sears, 5). However, grass-seed, hay, or silage production, or ploughing for forage or cash crops, offer suitable adjustments. Such cropping will not only produce high yields but also, by lowering the soil nitrogen, will again allow clover growth and establishment of a mixed pasture. The fascinating part of such a programme is the organization of the cropping phase so that the high soil fertility is utilized without reducing it to such a state that the ensuing pasture has again to develop through the excessive clover of phase 3. Ideally the crop would be fed out into areas at phase 3 to transfer fertility there, and thus finish up with the whole farm in phase 4.

This endeavour to simplify a complicated situation will probably reap a full harvest of objections. It is agreed that there are many exceptions and also many mixtures of the phases in practice, particularly on hill country. Such an approach does, however, help to fit the pasture into the complicated picture of soil, plant and animal.

Many farmers are, of course, well aware in a general way of such a cycle of production and troubles, and many instances could be quoted with the balanced grass-clover pasture as the cornerstone for good stock and good crops. Mr Morrison's farm described yesterday is an obvious example of this, plus his very nice use of valuable potato and grass-seed cropping. However, an even clearer picture of the whole pattern as detailed in this paper, can be seen on the farm of Mr Hillis in Southland. This property was inspected at last year's Grasslands Conference, and in brief his management is to use sheep at the pasture development stage, milking cows at the top grassy end, and then very heavy cropping of wheat and forage crop, to complete each cycle.

Mr Hillis is avoiding the troubles but getting the real benefits of high production pasture. To me such is very appealing.

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TABLE 1

Effects on Yields of Dry Matter (lb/acre) and Percentages of White Clover and Ryegrass, of White Clover, Mineral Fertilizer, Nitrogen, and Return of Milled Herbage, Palmerston North, 1956-59.

Treatment		March-Sept. 1956			October 1956-57			October 1957-58			October 1958-59		
		Total D.M.	% C	% R	Total D.M.	% C	% R	Total D.M.	% C	% R	Total D.M.	% C	% R
No return	Grasses alone + M .	500	0	100	3,100	0	97	1,900	0	94	1,600	0	57
	Grasses + N + M .	1,400	0	96	9,600	0	91	11,800	0	88	10,100	0	81
	White clover + M .	600	100	0	6,700	100	0	10,000	100	0	8,500	100	0
	Grass + clover .	700	14	84	9,200	57	42	11,400	69	28	9,500	59	36
	Grass + clover + M	1,700	52	48	10,100	55	44	12,000	68	28	12,400	57	40
80% return	Grass + clover .	600	13	86	10,000	49	49	13,100	59	37	12,900	54	42
	Grass + clover + M	1,700	55	45	11,200	40	67	14,100	49	48	14,900	43	53

M = Mineral fertilizer, C = Clover, R = Ryegrass.

SOME ASPECTS OF CHEMICAL COMPOSITION IN RELATION TO ANIMAL HEALTH

Dr G. W. Butler, Plant Chemistry Division, D.S.I.R.,
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This morning I propose to speak briefly about three research topics which we are currently working on at Plant Chemistry Division, and which all fall within the broad and complex field of plant-animal relationships. These topics are respectively:—

- (a) The selenium nutrition of ruminants.
- (b) Intraspecific variations in plants of chemical constituents which are of interest from the viewpoint of ruminant nutrition.
- (c) Discussion of a ryegrass strain trial in terms of differences in the live-weight gains of sheep on the various pastures, and also in terms of iodine nutrition.

Selenium

You are all, of course, familiar with the findings of Wallaceville and Lincoln workers (Grant, Drake and Hartley, 1959; McLean, Thompson and Claxton, 1959; Hartley, 1960; Thompson, 1960) that small quantities of selenium given to sheep either orally or intramuscularly lead to beneficial effects in many areas of the country—remission or prevention of white muscle disease, improvements in fertility and improvements in rate of growth of the animals.

It is obviously important that the various facets of the selenium cycle in New Zealand grasslands should be well understood and a number of research laboratories are at present tackling aspects of the problem which relate to their own particular interests and skills. At Plant Chemistry Division, my colleague, Mr Peterson, and I have been examining the uptake and metabolism of selenium by plants and also the form in which selenium is excreted in dung.

As you know, the selenium content of pasture herbage is very low, being of the order of 0.01 to 0.1 p.p.m. dry weight, which is 100 to 1000 times less than the average content of trace elements such as copper or zinc. Chemical determination of selenium in such small amounts presents experimental difficulties which have, however, been overcome by New Zealand workers (Cousins, 1960; Watkinson, 1960). So far, however, it has only been possible to determine chemically the total selenium content of the tissues. This has the limitation that all the selenium determined may not be nutritionally available and it is therefore desirable to know the chemical forms of combination of selenium in the plants.

Radioactive selenium affords a sensitive and convenient method of examining this question. The radioactive material is obtained as sodium selenite of high specific gravity (10,000 mC. per g.) and it can therefore be added to nutrient solutions at levels which are not far removed from the natural conditions in New Zealand and which are certainly well below levels at which toxic effects on plants would be seen. Figure 1 shows some pasture plants growing in nutrient solutions containing radioactive selenite, in a controlled environment cabinet. After a suitable period had elapsed for the uptake of radio-selenium and its assimilation into various compounds, the plants were harvested and subjected to chemical fractionation. The distribution of radioactivity in various compounds was then investigated.

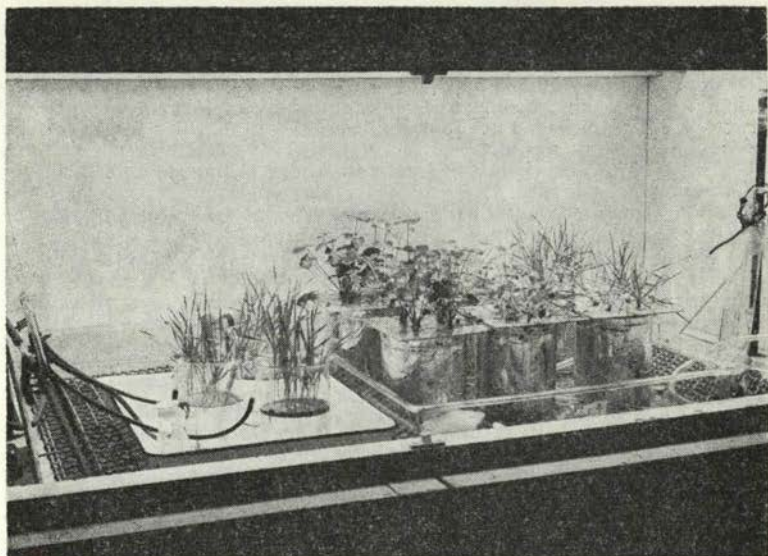


Figure 1—Plants growing in nutrient solutions containing radioactive selenite, in a controlled environment cabinet.

Species from these plant groups have been chosen for examination:

(a) A representative of the selenium accumulators. These are plants which are capable of absorbing selenium to quite high levels and which grow on seleniferous soils, i.e., soils with a high selenium content. We have used *Neptunia amplexicaulis*, a legume which is restricted to seleniferous soils in central Queensland, and for which selenium levels as high as 4,000 p.p.m. have been found (McCray, private communication). Furthermore selenium would appear to be beneficial for the growth of this plant, since when *Neptunia* is grown in vermiculite with A.R. grade nutrients there is a definite response to selenium (McCray, private communication)..

(b) A representative of an intermediate group of plants, which can contain moderate amounts of selenium (up to 50 p.p.m.) without marked toxic symptoms. Wheat was used as a representative of this group.

(c) Some pasture species (containing 0.01 to 0.1 p.p.m. Se)—white clover, red clover and perennial ryegrass.

The results obtained from the first two groups of plants show marked differences in the distribution of radioactivity. With leaves and stems of *Neptunia*, 90 per cent of the radioactivity can be extracted in boiling aqueous ethanol, whereas with wheat plants only 20 per cent of the radioactivity can be extracted in boiling aqueous ethanol and water. In the *Neptunia* leaves most of the extractable radioactivity is in selenite and in two compounds whose identity is being studied.

It is interesting that so much of the radioactivity (80 per cent) in the wheat leaves is not readily extractable by ethanol or water. Most of this radioactivity can be brought into solution by incubating the plant residues with the proteolytic enzymes trypsin and chymotrypsin. By means of electrophoresis and paper chromatography in several solvents, it was shown that the dissolved radioactivity is pres-

ent in two compounds selenomethionine and methionine selenoxide, which are selenium analogues of the corresponding sulphur compounds methionine (a common amino-acid) and methionine sulfoxide. It would therefore appear that the major portion of the radioselenium taken up into the wheat leaves became associated with the protein fraction. This is substantiated by the fact that when preparations of soluble protein are made directly from wheat plants which have been allowed to absorb labelled selenite there is appreciable labelling of the soluble protein. It is not yet clear whether all or any of the selenium compounds are bound to the protein by peptide linkages or whether the binding is looser, e.g., by salt linkages.

With roots of *Neptunia*, a very high proportion of the radioactivity was not extracted by 80 per cent ethanol or by water. This does not appear to be associated with protein, since very little radioactivity goes into solution when proteolytic enzymes are added. However, most of the radioactivity is rapidly soluble in bromine water, which suggests that it was present in insoluble inorganic form, such as elemental selenium.

There is thus a marked contrast in the distribution of selenium in these two species. It is interesting to speculate that the tolerance of the selenium accumulator to high levels of selenium might be due to the relatively small amount of protein binding of selenium in this plant. The experiments with pasture plants are currently in progress; the results will be of interest in comparison with the two classes of plant already examined as well as from the viewpoint of ruminant nutrition. In particular, the availability of the selenium to the animal and the extent to which total selenium analyses reflect availability should be somewhat clarified.

Excretion of Selenium:

During the course of this work, Dr Cousins of the Otago Dental School advised us that there was a high faecal excretion of selenium given orally to sheep as sodium selenite. When a dose of 5 mg. was given, 40 per cent of the selenium was recovered in the dung in 72 hours. This observation is important, since previous reports of experiments with non-ruminants had indicated a predominantly urinary excretion. It suggests that much selenium may be rendered unavailable to the animal in the digestive tract.

We have confirmed this observation at a lower dose-level, namely 20 g. selenium, by the use of radioactive selenite. This is the sort of level which an animal would ingest daily. Fifty per cent of the administered radioactivity was recovered from the faeces of two sheep, which were allowed to graze normally after injection of radioactive selenite into the rumen. By similar techniques to those used for the plant fractionation studies, we have found that:

- (a) Less than 10 per cent of the selenium is soluble in water or organic solvents.
- (b) Approximately half the radioactivity is dissolved by proteolytic enzymes.
- (c) The remainder is readily soluble in bromine-water and is apparently in insoluble inorganic form.
- (d) The radioactivity is predominantly in the fine material in the dung, very little being associated with the fibrous material present.

The availability to plants of the selenium present in the dung from selenium-dosed animals would appear to be an important point to establish for our understanding of the selenium cycle in our grasslands—and also perhaps for our peace of mind! Accordingly perennial ryegrass is at present being grown on mixtures of sand and radioactive dung, and the extent of uptake of radioselenium by the plants will be determined.

Genetic Variations in Herbage Constituents:

In the breeding of herbage plants, one of the principal aims should be to develop improved varieties which are not only productive (in terms of yield per acre per annum, or seasonal yield), but also of optimum chemical composition from the viewpoint of ruminant metabolism. For pasture species which are the subject of intensive selective breeding programmes, it is therefore desirable to assess the extent of genetic variation in various chemical constituents which are considered to have nutritional significance.

Some experiments along these lines have been carried out at Plant Chemistry and Grassland Divisions with the ryegrass. Iodine was the first chemical constituent to be examined. It was found that thirteen perennial ryegrass plants taken at random gave iodine contents ranging from 18.5 to 247.0 μg . per 100 g. dry weight. Similarly the iodine contents of seven short-rotation ryegrass plants ranged from 7.5 to 57.5 μg . per 100 g. dry weight. Analyses of plants derived from diallel crosses of four of the perennial ryegrass plants were made and it was shown that the percentage of iodine content of the herbage was an inherited characteristic (Figure 2). The cross data also showed that there was a maternal effect.

IODINE CONTENTS OF PERENNIAL RYEGRASS PLANTS.

$\mu\text{G I PER 100 G. F.W.}$

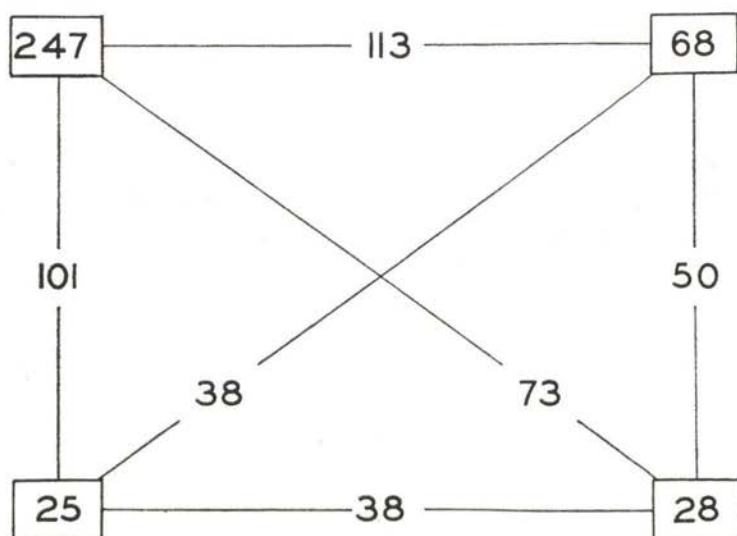


Figure 2—Cross data for herbage iodine contents of diallel crosses from four parent plants. Values for the parents are shown at the corners of the diagram and the values for the crosses are the means for 20 clones of each cross.

A more extensive experiment has recently been completed, in which seven plants derived by hybridisation from perennial and short-rotation ryegrasses have been examined for herbage contents of a number of mineral constituents (in collaboration with Dr P. Barclay, Grasslands Division). The plants were laid out as clones in a randomised layout, so that variations due to soil and environment could be allowed for.

It was found that nitrate levels varied up to ten-fold among the seven plants. Smaller variations (up to three-fold) were found for sodium, potassium, calcium, manganese, aluminium, copper, titanium, iron, zinc, sulphate and acid-soluble phosphorus. Some interesting interactions were found between the levels of a number of the mineral constituents. These are listed as correlation coefficients in

TABLE 1
Significant Correlation Coefficient Between the Levels of Various Mineral Constituents in the Herbage of Seven Ryegrass Plants.

	NO ₃	PO ₄	SO ₄	Ca	Mn	Al	Ti	Fe
NO ₃	—	+0.901	+0.685	—	—	-0.834	-0.703	-0.685
PO ₄	—	—	+0.808	—	—	-0.967	-0.887	-0.666
Ca	—	—	—	—	+0.800	—	—	—
Na	—	—	—	-0.721	—	—	—	—
K	—	—	—	+0.674	—	—	—	—
Al	—	—	-0.729	—	—	—	+0.963	+0.731
Mn	—	—	—	—	—	—	—	-0.795
Ti	—	—	—	—	—	—	—	+0.734
Cation exchange capacity	-0.808	-0.925	—	—	—	+0.971	+0.936	+0.817

For 0.669, $p = 0.10$
 0.754, $p = 0.05$
 0.874, $p = 0.01$

Table 1; also shown are some significant correlations with values obtained for the same plants for the root cation exchange capacity. This quantity was determined by Mr N. Mouat of Grasslands Division and varied by a factor of 1.5 for the seven plants. Environmental effects were removed from the data in Table 1, which are to be regarded as "genetic" correlations.

It will be seen that there are strong positive correlations between the cation exchange capacities of the roots and the levels of the polyvalent cations aluminium, titanium and iron. Conversely, the cation exchange capacities of the roots were negatively correlated with nitrate and phosphate levels. I have not time to go into the details of this today, but will merely ask you to accept the statement that this is what one would expect from Donnan equilibria if the step from soil solution into the roots was the rate-limiting step in the process of uptake of these minerals by the plants. In this connexion, it should be pointed out that the analyses quoted are for herbage taken when the plants were in a state of rapid growth and when the demand on soil nutrients would presumably have been greatest.

Some other interactions, which show up in Table 1 are to be expected from the plant physiological literature, for example the negative correlation between iron and manganese.

Growth of these plants was also determined at (or near) times of harvest of herbage for analysis. It is interesting to note that in no case so far has variation in a particular plant constituent been correlated with differences in herbage production of the plants. This emphasises the point that the assessment of the nutritive value of plants being used in the development of new strains required detailed chemical servicing.

Variations in the levels of the alkaloid perloine were also examined, since this constituent is also of interest from the point of view of ruminant nutrition (Cunningham and Clare, 1943). Perloine levels varied up to 50-fold amongst perennial ryegrass parent plants; with the seven plants used in the preceding experiment the values ranged from 8 to 264 mg. perloine per 100 g. dry weight.

To sum up, genetic variations in herbage levels of nitrate, iodine and perloine are large in the ryegrasses, and smaller variations occur for a number of other constituents. It is clear that the work should be extended to other chemical constituents and also other pasture species. Variations in carbohydrates are at present being examined by Dr Bailey at Plant Chemistry Division; cobalt, selenium and lignin levels are also either being determined or planned for early action.

Ryegrass Strain Trial:

Finally I wish to refer to two trials which have been carried out during the past five years, jointly by members of the Sheep Husbandry Department of Massey Agricultural College and of the Plant Chemistry and Grassland Divisions, D.S.I.R.

The experiments are being carried out on a paddock scale on the Massey College sheep-farm on a total area of 16 acres. Four different types of pasture were established on the area, namely:

Perennial ryegrass.

Short-rotation ryegrass.

Perennial ryegrass and white clover.

Short-rotation ryegrass and white clover.

Nitrogen in the form of sulphate of ammonia was applied to the pure grass swards from time to time as required, the annual dressing being approximately 15 cwt per acre. All treatments were top-dressed with 3 cwt superphosphate and 10 cwt lime per acre annually.

In each trial, the pastures were stocked with ewe-hoggets in May of the first year. The paddocks were set-stocked throughout each trial, the minimum carrying capacity being 6 ewes per acre. Where necessary, extra sheep were brought on to the area to control excess growth. The ewes were mated in the second year of each trial and their lambs were reared to the weaning stage. All animals were weighed periodically and all were slaughtered in December of the second year of each trial. Detailed examinations of carcase composition were then made.

In both trials, differences in the growth rate of the ewes on the various pasture treatments became apparent at an early stage and continued throughout. Figure 3 shows the divergence mean live-weights for the various groups of animals during the first nine months of the second trial. It will be seen that a difference of 25 lb had opened up by the end of this period between the animals which had grazed short-rotation ryegrass plus clover throughout and those which had grazed pure perennial ryegrass. The live-weight gains on the other two treatments were intermediated between these two

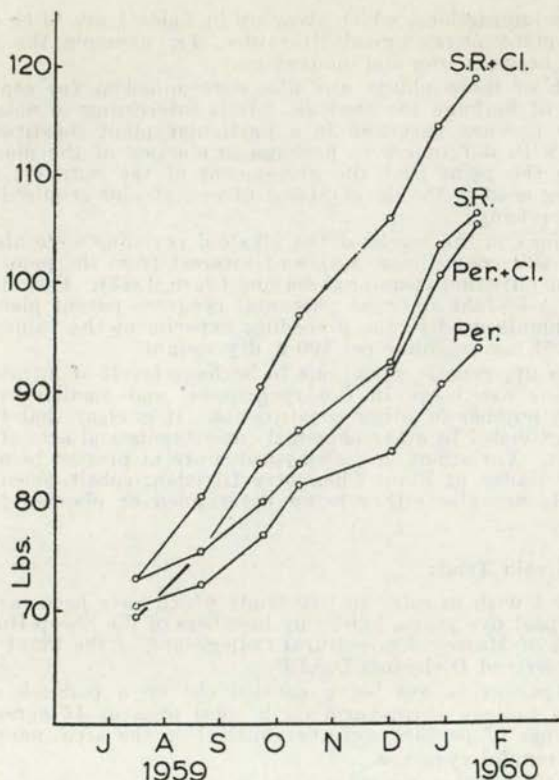


Figure 3—Mean live-weights for the four groups of animals during the first nine months of the second trial. P, perennial ryegrass; S.R. short-rotation ryegrass; S.R. + W.C. short-rotation ryegrass plus white clover; P. + W.C. perennial ryegrass plus white clover.

extremes. A feature of these results was the general agreement between the first and second trials and also between individual replicates of the treatments in each trial.

Iodine:

Iodine nutrition of sheep was also examined in these trials. Earlier work (Flux, Butler, Johnson, Glenday and Petersen, 1956; Butler, Flux, Petersen, Wright, Glenday and Johnson, 1957; Johnson and Butler, 1957) had shown that there were large differences in the total iodine content of herbage of different pasture species and strains growing on the same soil. For example, short-rotation ryegrass had only one-fifth of the iodine content of perennial ryegrass. Also it had been shown that when white clover was fed to small animals, the uptake of iodine to their thyroid glands was retarded. This is known as a goitrogenic effect, and evidence was obtained which indicated that two chemical compounds present in the white clover, known as cyanoglucosides, were responsible.

It would appear therefore that the iodine nutrition of the animals set-stocked on the four types of pasture used in the trial would differ markedly. Accordingly, half the animals on each pasture type were given an iodine supplement in the form of "NEO-HYDRIOL," an iodinated poppy-seed oil, which was injected intramuscularly. This dose was sufficient to raise the blood iodine level three- or four-fold and to hold it at that level for at least 12 months. Differences in live-weight gain, wool production and fertility were examined for the iodine-injected and non-injected animals on the four pastures, and at slaughter the thyroid glands of the ewes and their lambs were weighed and analysed for total iodine.

The results of the first trial have been described in detail elsewhere (Flux, Butler, Rae and Brougham, 1960). In both trials, no differences in animal production were observed. No cases of congenital goitre occurred in the lambs. The thyroid data proved particularly interesting and the mean weights for the different groups are summarised for both trials in Table 2. It will be seen that the goitrogenic effect of the white clover was quite pronounced in the first trial, but negligible in the second trial.

TABLE 2

Mean Thyroid Weights (Grams) for Ewes and Lambs Grazing Four Pasture Treatments

N.I. = not injected with Neo-Hydriol. I. = injected with Neo-Hydriol.								
Treatments	Perennial		Short-rotation		Perennial + White Clover		Short rotation + White Clover	
	N.I.	I.	N.I.	I.	N.I.	I.	N.I.	I.
First trial								
Ewes . .	7.6	4.2	5.9	5.3	9.0	5.2	12.7	5.1
Lambs . .	2.2	2.2	2.4	1.6	5.4	2.5	6.0	4.3
Second trial:								
Ewes . .	9.1	6.0	8.0	6.0	9.0	6.7	7.5	7.5
Lambs . .	2.2	2.5	10.8	2.6	3.2	3.2	3.9	3.2

An unexpected development was the presence of goitrogenic effects in animals grazing the pure ryegrass pastures, the most marked being noted in the lambs grazing short-rotation ryegrass in the second trial. These effects were not due to a few animals with very large thyroids, but were overall group effects. It is clear that other factors than those so far considered are also important in regulating the iodine nutrition of sheep and lambs on pasture and experiments are currently in progress to endeavour to elucidate these.

These experiments were carried out during four seasons in which goitre did not occur in sheep in the district. It is probable that the effects observed would have been larger in "goitrous" years.

This trial originally set out to test differences in animal production caused by differences in iodine nutrition. This has proved to be a minor issue, but it will be appreciated that the finding of such large differences in nutritive value of the different feeds has been a thought-provoking consolation prize. It is clear that the elucidation of the chemical bases for these differences is of considerable importance. An understanding of the salient features of the ruminant physiology of animals on the different treatments would appear to be necessary and data on this aspect will be presented in the following paper.

Officers concerned in this trial have been Professor A. Rae, Mr R. Barton, Dr D. Flux, Mr M. Ulliyat, Dr A. Johns, Dr G. Butler, Dr R. Bailey, Mr N. Bathurst, Dr L. Corkill, Mr R. Brougham and Mr A. Glenday.

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SOME FACTORS AFFECTING INTAKE AND PRODUCTION IN RUMINANTS

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Introduction:

In the previous paper by Dr Butler results of experiments have been discussed which constitute part of our programme aimed at determining the factors which influence the nutritive value of pasture plants for sheep and cattle. The purpose of this paper is to put forward a probable explanation as to why short rotation ryegrass has given greater live-weight gains than perennial in our trials, and to discuss particularly the factors which influence the utilization of pasture by the grazing animal.

Digestive Process in the Rumen:

We will consider briefly the digestive process peculiar to the ruminant. Its stomach is divided into four compartments, the first two of which form a large fermentation vat, where conditions are ideal for microbial digestion of the food. We know that any pasture will supply the cow or sheep with carbohydrates ranging from the simplest sugars to the complex fibrous celluloses. These are broken down by the micro-organisms to the same limited end products, although at rates which differ greatly with different carbohydrates. The result is a mixture of volatile fatty acids—acetic, propionic and butyric—with perhaps some lactic acid; water, carbon dioxide and methane are also produced during the fermentation. With diets of hay, which is of course relatively high in fibrous cellulose, the mixture of acids found in the rumen usually consists of approximately acetic 70 per cent; propionic 17 per cent; butyric 10 per cent, and traces of higher acids (3 per cent). Where the diets are rich in soluble sugars or starch the proportion of acetic falls and that of propionic rises. In extreme cases, e.g., a cow receiving 2 lb hay and 24 lb concentrates, the proportions may be 41 per cent acetic and 39 per cent propionic. With a diet consisting entirely of hay, the production of acids by fermentation is relatively slow and regular, so that there is little rise and fall over the day in their concentration in the rumen contents. With increasing amounts of soluble carbohydrates, such as in concentrate feeding, the acids tend to be produced more rapidly giving a peak two to four hours after feeding, followed by a pronounced fall.

A unique feature of the ruminant stomach, as opposed to the simple stomach of man or dog, is that direct absorption of the products of digestion into the blood stream occurs to a significant extent. This absorption is facilitated by the inner surface of the rumen being covered with papillae. It had been thought that the development of these papillae was the result of the physical nature of the food itself. They are absent when the young animal is living on milk and develop when solid food is being eaten. Surprisingly enough, it has now been shown that the chemical products of digestion—the volatile fatty acids—exert a much greater stimulating effect on their appearance than does the physical form of the food itself. In fact, differences in level and proportions of the acids resulting from different types of feed can have a marked influence on the extent of papillary development. The size of the rumen developed does, as we shall see later, appear to depend on the physical nature of the food. The points outlined to date can be summarised by saying that nature of the food that the animal eats can determine:

- (a) the percentage of acetic and propionic acid formed in the forestomachs,
- (b) the rate of digestion,
- (c) the type of development that occurs in the absorbing surface in the animal's stomach.

Utilization of Products of Fermentation in the Rumen:

We can now consider the implications of the knowledge that we now have in being able to vary these acids by feeding different foods. Work in the last few years has shown that acetate is used by the animal in the production of fat, and particularly milk fat, by the dairy cow. It is now fully established that diets which bring about a fall in acetate and an increase in propionate in the rumen (i.e., diets low in roughage) cause a fall in milk fat production (in severe cases this can reach a level of 1 per cent). Infusion of acetate into the rumen can experimentally counteract this change whereas propionate will not.

Propionate is concerned with carbohydrate and protein synthesis. Propionate given to a dairy cow increases the solids-not-fat content, which is mainly represented by an increase in protein.

The three volatile fatty acids, acetic, propionic, and butyric acids which are the major sources of energy for the ruminant are used with a fairly constant efficiency of 85 per cent when they meet maintenance energy needs.

When they are used as a source of energy for fat synthesis in the fattening animal acetic is used with an efficiency of 33 per cent, propionic 55 per cent and butyric 62 per cent.

Greater weight gains have been obtained in growing animals where diets have been manipulated to produce a fermentation which gives a relatively higher proportion of propionic acid.

It was mentioned earlier that this can be done by feeding a diet relatively high in soluble sugars and low in fibre. It can also be achieved by finely grinding hay. This process is being widely employed in the U.S.A. where the ground hay is made into pellets. The rumen bacteria can more easily ferment the finely divided fibre than they can ferment the unground hay. The result is that not only is there an increase in the rate of digestion of ground hay but the proportion of propionic acid is increased.

The effect on live weight gains of the pelleting treatment is illustrated by an experiment carried out in the U.S.A. With a diet consisting of coarsely chopped hay, ground corn, and linseed oil meal, 8 steers gained an average of 2.05 lb for 56 days. Another 8 received the same weights of food per 100 lb body weight, but the hay was ground and pelleted. This group gained 2.55 lb daily. Examination of their rumen contents showed a marked fall in acetate and an increase in propionate content.

In general, pelleting of hay results in an increase in intake over that of the unground forage. In a Californian experiment with pelleted lucerne hay and long hay fed to lambs, pelleting the hay resulted in an increase in intake from 2.8 lb to 3.59 lb per day with weight gains of .24 and .38 lb per day respectively.

Appetite:

This increase in appetite with pelleting brings us to the subject of factors regulating intake of food by sheep. We must go back for a moment and consider the mode of digestion in the ruminant. It is evolved to make use of the fibrous part of the plant by microbial fermentation. We have an organ in which the food is constantly stirred and the larger plant particles are regurgitated to be rechewed by the animals. As the food is digested and broken down into a finely divided state it passes on to the third and fourth stomachs.

Hence the more rapidly the food is digested the more rapidly it passes on down the digestive tract. Rapidly digested concentrates and finely divided hays pass on more rapidly than the long fibrous hay. With the passage of the food the animal has the desire to eat more.

The generalisation is now becoming apparent that the ruminant eats more of high quality diets than of low quality diets. This has, in the past, been stated in the reverse form by a number of people, that the amount of different foods consumed was such that the amount of indigestible matter or "ballast" was the same for each. This appears to be due to the effect of food on gut distension and rates of passage of the indigested residues.

This effect of quality of food on intake is well illustrated by the experiments of Blaxter reported to the 8th International Grasslands Conference and shown in Table I.

TABLE I
Food Intake of Sheep Fed ad lib and their Resultant Gains

Food	Appetite dry matter 0.73	Energy digested in excess of estimated maintenance 0.73	Observed gain/day 0.73
	Kg. W	K cal./Kg. W	g/Kg. W
Poor hay	58	16	+ 0.7
Medium dried grass	81.6	122.5	+ 5.4
Good dried grass	93.8	216.4	+ 9.4

It will be seen that appetite was 62 per cent greater for the better food. In terms of energy available for productive purposes the high quality material was superior by a factor of 12, a factor which also held for weight gains during the experiment.

What is becoming apparent is that quite small changes in the apparent digestibility of food can have considerable consequences in terms of production under ad lib feeding conditions.

I would like to point out at this stage that the regulation of food intake by ruminants is the very reverse state of affairs pertaining to other species. With poultry, rats, and humans, it appears that the intake of digestible food nutrients is the same whether high or low energy diets are eaten. In other words, the mono-gastric animal tends to eat to a constant energy intake. With ruminants the quality of the food is the governing factor where quality is donated by the digestibility of its energy.

As Blaxter has pointed out, if an animal eats more of one food than another, it is usual to ascribe such a difference in intake to the fact that one food is more palatable than another. "Palatable" means agreeable to the taste. The results of experiments with sheep show, in fact, that the voluntary intake of fodders was related to the digestibility and rate of passage of the foods, attributes which are hardly consonant with their "acceptability to the palate or taste." This is, of course, a very simplified concept giving the general picture which can be modified by both animal and plant factors.

Up till now we have considered the utilization of food by what we might call the average animal. As you well know there is a very considerable difference in the rate of growth between individual animals in a flock on the same feed. We have assumed in the discussion above that all animals ferment the same feed in the same way and at the same rate. This is unlikely, as we have now learnt that we cannot consider the rumen just as a fermentation vat in which, if we feed particular substances, we will get the same result in all animals.

There can be quite a considerable quantitative difference in the microbial flora of animals on the same feed. In fact it would appear most unlikely that the quality of feed would be the only determining factor of feed intake. For instance, we know full well that different breeds of dairy cows will produce milk of different composition when fed on the same feed. Also, when the same animals have extra energy requirements such as in pregnancy and lactation an increase in appetite would have to involve an increased rate in turnover in the rumen for satisfying the increased need. Presumably in pregnancy the actual volume of the rumen will be restricted by the increasing size of the fetus. This can possibly be counteracted by a greater rate of passage.

Another illustration of the difference between animals in the fermentation of the same feed is illustrated in studies by Hungate on the relative fermentation rates of European and Zebu cattle. It is a common belief in East Africa that Zebu are able to utilize poor forage more efficiently than European cattle. It was found that the fermentation rate in the rumen was higher in Zebu cattle than European when both were fed on the same hay. This indicates that there can be considerable influence of the animal in the rumen fermentation.

Ryegrass Strain Trial

Now we come to our ryegrass trial experiments outlined by Dr Butler in the previous paper, and the data I wish to discuss are in Tables II and III.

TABLE II
First Trial (1958-59)

Data obtained from ewes (78) and lambs (55) fed entirely on the four types of pasture.

	Perennial Ryegrass	Perennial Ryegrass + W. Clover	Short Rotation Ryegrass	Short Rotation Ryegrass + W. Clover
Final live weight ewes (lbs)	103	119	116	136
Carcass weight	56.2	70.2	74.7	81.5
Average daily weight gain of lambs	0.30	0.40	0.38	0.47

In the weight of rumen contents there is a highly significant difference between grasses with the addition of clover making little difference. However, addition of clover to the diet had a significant effect in the concentration of the products of microbial digestion, the volatile fatty acids, while the difference between grasses was less marked. Hence we see that the animals that have grown the fastest the S.R. + C, have actually the smallest forestomachs and the highest level of fermentation. Intake measurements have not been made, but from what we know of other recent work it is highly probable that appetite increased as we go across the table from perennial to S.R. + C. It is evident that the animal with the slower fermentation rate can in part compensate for its lower fermentation rate by a more capacious rumen. In the case of the S.R. + C not only will there be more acid produced, but it will have to be absorbed more rapidly from the smaller organ. Although there is very considerable variation in each group it has been found that the papillae which provide the absorption area are in general better developed in the S.R. + C than in the P sheep.

The individual volatile acids produced in the rumens of animals on the four pasture species have so far only been determined for the perennial ryegrass and the short rotation ryegrass plus clover groups.

It was found that the short rotation + clover group was significantly lower in acetic and significantly higher in both propionic and butyric acids than the perennial ryegrass group. The relative contribution of the clover and the ryegrasses to this difference still has to be determined.

It is evident, however, that the short rotation ryegrass + clover produces, besides a more intense fermentation in the rumen, a mixture of acids that are more efficient in producing weight gain than are those formed from perennial ryegrass.

Discussion

From the results on the relative weight of rumen contents and other evidence that we have obtained, it would appear that it is not only the physical action of the food on gut distension that regulates appetite. It is highly probable that the concentration of the end products of the fermentation can be the controlling factor under the condition of high fermentation rate in the rumen. In simple stomached animals it is believed that glucose concentration in the blood acts as the regulator of feeding behaviour. In sheep and cattle the alteration of sugar concentration in the blood has no influence on appetite, whereas the level of acetic or propionic acid does. So presumably it will depend on which reaches its physiological threshold first, the concentration of acetic or propionic acids, or the physical fill of the rumen, that will determine which has the controlling influence on appetite. From this evidence it appears that we have the same differences between perennial and short rotation ryegrass as we have between hay and concentrates or long hay and ground hay. Perennial behaves as a more fibrous plant, more slowly digested, giving a higher proportion of acetate while short rotation is more rapidly digested with less of the fermentation products coming from cellulose. Clover with its low fibre and high soluble carbohydrate also increases the intensity of the fermentation. We hope now to carry on this programme and determine which are the particular components of the plant which give rise to a particular rate of fermentation and proportion of fatty acids. The proportion of these components will, of course, vary with the stage of growth of each particular species.

It seems probable that a particular pasture mixture which is ideal for lamb fattening may not be the ideal one for milk production.

We trust that further work will bring a rational approach to plant breeding and pasture management.

It must not be forgotten once again, that the animal comes into this, and to understand fully the problem of appetite and production of livestock at pasture we must know why different animals have different live weight gains on the same pasture. The difference in utilization of the end products of fermentation between animals is a complicated story which we do not propose to tackle, but there are many aspects of animal differences in regard to the rumen fermentation of feed that can be clarified. Besides being hopeful of improving pasture for particular types of animal production, there would appear to be scope for the breeding and selection of animals for maximum efficiency of conversion of herbage and hence maximum live weight gains.

In this talk I have dealt only with the basic factor influencing appetite, i.e., the intake of herbage which is not deficient in minerals, in which toxic substances are not present, and other factors which present special effects, such as decreasing "palatability."

In leaving them out of consideration I do not wish to give the impression that they are not important. They certainly are, and we hope to study them, but a discussion of them at this time would unduly lengthen this paper.

FARM FORESTRY

Species For Various Sites and Purposes

A. W. Grayburn, Assistant to Superintendent, Selwyn
Plantation Board.

Introduction

In a recent panel discussion on Forest versus Grass related to land use, a Hawkes Bay farmer said that, "in New Zealand we had entered a period when there was a distinct reluctance to re-establish the forests. This stemmed from a realisation that men had destroyed far too much too quickly. Resentment and guilt had produced a prejudice against foresters upon whom had fallen the task of endeavouring to re-educate the farmers." As a forester addressing a farmers' gathering such as this, I feel a little in that position. Many of you will not require any persuading that trees have a use on the farm while others will be harder to convince. There seems to be more supporters of the saying "plant trees for your lives" where no trees existed at all before, while there is more reluctance to plant where the farms were once covered with native bush. However, I hope to be able to show you that trees can enhance the value of a property in more ways than one.

I propose to deal with the subject under five main headings, viz.:

- I. Reasons for wanting to plant trees.
- II. Planning your shelter.
- III. Farm management related to shelter.
- IV. Farm woodlots.
- V. Amenity planting,

but the main emphasis will be on shelter.

As far as is possible, all parts of the South Island will be dealt with in a general way. Specific problems must be dealt with by looking at each individual farm because of its own peculiarities and local conditions so one cannot cover them all here.

I. Reasons for Wanting to Plant Trees:

A.—Shelter. Most farms in New Zealand need shelter of some sort for one reason or another according to the type of farming practised and the locality.

1. *Wind*: It can be said that protection from wind is the main reason for providing shelter and investigations, which have been made into shelter design and value here, have used wind as the main criterion. Most other important factors are associated with winds and wind changes in some way. As the South Island lies in a windy region of the world we can look upon wind protection as our chief factor to consider.

2. *Cold*. Sudden severe drops in temperature are usually associated with wind changes and shelter for one often provides shelter for the other. However, some places will be concerned with trying to encourage warm conditions for early pasture or crop growth, e.g., town milk supply farmers, market gardeners and so on. Stock will produce more meat, wool and milk if the feed they consume is not required to maintain body temperatures on cold exposed pastures. Milk production has been increased by as much as 16 per cent.

3. *Shade*. Most stock do not like to be without any shelter where very hot sunny days are experienced for long periods at a time.

4. *Stock Food.* I mention this reason here as often trees and shrubs suitable for shelter may also be suitable for forage purposes. This practice is usually not necessary in New Zealand but it is in other parts of the world. In very bad seasons when food is in extremely short supply, loppings from shelter trees could save a few lives.

B.—Woodlots or Plantation. Today farmers are being urged and encouraged by the Government to plant trees on their properties as a crop. It has been estimated that New Zealand's total exotic forest estate should be 3,000,000 acres by the year 2025 A.D. which is 2,000,000 acres more than the present area. It is hoped that half of this additional area will be planted by farmers.

While much good timber in the past has originated from shelter belts, it is seldom possible to achieve both good shelter and good timber production from the one planting. Many foresters and farmers disagree on this point but any significant timber production in the future must come from properly established and managed woodlots. The economics of such an undertaking will be of vital importance to you and will be the subject of the next paper given by Mr Cooney.

Woodlots can be established for various reasons:

1. *Commercial Enterprise.* To supply an existing market or one which you know will be established in the area. This can be for round produce to be treated in a preservation plant, for sawlogs or for pulpwood, or for material to be used on your own farm. Choose a species for which there is already a continuing market or likely to be.

2. *For Occupying Waste Land.* Usually restricted to hill country where there are areas which cannot be cultivated or grazed to advantage. There may be other reasons why this land is more or less idle and could well be planted to trees and so be more productive. All of you will be interested in increasing the productive potential of your farm.

3. *For Occupying Weed Infested Land.* It is here that productivity can be increased especially on marginal land. Aggressive weeds such as gorse, broom, blackberry and nasella tussock can be beaten by fast growing tree species, e.g., Radiata pine. The slower species such as Douglas fir, Larch and Corsican pine can be helped if the weeds are sprayed when they threaten to compete too much with the young trees. Many catchment areas which might erode if the weed cover were removed for grassing would remain more stable if planted in trees which gradually take over from the weeds.

4. *For Erosion Control.* Many hill country farms and farmers along streams subject to flooding will be interested in stabilising the land with tree planting. If they can be grown as a woodlot, some financial return can be expected too without endangering their stabilising effect. Parts of Ashley State Forest in North Canterbury were established for this reason but will form part of the production forest too.

C.—Amenity Planting. It is under this heading that a very much wider range of species can be justified because time and expense usually don't count. But site and climatic factors do restrict you to some extent—more of that later.

1. *Shelter.* Ornamental trees can be incorporated on shelter belts and form part of the shelter pattern around homesteads, buildings and hillsides. This is particularly so if basic shelter is already established.

2. *Beauty*. There are species which can be chosen for their
- (a) Attractive foliage in various seasons.
 - (b) Flowers.
 - (c) Coloured fruit.
 - (d) Bark.
 - (e) Natural shape and general appearance.
- and (f) A combination of many features.

3. *Edible Nuts and Fruit*. Many species come to mind which you would like to have but don't particularly want to put them in the homestead orchard.

II. Planning Your Shelter.

As long ago as 1908, an Irish forester said, "It is not too much to say that the same attention should be given to the proper planning and distribution of natural shelter in the construction of a farm as is given to the proper planning, construction and maintenance of fences, drains, farm buildings, etc." The same is equally true today and cannot be emphasised too much. As trees take a long time to grow, correct planning at the establishment stages will avoid mistakes and disappointments which may only become evident after many years have elapsed. It is often too late to correct them at that stage.

A.—Overseas Experience. A considerable amount of investigation has gone on in the past in non-English speaking countries. Language difficulties have made it difficult to analyse this work. From 1953-55 Dr J. M. Caborn working at Edinburgh University analysed all the published work on shelterbelts in the world and initiated a research programme of his own. The results were published in 1957 and form the basis of our knowledge of shelterbelts and their effect on wind-flow. He looked upon wind as the major factor to be considered and aimed at getting as much shelter as possible from wind near the ground.

It was shown that the best shelter effect was obtained from a shelterbelt with abrupt margins and where there was up to 48 per cent permeability. This caused the greatest disturbance to the air flow and set up a series of light eddies and turbulent flow which form the basis of shelter effect. The velocity of the wind is then resumed more gradually and less harmfully. The distance to which there is shelter effect out into a paddock is determined by the height and permeability of the belt. It is possible to prevent wind from resuming its full velocity by having parallel belts at right angles to the wind and no more than twenty-six times the height apart. Whether you can do this will depend on your acreage, your sub-division and the type of farming. The best belts are no shorter than twenty-four times the height to reduce the eddying effect around their ends. But clumps do have their value for other reasons. Generally speaking gaps in shelter belts are not dangerous from the point of view of wind damage but they tend to have a funnel draught effect.

Depending on species and maintenance, it was shown that one or two row belts gave the best results. With dense tall growing species, one row is adequate while less dense species will need either two rows or a second row of a dense shorter species on the leeward side. In this way a greater range of species can be used and some sort of rotation without clear felling may be practised. At this stage it could be argued that if conifers are being used, a three-row belt would give a good timber producing row down the centre. But it must be emphasised that if this is done, the permeability is reduced and so is the effectiveness of the shelterbelt and therefore it cannot be recommended.

Caborn emphasises that a lot more work needs to be done before a shelterbelt pattern can be defined for hill country. Wind behaviour on hill country is much more dependent upon topography than on the flat so each case will need particular investigation.

B.—Regulations. There are some statutory restrictions which may determine where and what you do in the way of shelterbelt establishment. Take these into account to avoid the humiliation of having to remove your trees at a later date without any redress.

1. *Noxious Weeds Act 1950.* In some localities it is illegal to plant some of the poplars and willows, hakeas and hawthorn.

2. *Fencing Act 1908 and Amendments.* See that whatever you plant does not offend your neighbour because without his consent you cannot plant anything closer than two feet from the boundary. Even then he may take legal action because of shading, soil deterioration, etc.

3. *Public Works Act 1928.* (a) Roads: Trees must not endanger the road in any way by restricting visibility, being detrimental to its maintenance, causing icing, being liable to fall over the road in a storm, shedding slippery leaves and so on.

(b) Power and Telephone Lines: Trees must not endanger the lines in any way or impair their efficiency.

(c) Aerodromes: If too high and too close to a landing strip, trees may endanger the aircraft using the aerodrome.

C.—Layout and Design. By dealing with some of the do's and don't's you will see what might best suit your conditions. So much will depend on locality, farm layout and type of farming practised.

1. Firstly, have a clear idea of what the shelter is for—against a sea wind, against sudden southerly storms, against north-west winds, to promote early pasture growth and so on. For best results belts must be at right angles to the wind you wish to reduce in velocity.

2. In the light of overseas research, belts must be narrow, i.e., one or two rows. This will save space particularly on small farms with a high land value where every acre must produce. But even market gardens can afford to have shelter where it is necessary. Narrow belts are easier to maintain too.

3. Avoid shading of roads, tracks, gateways, etc., which may ice up or bog in the winter. A belt orientated north to south will give the least shading in winter and will give almost maximum protection against winds from the easterly and westerly quarters. Never plant tall growing trees near buildings unless you intend to top. There is always the danger they might blow over. A two-way angled belt in the corner of a paddock is often a good idea to provide a warm sheltered spot.

4. Aim at a certain amount of permeability in the shelterbelt and this can be obtained either by using conical shaped trees, broad-leaf trees with rounded tops or trees and shrubs with varying height growth to give a broken profile. There must be a nice balance between permeability and draughtiness.

D.—Choice of Species. In a talk such as this one can only deal with the basic proven species. The forester has not found the farmer's perfect shelter tree yet—one that grows to about 20 feet in four to five years then immediately stops growing in size so that no maintenance is required, and is attractive, too.

Many of you will not like *Radiata* pine and will try to avoid using it. But under many circumstances there is practically no other

choice. For initial shelter under most conditions, it has no peer. It is hardy and yet grows quickly but can be kept trimmed almost indefinitely. If you don't like it but are forced to use it because of circumstances, plan a gradual replacement by rotation once the initial shelter is well established.

Macrocarpa. Not an easy species to establish and therefore box grown stock should be used. It is particularly useful in coastal areas because it withstands salt winds. It can be readily trimmed.

Cupressus arizonica. A very variable species as found in New Zealand, ranging from very open leggy types to dense compact forms ideal for shelter. It grows well on fairly dry sites. Use box grown stock, too.

Lawsoniana. No longer recommended because of its susceptibility to the cypress canker. This is most unfortunate because *Lawsoniana* is an ideal shelter species on good soils with a fair rainfall.

Thuya plicata (Western Red Cedar). It is now taking the place of *Lawsoniana* and looks very similar to it. Planting stock is rather hard to get. It likes a good damp site.

Deodar and *Atlantic Cedars*. Both are doing well on poor dry soils but the former is favoured because of its denser foliage. It is slow growing so needs no attention for many years.

Douglas Fir needs a minimum of 35 to 40 inches of rainfall if grown for shelter. It is an ideal species for farm woodlots along with *Larch*, *Radiata* pine and *Corsican* pine.

The Poplars, *Lombardy* and *Black* stand out in this genus although *Robusta* and *Yunnanensis* are being used now, too. *Lombardy* poplar in a single row kept trimmed regularly takes up little room and has been used traditionally around orchards and market gardens. Avoid the suckering varieties. The so-called Evergreen *Lombardy* is found here now and may have some advantages. It is a popular genus for erosion control work.

Willows. More could be done with willows especially by using a wider range of species. They have been used for fodder purposes and erosion control.

Eucalypts. Generally speaking this is a disappointing genus in the South Island. Disease and general unthriftiness have made them unpopular in recent years as well as the difficulty of raising them. In certain localities the following species have done well: *obliqua*, *regnans*, *fastigata*, *globulus*, *gunii*, *viminialis*, *gigantea*, *linnearis* and *scabra*. *Eucalypts* are a subject on their own and much of the difficulty with them is in their identification.

Wattles are not recommended as they often develop into a weed species.

European Hardwoods which have done well on suitable sites include Silver Birch, Ash, Sycamore, Lime, Chestnut and Planes.

Pinus murrayana is a most hardy and aggressive species. It will thrive on the wettest sites as well as on the poorest and at high altitudes. Therefore it promises well for soil erosion work but threatens to become a weed in some places because it is a prolific seeder. Good land management would overcome that disadvantage.

Native Flax is ideal as a nurse crop on exposed sites whether inland or coastal.

A wide range of shrub and small tree species can be used in conjunction with the tree species already mentioned, particularly if they can stand a little shade. *Phebalium* is being tried now but it is barely stiff enough for very windy localities. Lesser known species about which there is only limited knowledge and experience for

shelter purposes include: *Cupressus benthami* (Spanish fir), *C. torulosa*, *C. leylandii*, *C. lusitanica*, *C. sempervirens*.

It is a good idea to look around and see what is already growing well in the district and choose those species. Often the correct strain of a species is important, too, just as you vary your breeds of cattle, sheep and wheat to suit particular conditions. But foresters have not made the advances in this direction yet that agriculturalists have.

E.—Establishment and Maintenance. Order planting stock well in advance so that planning is not upset and good healthy stock is supplied. Spacing will vary with species and requirements. To obtain quick shelter, plant close and thin out before there is too much suppression of side branches resulting in draught holes.

It is essential to fence before planting so that stock don't eat the trees first. Fencing should be permanent, so for economy shelterbelts must coincide with subdivisions. Have fences at least eight feet from the planted row and further if possible. If it is intended to trim, plan your fencing so that the machine cutting arm can reach its work.

Prepare the ground before planting by pitting and clearing away competing vegetation. If the area is ploughed first, make sure it is well consolidated before planting to avoid early windthrow. While young trees like shelter, they must not be choked by competing vegetation. Keep them cleared until well established.

If the belt is to be trimmed, commence early and do it regularly to maintain a good shape. As soon as the height has been attained at which topping is intended, start this work and continue regularly. Many good belts are ruined by late topping which at that stage must be too severe. Good fencing and maintenance will prevent a shelter belt from becoming draughty.

Replacement of old or poor belts needs careful planning so that parts of the farm are not suddenly deprived of shelter. Take advantage of the old shelter, no matter how poor, to hasten the establishment of the new.

III. Farm Management as Related to Shelter

One often hears shelterbelts or particular tree species being blamed for stock ill health, etc., when some bad farm management practice is the real reason. For example, blood poisoning or fly strike are not caused by radiata pine or macrocarpa shelterbelts. But on the other hand, the value of shelterbelts is difficult to measure in £ s. d. although there is no doubt that they improve a property. Full advantage can only be made of the shelter on a farm if certain things are done or avoided and prejudices overcome.

A.—Stock Health. (1) If a belt is draughty or the ground near it has been fouled over the years, don't allow lambing ewes or newly shorn sheep to camp under it. A temporary fence erected out on fresh grass will keep them away from those dangers and still allow the animals to get the best shelter.

(2) During warm, humid conditions, keep sheep away from trees to avoid the likelihood of fly strike; they shouldn't need shelter under those weather conditions anyway.

(3) Later in a summer season, sheltered grass often becomes rank and less palatable so its growth must be controlled by mechanical means.

(4) Avoid souring of the ground or an unbalanced build-up of fertility along a shelterbelt by preventing stock camps and a concentration of droppings there.

(5) The high country farmer already knows the value of winter and summer grazing according to its sheltered warm aspect as well as its freedom from snow or snow drifts. The same principles apply to the lowland farmers but in different degrees.

B.—Pastures and Crops. (1) It has been shown that there is a loss in productivity close to the shelterbelt but that this loss is more than balanced by the gains from shelter twice the height to twelve times the height out into the paddocks. Therefore it may pay not to sow that area immediately adjoining a belt.

(2) Avoid shading a crop for long periods because its ripening will be too uneven for efficient harvesting.

(3) Make sure that trees do not shed branches or fall into a crop because they will damage harvesting machinery and cause unnecessary delays.

(4) Choose species for shelterbelts that have a limited surface rooting system otherwise they interfere with ploughing and take too much nutriment from the adjoining crop.

(5) Reserve sheltered, warm pastures if early spring feeding off is required. A gain of a week or two at the beginning could improve returns for lambs or town milk supply.

(6) Shelter plays its part in reducing evaporation, conserving soil moisture and keeping soil temperatures up so that there are better conditions for early germination and rapid growth.

C.—Weeds. Never allow aggressive or noxious weeds to become firmly established in amongst shelterbelts. Many of them are relatively shade tolerant and can exist quite well under trees from which they may spread at any time. Barley grass is an example as well as gorse and broom. It is only in woodlots that the dense shade will kill weeds; there is too much side-light in a shelterbelt. Therefore they have to be removed by hand or killed with hormone sprays.

As shelterbelts are a barrier to the winds so also are they a barrier to windblown seeds. Bird carried seeds will also be dropped from trees so a constant vigilance for weeds will be necessary.

IV. Farm Woodlands

As this is a subject on its own, I shall only deal briefly with it here. Many comments already made apply equally well to woodlots.

A.—Establishment. Fence the area and eliminate rabbits, hares and opossums. If weed growth is dense, line cutting will be necessary. Adopt a spacing of 8ft x 8ft (680 per acre) for fast growing species such as radiata pine, and a closer spacing 7ft x 7ft (900 per acre) or 6ft x 6ft (1210 per acre) or a combination of these spacings for slower growing species such as Douglas fir, Corsican pine, larch or macrocarpa. Planting is best done in the late winter especially where heavy frosts are encountered and frost lift is likely. If more than 25 per cent die, replant in the blanks the following year.

Some nurserymen contract to supply the trees and plant for you on the basis of guaranteeing a certain survival after a year or two.

A certain amount of cleaning around each tree or spraying may be necessary before the trees grow clear of scrub and weeds. Only plant each year the quantity you know you can treat well in subsequent years.

B.—Choice of Species. What species you use will depend on your reason for establishing a woodlot, see I B and also II D. The most popular species today for this purpose are:

Radiata pine—for all uses.

Douglas fir—for structural timber, and treating with the oil based preservatives. Ideal for stock yard rails, poles, etc.

Larch—similar to Douglas fir.

Corsican pine—framing timber, flooring, and treating with water borne preservatives for fencing material.

Eucalypts—are not popular in New Zealand for general purpose timbers but are good for farm timber. No really durable species here.

Macrocarpa—generally rather disappointing. Has many defects and is only durable in some districts.

Poplars—only a limited demand but could be grown for dunnage, decking and pulping.

C.—Maintenance and Management. In the future, the emphasis will be on quality so that if good prices are expected, adequate tending will be necessary. The aim is to grow straight, large logs with as few or small knots as possible. Knots originate from branches, so branches should be removed as early as possible without impairing the health and vigour of the tree. Green knots are less of a defect than live knots.

(1) Begin pruning as soon as the lowest branches show signs of dying and prune up to 6ft or 7ft in the first operation. Pruning may be done with secateurs, pruners, saws or axes but the latter requires most skill.

(2) High pruning can be done later in conjunction with thinning operations. It is more expensive and difficult to do, so must be restricted to the 100 best trees which will be kept for the whole rotation. Favour the high pruned trees during thinning so that they are given the maximum growing space.

(3) The intensity and timing of thinning will depend on markets and labour available balanced against the ideal prescriptions. Thinning can yield a good supply of round produce for preservative treating, small sawlogs, firewood and pulp logs.

(4) Keep in mind the dangers from fire spreading into your plantation by having firebreaks where necessary. Good utilisation will keep slash fuel on the ground to a minimum. Thinning must not be so severe that wind damage can follow easily.

V. Amenity Planting.

Many people have been disappointed at the results they have had because they have expected too much too quickly. Some of the most beautifully planted homesteads and parks have taken 100 years to reach the state they are in today. Most ornamental trees are either very tender or slow growing. In exposed localities primary shelter is required first around a homestead before many species can be contemplated at all. Some species will never grow because of the climatic and soil conditions prevailing. Keep these things in mind when making your selections.

Look about your own locality and choose species which have already done well in other gardens under similar conditions. Consult a local nurseryman for advice. Many horticultural references have lists of species for various purposes and conditions.

Planning is very important here too, to avoid shading, leaves in spouting, falling on buildings, roots robbing vegetable gardens, disease carriers, interference with piping and power lines, tall specimens hiding small ones and so on. In a new garden it is legitimate to overcrowd at first to get an effect but they must be thinned out as they grow. Favour focal point specimens in the original planting and in subsequent thinning. It pays to be ruthless.

If the soil is poor or shallow, dig big holes and refill with a good compost soil to give the trees and shrubs a good start. Water during dry seasons at first and mulch too. Stake if wind whip is likely.

Conclusion

The choice and establishment of trees on a farm requires just as much careful planning as any other operation. Carry it out well, maintain them to the best of your resources and their financial and intrinsic values will be considerable. Every living thing needs shelter in some form to grow to best advantage.

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FARM FORESTRY UTILISATION AND FINANCIAL RETURNS

E. A. Cooney, Superintendent, Selwyn Plantation Board.

Introduction

Mr Grayburn has dealt with the establishment and management of shelter belts and woodlots.

The purpose of this paper is to give some indication of the forms of utilisation and the financial returns which can be expected.

It is proposed, first of all, to give a brief, general picture of exotic forestry in New Zealand—the areas, and ownership, the use of the forest resources, the requirement for the future—so that the importance of forestry in the national economy can be gauged, and so you can appreciate the vital part farmers must play if the objective of the Forest Service for 3,000,000 acres of exotics by A.D. 2025 is to be achieved.

The next section of the paper will deal with the utilisation of your own trees and the various factors which influence the financial returns from them.

Finally, there will be examples of costs and yields from stands exploited by the Selwyn Plantation Board.

Exotic Forests in New Zealand

Total Exotic Forest Area in New Zealand—in acres.

	1920	1930	1940	1950	1960
State	37,000	246,000	439,000	464,000	483,000
Private & Communal	18,000	255,000	401,000	444,000	460,000
Total	55,000	501,000	840,000	908,000	943,000

It will be seen that the ownership is shared almost equally between State, and "Private and Communal." At 1960 the North Island had 721,000 acres, the South Island 222,000 acres. So there are roughly, 1,000,000 acres of exotic forests in New Zealand.

The present production of sawn timber, pulp, round products, etc., falls short of the annual increment of the forests by at least 45 million cubic feet. The Forest Service estimates that with increased population the current surplus will disappear by 1985. By reviewing the economic requirements of the future, it was concluded that there were sufficient lands more suited for exotic forestry than for farming to warrant the development of an export target of 150 million cubic feet, in place of the current 50 million cubic feet allocation. The Forest Service aims therefore to treble the current level of planting to provide another million acres by 2000 A.D. and a third million acres by 2025 A.D.

Half of the expanded programme has been envisaged from a farm-forestry effort.

At current prices the target of an exportable surplus of 150 million cubic feet of raw material as timber and pulp products would have an export value of £50 million. "This export of forest products should make a valuable contribution to the country's balance of payments, which by this far distant date will tend to have been reduced by an ever increasing internal consumption of many of its primary products."

This is good sound policy and I have no doubt that the Forest Service will achieve its own objective, but the success of the whole

plan depends entirely upon the co-operation of farmers for that other million acres! It means that farmers will need to plant, on an average, 16,000 acres a year until 2025!

What incentive have you?

Relief from death duties and the spreading of royalty income over five years? Yes, you have those, but are they sufficient? I doubt it! You will want something more—probably a more equitable spreading of income until the forest is on a sustained yield basis, and some guarantee that a profitable market awaits your crop both at the stage of commercial thinnings and at maturity—a “floor price” related to the price of other primary produce.

These are obvious requirements. Subsidies and suspensory loans have been mentioned recently as Government policy but as yet terms and conditions have not been published. It is open to argument whether this is an incentive or not.

Is it possible for farmers to lease to the Forest Service those portions of their farms at present unproductive? Is this a better scheme than growing the trees yourselves?

The Forest Service plan bristles with difficulties. On past experience, I venture to say that few of you would be prepared to plant trees—other than for shelter and shade—unless these difficulties are resolved. Obviously, it is in the national interest that the scheme succeeds. Human nature being what it is, you have to be convinced that it is also in your own interest.

Utilisation

It would be as well, perhaps, at the outset, to explain the two units of measurement commonly used in the utilisation of timber.

They are the cubic foot and the board foot.

The cubic foot is 12in x 12in x 12in thick.

The board foot is 12in x 12in x 1in thick.

So, theoretically, there are 12 board feet (bd ft) in each cubic foot (cu ft). Trees of course just don't grow with a square bole so the conversion from the round log to sawn timber results in waste in slabs and sawdust, and instead of getting 12 bd ft from 1 cu ft of saw log, the yield varies from 5.5 to 7 bd ft depending upon the type of sawing and size of log. The smaller the log the lower the conversion.

There are some localities, however, where log scales such as Goss, Hoppus, and Hoaken Dohl are still used, but it is just a matter of time before the cubic foot is used universally. It is a true measurement of volume, and the Forest Service have cubic foot log scales, for several species, for each conservancy.

Knowing the price per cubic foot (e.g. 1/-) a fairly accurate method of converting this to a price per 100 board feet is to multiply as follows:

For logs averaging 8in to 9in 1/- x 18 = 18/-

12in 1/- x 16 = 16/-

above 12in 1/- x 14 = 14/-

What are the main products from our forests?

The most important is still sawn timber despite the increased use of alternative building material. In fact per capita consumption rose from 206 bd ft to 277 bd ft in the years 1940 to 1960. Since 1955 the volume of exotics cut for sawn timber has exceeded the volume of indigenous timber and in 1960 the figures were 351 million bd ft and 302 million bd ft respectively.

Next in importance is the timber used for wood pulp and pulp products. The volume is in the vicinity of 30 million cubic feet annually at present.

Round products such as posts, poles, and strainers, etc., and plywood logs use approximately five million cubic feet.

So we have from our exotic forests: 60 million cubic feet for sawn timber, 30 million cubic feet for pulp and pulp products, five million cubic feet for round products and plywood.

Although it has been stated that there are 45 million cubic feet of annual increment unused at present, this figure is likely to be conservative and the National Exotic Forest Survey when completed could easily reveal that the annual increment is nearly 180 million cubic feet.

Up to this stage I have endeavoured to give a brief outline of the general situation. Now let us consider that you have a shelter belt or plantation. The form of utilisation will depend upon:

Species

Age

Silvicultural management

Markets available.

Species and Age

The four main species which have commercial value are Radiata pine, Corsican pine, Douglas fir and Ponderosa pine. Sites limit the choice of species, and although Mr Grayburn has given you a wide range for shelter, from a "planting for profit" viewpoint the above four are the most likely to be used.

If the aim of management is to produce logs for sawn timber and plywood from the final crop all need to be thinned, and the first commercial thinning would be done when the stand height is between 40 and 50 feet. The age this is done will vary with the species, and the site, but by using stand height as the criterion you can visualise the size of the product. Obviously there will not be any saw logs so the product will be used in the round or split form.

The second thinning, when stand height is 60 to 70 feet would yield saw logs in addition to minor forest products.

Depending upon the locality and aims of management, there could be a third thinning—mainly for saw logs—and then at rotation age the clear felling of the final crop. For Radiata pine this may be up to 50 years; Corsican and Ponderosa pine up to 80 years; and Douglas fir up to 100 years.

Silvicultural Management

Many factors influence the silvicultural management of a stand but the principal one is markets. Given a market for thinnings the management of a crop of trees is much simplified.

Pruning is not only desirable but necessary if the final product is to be of high quality. There is always a demand for quality, whatever the product, and in the "Financial Returns" section shows you just what premium there is for quality.

Markets Available

The forest owner who has a sawmill, and a pulp mill, and particle board mill, and timber preservation treating plant within a reasonable distance, is indeed fortunate. Obviously, the more remote the plantation the less chance there is of entering a profitable market. Even a poor quality stand is worth something if it is within 30 miles or so of a processing plant. On the other hand, there are probably some of

you who have a plantation and find that no one is interested in its products. Locality is important, and governs demand. In the Wairarapa and Hawkes Bay fencing material is at a premium and thinnings have a ready market. This is not so in Canterbury. The market for small thinnings as posts, firewood, and wood for particle board absorbs only a fraction of the annual increment.

In Southland there should be a good demand for fencing material, and the proposed pulp mill at Maitua must be of benefit to all forest owners.

In the Bay of Plenty, the Tasman Pulp and Paper Company at Kawerau is prepared to purchase—at a price—sawlogs and pulp wood within a radius of 30 miles of Kawerau and 15 miles of Murupara.

Present indications are that Nelson will eventually get a pulp and paper industry.

So the position as far as markets is concerned is improving rapidly.

Methods of Marketing

Any farmer who has trees to sell may sell them in three ways:

1. At the stump.
2. At the plantation edge.
3. At the mill skids or market place.

1. **At the Stump.** This means that he sells his trees standing, on royalty in either of two ways:

- (a) As a block sale, with the volume to be sold assessed standing, using a volume table, or
- (b) On the basis of volume cut, the logs to be tallied using a log scale.

(a) This is obviously the best way to sell, but the volume must be assessed by a skilled forester for a sawmiller's estimate of the volume is usually peculiarly conservative! Any request for assistance from the Forest Service will be gladly given, or there may be a consultant forester available to do the original assessment. This volume is taken as sufficiently accurate for the purpose of sale and it should be made quite clear that there shall be no abatement in price nor shall the contract be voidable should the volume cut be less than the estimate. It is important to point this out to the purchaser otherwise there is room for argument and possibly litigation at the completion of the contract.

(b) This of course gives an absolute volume as each log is measured. It is not always necessary for the vendor to measure the logs for usually the purchaser employs contractors—for logging, or for transport, or both—and the contractor's tallies can be accepted.

Whether the trees are sold standing, or in the log, the unit of measurement should be the cubic foot using the Forest Service volume table, or log scale, for that district.

2. **At the Plantation Edge.** In this case the sale is made in the form of logs (or posts, etc.) snigged out to the plantation edge (or to tracks running through the plantation if on flat ground) ready for loading. The vendor employs the bushmen on contract, and the price charged for the logs is the royalty plus the cost of logging.

This form of sale is becoming increasingly popular in Canterbury where the Forest Service instituted the practice some years ago.

3. **At the Mill Skids or Market Place.** This is not the usual method but with small areas of trees it may pay the vendor to make a sale in this manner. The price includes royalty, logging, and transport.

Financial Returns

Those people who invested money in forestry bonds in the "boom" years of the 1920's no doubt remember the glib sales talk of the bond salesmen "£500 for your £25 in 20 years!" These salesmen found plenty of "minute men," whose patience over the years, waiting for returns, must have been tried many times.. There is money in trees but the returns vary considerably, and are never fantastically high to the grower!

In any industry, everyone must make a profit—the provider of the raw material, the contractors associated with its harvesting and transport to the processing mills, and the miller—whether it be a saw-mill, or pulp and paper mill, or any other processing plant. If the ratio of profit for the capital invested is weighted unfairly against any one section then that industry cannot flourish.

The "life blood" of a processing plant is the sawlog, pulpwood, plywood log or whatever the raw material is which goes into it. The "life blood" of the forest owner is the stumpage he receives for his trees. Stumpage, or royalty as it is called down here, is the price the grower receives for his standing timber, and is determined by the price the purchaser is prepared to pay at his plant; in other words, the "mill door" price less the associated costs in getting the raw material from the standing tree to the mill door.

Obviously then, there are several factors which must influence stumpage rates. They are:

1. Locality.
2. Access.
3. Volume—per acre and in total.
4. Quality.
5. Supply and demand
6. "High policy."

1. **Locality.** It should be stressed again, the importance of locality. To transport logs by road 42 miles from Te Pirita to Christchurch costs 8d per cubic foot or £400 for the produce from one acre of this particular forest.

Other examples of road transport costs to Christchurch: 8d per cubic foot from Dunsandel, 33 miles; 8.25d per cubic foot from Eyrewell, 35 miles; 12.5d per cubic foot from Balmoral, 60 miles; 5.5d per cubic foot up to 10 miles.

Transport costs of logs from Hanmer (90 miles from Christchurch) are:

- 8.75d cu ft Hanmer to Culverden (by road)
- 5.5d cu ft Culverden to Christchurch (by rail)
- 2.5d cu ft railway siding Christchurch to sawmill (by road)

16.75d per cu ft total.

The prices for the above logs, at the mill skids in Christchurch are:

	per cu ft
Dunsandel . . .	22.0d
Te Pirita . . .	24.0d
Eyrewell . . .	19.35d
Balmoral . . .	22.5d
Hanmer . . .	27.0d
"Within 10 miles" . . .	23.0d

2. **Access.** Good public road access on a flat aspect, is obviously better than a farm road on rolling or steep topography.

Logging camps can vary considerably from the easily accessible plains plantations to the one located on a hillside where a crawler tractor or heavier equipment is required. On the plains a truck can be driven alongside or through a plantation but the position is vastly different on broken country. For example, the cost of extraction of pulpwood in Nelson could be up to 4d per cu ft higher than the cost of extraction on the Canterbury Plains.

3. **Volume.** Both volume per acre, and total volume available are important. Logging costs vary with the volume per acre, and usually the greater the volume available the more valuable the stand. Millers can see continuity of cutting and this is an advantage.

4. **Quality.** It is probably not realised what difference in value there is between logs from a well managed stand—thinned often, pruned at the several heights so that all knots are right knots and the maximum amount of clear timber is obtained—compared with a stand which received no attention from the time of planting until exploited.

Apart from the increased logging costs in the neglected stand with its dead and suppressed trees, the difference in quality of the timber yield from each stand results in a wide variation in financial return.

Sawn timber is sold according to grade. Roughly, there is a difference of 25/- per 100 bd ft between the bottom grade (box) and dressing grades. An untreated Radiata pine stand, with its high green crown level, will probably yield no more than one-third scantling grade and two-thirds box grade. If we take the volume as 60,000 bd ft to the acre, and by proper management reverse the proportion of grades, there is a difference of 10/- per 100 bd ft, or £300 an acre. This represents an extra 8d per cubic foot stumpage on a stand volume of 9,000 cubic feet. This is likely to be the minimum increase for no account has been taken of the premium for plywood logs, and long length clears.

Tree crops established from now on, or those ready for the first silvicultural treatment, are unlikely to be profitable unless managed correctly. In future there will be an increasing demand for quality, and poor quality stands will give a correspondingly poor financial return.

5. **Supply and Demand.** The importance of this factor is obvious. Canterbury can be taken as a case in point. Radiata pine is being sold by sawmillers at a price below that fixed by the Price Tribunal in order to compete with rimu from the West Coast. The available cut from Canterbury's forests is more than double the production of 26 million board feet of sawn timber. A reduction in the volume of sawn rimu would lead to increased demand for Radiata pine and a lifting of the present stumpage rates.

6. **"High Policy."** If price control were lifted, and all sap timber, regardless of species, had to be treated with preservative, there would be a much greater use of exotic timber; and rimu would be used for special purposes. It was said recently at a conference of foresters that "whatever economists might say major decisions by Government are based on politics." This is probably true, and however desirable it would be to the grower of exotic timber to have price control lifted and all sap timber treated, the decision will be a hard one for Government to make.

The establishment of a pulp and paper industry at Kawerau was made possible by the Government fixing a very low stumpage for the

raw material for a period of 25 years. It is a flat rate for both pulpwood and sawlogs. The price is 3d per cubic foot. Being a shareholder—and a tax-gatherer—the Government will supplement the stumpage income by dividends and tax, once the Tasman Pulp and Paper Company becomes profit making. Unfortunately for the private forest owner, this stumpage rate becomes the standard for the district and has a tendency to influence rates throughout the country. His income is from stumpage alone. He is not a processor!

Influence of Stumpage Rates on Various Products

1d per cubic foot = 1/3 per 100 bd ft.
= 12/6 per 1,000 bd ft.
= 125/- for the 10,000 bd ft in an all-timber
three-bedroom house!

So that at 3d per cu ft = £18/15/- the grower received for the timber
in that house.

6d per cu ft = £37/10/-
and at 1/- per cu ft = £75
9.6d per cu ft = £60

1d per cu ft = 10/- per ton of newsprint—retail price approx. £75.
= 8/4 per 100 6ft x 5in — 6in posts retailed at £45.
= 16/8 per 100 7ft x 7in strainers retailed at £125.
= 25/- per 100 8ft x 8in strainers retailed at £175.
= 6/8 per cord of pulpwood or firewood.

On an average, a timber merchant makes 12/- per 100 bd ft gross on Radiata pine—this is equivalent to 9.6d per cubic foot! He has expenses of course, but so too has the forest owner in growing his crop for anything up to 50 years!

It is hoped that the presentation of figures in this way has made you realise that the influence of stumpage rates on final cost is very small. The increase in the cost of the finished product required to give the grower a reasonable return for his investment makes little difference to the selling price of that product. It makes all the difference to the forest owner!

With the length of time the crop takes to grow, the risks from fire, windthrow, disease, etc., the present stumpage rates are too low. Far too low in many cases.

Experience of Selwyn Plantation Board

The Board is fortunate to have its 13,500 acres of plantations situated 15 to 50 miles from Christchurch. With one exception, all are on the plains, are served by good roads, and logging is easy.

The plantations were established primarily for shelter. Although there is a complete series of age classes, the age classes are not evenly distributed due mainly to gales and to increased planting during the last 25 years.

The main species are
Radiata pine—9,500 acres.
Douglas fir—900 acres.
Mixed conifers—800 acres.
Gum and Wattles—2,300 acres.

Those stands being clear felled now had no attention after planting other than fire protection. Most of the areas planted in the last 40 years have been given some silvicultural management. Almost all are low pruned, some have been given a first thinning and high pruned to 14ft, others have had a second thinning. Gales have sometimes been responsible for a very heavy thinning!

Apart from the fact that they are growing in a non-forest climate—low rainfall, porous soil, subject to gales, and summer droughts—the Board's plantations are favourably situated. They are close to market, extraction and transport costs are low, there are no roading costs, and in quality they compare well with other stands available to the Christchurch market. Except for first thinnings, there is a good demand for all products, so they comply reasonably well with those factors necessary for good financial returns.

Do they pay?

The Board has been in existence now for 50 years. With no capital to start with, and no source of revenue other than that from the leased reserves and its forests, the Board has created a forest estate, and cash reserves, of no small magnitude. Cash assets are now worth approximately £120,000. All this has come from trees—not from subsidies, grants, rates, or levies. This is the answer to those who say "Forestry does not pay!"

Costs

The cost of establishment of Radiata pine on the plains varies from £12 to £20 an acre depending upon whether it is a first or second crop, whether a rabbit-proof fence is necessary, and the type of ground cover. Low pruning costs 28/- per 100 trees or roughly £11 an acre of 800 trees. High pruning of 80 to 100 trees costs £5 an acre.

The annual cost of maintenance is 30/- at present but was as low as 10/- in the 1930's.

Bushmen on contract cut first thinnings for firewood for 45/- per cord, and second thinnings for saw logs at 4d to 5d per cubic foot and again 45/- per cord for firewood. Clear felling of mature Radiata pine costs 2½d to 4d per cubic foot.

Contract rates for post and pole production from Corsican pine thinnings are: 5d to 6d for felling and extraction to outrow, and 8d for barking. Transport to Christchurch of this minor forest produce is 5d to 8d if dry, and 8d to 12d if green.

Rates for cutting gum and wattle firewood are 50/- per cord. Transport to Christchurch is 30/- for Radiata pine, and 35/- for gum and wattle.

Royalty Returns

On a per acre basis yields have been as high as £600 for 60-year-old Radiata pine.

The 1200 acres of 21 to 45-year-old Radiata pine blown down in the 1945 gales yielded £60 per acre!

First thinnings of Radiata pine yield £16 to £22, second thinnings £40. Should the final crop reach maturity, estimated final yield is £400 at 40 years and £600 at 50 years (based on current royalties which are 12d to 13.5d for mature timber and 8d to 10d for thinnings).

Other conifer species are not being clear felled but Corsican pine is yielding up to £160 for fencing material. Royalty per cubic foot ranges from 18d for posts, to 27d for strainers and small poles, and 57d for the larger power and telegraph poles. Obviously, a tree is more valuable as a pole than as saw logs, strainers, posts, etc.!

Douglas fir thinnings return 24d per cubic foot as small saw-logs. There is no market for fencing material other than as untreated rails. The three treating companies in Ashburton and Christchurch use water soluble preservatives. Douglas fir must be treated with pentachlorophenol or creosote.

Yields from the mixed species of *Eucalypts* rarely exceed £90 an acre for sawlogs and stakes at 1/4 per cubic foot and firewood at 30/- per cord.

Wattle varies from £30 to £48 at 33/- per cord. The Board's policy is to convert gum and wattle plantations to Radiata pine. The present crop served the purpose of quick shelter in the early days, but financially this is not attractive.

What Interest Rate is Earned?

Radiata pine offers the best return and individual plantations could yield as much as 8½ per cent. Dr J. T. Ward used the plantation as an example in his paper, "Economic Principles of Land Use—a Comparison of Agriculture and Forestry." Like every other crop, however, the money must be in the bank before you are certain of it!

For the risk entailed the interest earned should be better than the rate for gilt-edged securities. It is hoped that a more realistic appreciation of stumpage values by the largest sellers of timbers in New Zealand will make this possible!

Conclusion

New Zealand is well served now with Farm Forestry Association, and every farmer who grows trees for any purpose should be a member. A strong association is in the farmers' interests for not only could it become an advisory and marketing organisation, but the New Zealand Association is the obvious organisation to present the farmers' claims for better incentives to establish the one million acres of forests envisaged under the present policy.

Finally, I would like to remind you that whereas your normal farm crop matures, is harvested, and usually sold in the same season, trees mature in 40 years or so, but are still putting on increment for many years longer. There is no urgency to harvest them, and if the prospective buyer's price is not attractive—LET THEM GROW!

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