

LINCOLN COLLEGE
FARMERS'
CONFERENCE
1972

Adams

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Cover: Lincoln College, Canterbury, New Zealand.

—photograph E. R. Mangin

LINCOLN COLLEGE FARMERS' CONFERENCE 1972

*Proceedings of the 22nd Lincoln College Farmers'
Conference, May 17 to 19, 1972*



LINCOLN COLLEGE
UNIVERSITY COLLEGE OF AGRICULTURE
CANTERBURY

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General view of the W. H. Gillespie Memorial Hall taken during the official opening ceremony.

W. H. GILLESPIE MEMORIAL HALL

Prior to the start of the 1972 Conference, a short ceremony was held to open officially the W. H. Gillespie Memorial Hall, the Conference venue. The building was completed early in 1972. The Hall was declared open by Sir John Ormond, B.E.M., J.P., Past Chairman of the New Zealand Meat Producers Board, before an audience of over 500 farmers and invited guests.

A brochure issued at the time described the Hall and the work of the late W. H. Gillespie as follows:

"The W. H. Gillespie Memorial Hall is incorporated in and may be regarded as one of the two major parts of the Lincoln Union complex, the other being the common rooms, cafeteria and Students' Association offices. The siting of the building was therefore dictated by many factors.

"The position chosen is between the present and proposed teaching and library facilities on the one hand and the residential blocks on the other and planned landscaping will provide a most attractive setting. The Union is also sited on one of the proposed pedestrian walkways between these two functional groups.

"The late W. H. Gillespie was for 10 years (1951-61) Chairman of the College Council, a time that saw great growth in the College from a relatively small institution to one that now takes its place as the largest agricultural and horticultural faculty in Australasia. Several of the larger buildings now on

the campus were built or planned during his term of office and it was largely due to his indefatigable work that the national memorial to the late George Forbes, M.P. and former prime minister, was built at Lincoln.

"From a farming community himself, the late Mr Gillespie had a strong interest in farming affairs. He entered Parliament in 1943 as representative for the Hurunui electorate, was appointed to the then College Board of Governors as a representative of South Island members of Parliament in 1949, and held that post until 1961. He served a term as Minister of Agriculture (1960-61) in the early days of the Holyoake Government.

"The building is basically reinforced concrete using a simple system of columns, beams and slabs, with walls of vertical precast concrete panels. Of some 6,800 square feet including stage, the Hall will provide seating for up to 1,000 at College graduation ceremonies, conferences and meetings. It will also be used by the Students' Association for cultural activities and indoor sport.

"Financing of the total building was a joint venture between the College, the Students' Association, public subscription and government grant."

CONFERENCE ORGANIZING COMMITTEE

The following are the members of the Farmers' Conference organizing committee as at July 1, 1972.

- J. O. Acland, Peel Forest, South Canterbury.
- S. C. Bowmar, 4 Lewis Street, Gore.
- Sir Malcolm Burns, Lincoln College.
- Professor I. E. Coop, Lincoln College.
- D H. Crabb, Lincoln College (*Secretary*).
- J. R. Cresswell, "Omaka Downs", Blenheim.
- R. S. Emmerson, "Forest Range", Tarras. (Otago-Southland Y.F.C.)
- P. C. Ensor, "Double Hill", Methven.
- R. Johnston, Ashley Gorge, Oxford.
- G. P. McIntosh, Waikuku, R.D.3, Rangiora.
- D. K. Mackenzie, Ealing, R.D.3, Ashburton (*Chairman*).
- W. N. Maxwell, "Mt Sandford", Cheviot R.D.
- L. R. Morris, The Old Glebe, 93 Stone Street, Wanaka.
- P. G. Morrison, Hukanui, Darfield (*Vice-Chairman*).
- J. W. Overton, 183 Halswell Road, Christchurch.
- B. Russell, Irwell, R.D.3, Christchurch.
- S. M. Wallace, Lake Haupiri, Nelson Creek, Greymouth.
- A. R. Wilson, Ikawai, 7 R.D., Waimate.

OPENING ADDRESS

HON. R. D. MULDOON
Minister of Finance

In March the National Development Conference discussed the new export targets, which are the basic figures for the NDC exercise, and which roll forward the original targets to a new period with a base year of 1969-70 and a final year of 1981-2.

The export targets for 1981-2 show a projected share for agricultural products of 55%, being 52.4% of pastoral products and 2.6% of other agricultural products. These figures re-emphasize what I have stated from platforms throughout the length and breadth of this country, that, during your time and mine, the bulk of our external wealth will come from the land, and particularly from our traditional pastoral industries.

Although during this period agriculture's share of the export increase is only 44%, the amount in money terms is impressive. It represents an increase for pastoral products from \$910 million in the 1969-70 year to \$1,857 million, in the 1981-2 year, an increase of 104.1%; and for other agricultural products an increase from \$32 million in the 1969-70 year to \$92 million in the 1981-2 year, an increase of 187.5%. These figures can be attained, as indeed the figures of the original targets have been attained, and the performance of the past twelve months is interesting in this respect.

At the time of the change of government in 1960, New Zealand exported \$3.2 million worth of sundry manufactured goods, that is, total manufacture excluding forest products. By 1967, that figure had grown from \$3.2 million to \$19 million — quite a good increase. But in less than five years the 1967 figure of \$19 million has increased to a total for the year ending March, 1972, of exactly \$100 million — a more than five-fold increase.

In case anyone is feeling a little sad about this, I am giving you these figures to compare that figure of \$100 million, which is such a spectacular increase, with the total returns from pastoral agriculture in all its forms of \$1,084 million for the same period. These results in the farming field have been achieved by diversification and by improved technology. A

figure that impressed me tremendously last year was when the Dairy Board was able to say that it was exporting to exactly 100 countries. I think it has spoiled that statistic by getting into one or two more countries so that now we can say only they are exporting into over a hundred countries, and I doubt whether anyone in this hall could nominate even fifty of the countries concerned. This diversification is not only a tremendous effort by the Board but the kind of answer that is necessary to Britain's entry into the EEC.

This is the week of the Pacific Basin Economic Committee meetings in Wellington and it is worth recording that today more than 40% of our dairy products are sold in the Pacific Basin as against 5% ten years ago. This is election year, and these figures provide the best answer to the reckless statements of my political opponents that export performance has languished under the present Government. Certainly we are broadening our export base and we will earn large sums overseas from new fields, such as minerals and the expansion of the sales of forest products, fish and sundry manufactured goods. Our tourist earnings have leapt from \$17 million to \$45 million in four years. These are spectacular figures. The export of horticultural products, too, has its success stories with such things as strawberries and other small fruits and berries. Overall, however, this country's prosperity will still be determined by our ability to produce more in our pastoral industries and, what is equally, if not more important, to get those products into markets where they can be sold at a fair price. I believe that our producer boards have a first-class record in this respect, but it is Government that will have the main task of keeping the doors open and negotiating access on reasonable terms into both traditional and new markets.

One of the many reasons why there should be no change of government in November is that we know this game; our Prime Minister is one of the best negotiators in the world in this field, and, what is equally important, we know the farming industry. Until this year, farmers throughout New Zealand had been experiencing difficult times. There had been two successive dry years over most of the country, wool prices were still very little above the low point reached in the 1967-8 year after the collapse of the market at the end of 1966, dairy product prices had just commenced an upturn following a number of years at levels which looked progressively less attractive in the face of rising costs, and only lamb and beef prices showed any reasonable increases year by year.

During the past twelve months the picture has altered quite dramatically. Dairy product prices have reached and maintained record levels, and a good finish to the season, particularly in the North Island, has produced returns that suggest that national production will be up by at least 3% on the previous year. The seasonal wool price, with 90% of the clip already sold, averages 65 cents/kg, which is 29% above the 1967-8 figure. After a disastrous start, lamb schedule prices

have recovered to a level where Meat Board intervention is minimal, and the sheep retention incentive has clearly played an important part in assisting sheep farmers towards a healthier position. Increased activity in farm service industries, and a reduction in advances from both banks and stock and station agents, indicate the boost that the sheep retention payout has given in addition to better returns generally, and there is no doubt that farmers are in a healthier situation than for some years. The dairy payout for whole milk farmers will reach the level I predicted at Dargaville in mid-February, and which raised strong criticism at that time, although, of course, the higher level involving the payout of the total surplus will not be reached, as the dairy industry, with the support and encouragement of Government, has wisely decided to put some \$35 million aside for the future.

I am well aware that, in spite of this better picture, farmers are still facing increased costs which have either kept pace with increased prices or, depending on the period selected, exceeded increased prices. Moreover, statistics taken across the whole industry can be very misleading, and increased prices are not spread evenly for either dairy or meat and wool producers. Diversification, particularly into beef raising, has further complicated the picture, while the various incentives given by Government from year to year fall with different weight in different types of farming. Subsidies on fertilizer, weedicides and pesticides and stock drenches, the removal of sales tax on farm motor cycles, exemption of farm land from land tax, and all the various other farm incentives affect individual farmers differently and I would be the last to claim that our farming industries are in a state of high prosperity.

They are certainly in much better shape than they were twelve months ago, however, and a meeting of the Agricultural Production Council last week considered what further assistance, if any, is required at present, and particularly in this year's budget. The Council's recommendations will come forward to Government for consideration and as usual will be treated sympathetically.

There has been criticism of the Agricultural Production Council and even suggestions that it is dominated by Treasury. Let me remind you of the membership. The Chairman is the Minister of Agriculture and even his worst enemy will admit that Mr Carter is a farmer's politician. Then there is the Director-General of Agriculture, the Chairmen of the Meat Board, Dairy Board, Wool Board, and Federated Farmers. The remaining members are the Secretary of Industries and Commerce and the Secretary of the Treasury. I really do not think the Secretary of the Treasury is that good!

Government members of parliament from farming electorates regularly bring along to me the balance sheets and accounts of individual farmers to illustrate the typical pattern of results in their areas and even in comparatively good years it is clear that the return on capital invested in farming is

quite inadequate. The greatest return to the individual farmer tends to come by way of capital appreciation during his lifetime, and as this is realized on death or sale of the property, there must be some problems. Competent estate management, however, can deal with most of these.

One difficulty we face in devising farm support policies is the tendency to chase seasons. The classical dilemma of agricultural production the world over is that high prices produce increased production of those products which in turn produces low prices. In some of our policies we have tended to fall into that trap, and wheat is a case in point. We must try to determine long-term trends and give the necessary encouragement for production that will meet long-term rather than short-term demand to the extent that we can identify it. Major droughts, of course, complicate the situation as stock that cannot be carried is killed, thus inevitably affecting future years.

Government has before it the Report of the Committee of Inquiry on Lending to Farmers, and it is clear that some of the recommendations at least do not find favour with the farming industry. It is, however, an independent report made by people with no bias against the farming industry and Government is giving it careful consideration. As most of its more important recommendations are long term in character, it is unlikely that it will greatly affect this year's budget.

In recent times government co-operation with the producer boards has become closer than ever. The present Government firmly supports producer control of our primary industries and I believe this policy has been more successful than any alternative. Government, indeed, does not accept the view of our political opponents that there should be trade union representatives on producer boards. It is difficult to see what constructive proposals they might add, and, if our experience of the membership of the President of the Federation of Labour on the National Development Council is any guide, they would be represented at meetings solely by a little card with a name on it.

In recent years, there has been the closest co-operation between Government and the Dairy Board in the negotiations on Britain's entry into the EEC, and at the time of the Luxembourg Agreement, when the Prime Minister, Sir Keith Holyoake, and other senior ministers, were sitting in his office exchanging views by telephone with Mr Marshall in Luxembourg, the Chairman, Deputy Chairman and senior officials of the Dairy Board were with us constantly. The retention of part of this year's surplus, which will save the farmer tax and help him when prices come down, was a unanimous decision of the Board supported by Government. The question of who spoke first is irrelevant. The Board did its part to assist in stabilizing the economy.

Not long before Christmas we were approached by the Chairman of the Meat Board to ask for our support for the

Board's intervention in the lamb market. This support was given immediately and the result has been a successful operation that has not only built up the lamb schedules, but given the meat processing companies cause to realize that they will not be permitted to load all their cost and financial problems on to the back of the producer. I feel sure that the overall result of this exercise will be much closer co-operation between the meat producers, represented by their Board, and meat processors. The Sheep Retention Incentive Scheme is a further example of co-operation between the Meat Board and Government for the benefit of the producer. Government will certainly continue to give the Meat Board all possible support.

We are now in the final stages of putting together in collaboration with the Wool Board, the proposed Wool Marketing Corporation. This is not just a major step, it is a courageous step by the industry. If it is accepted in its final form, Government will pass the necessary legislation early in this year's session of parliament so that the Corporation can be set up and begin operating as soon as possible.

Government received the final report of the investigating company last week. In conjunction with the Wool Board, it will be published and will be considered by the electoral college and the meat and wool section of Federated Farmers next week. As soon as a decision has been taken by the industry through its elected representatives, Government will accept that decision and act. If the decision is to go ahead, legislation will be introduced into the House and passed expeditiously. I emphasize that Government is neutral in this matter. We are putting no pressure on wool growers either to accept or reject the scheme.

I cannot claim that the proposed Corporation will be an immediate success and we must acknowledge that there are risks in moving from a system of selling that has operated for so many years. I think, however, that the misunderstanding of the move by some overseas users has been overcome, and that there is no doubt that the Corporation will give better service to the manufacturing user than was possible under the old system. If this has the effect of increasing the return to the producer by even a small amount more than he would have received under the auction system, then the move is worth while. We shall now await the decision of the industry, but this, again, is an example of government/producer board co-operation, in one of the most important moves ever made by the wool-producing industry.

The National Government has been called a farmer's government. I have always regarded this as a compliment, even when it was meant to be the reverse. I represent a city electorate, but I am quite certain that the majority of the people who vote for me recognize and accept the basic role of the farmer in the New Zealand economy, and realize that a prosperous farming community means a prosperous New Zealand.

I repeat, that 70,000 farms and 120,000 people produce, with the assistance of their service industries, \$1,084 million in external income. It is not just good politics to keep the farmer in business, it is economic commonsense.

Both in New Zealand and overseas I shall continue to tell the story of the New Zealand farming industry. I have no doubt that in the years to come we will continue to increase the prosperity of the whole community by doing the things that we do best.

THE PROBLEMS OF MARKETS

SIR JOHN ORMOND

Former Chairman, N.Z. Meat Producers Board

Before discussing the problems of markets, I feel it necessary, first, to go right back to the grass roots of the meat export industry in New Zealand. It is an industry with peculiarities and problems that I doubt are matched by any other industry anywhere in the world.

Consider these points:

As few as some 60,000 flock and herd owners form the base of our pastoral production (meat, wool and milk products) which among them provide the raw materials from which come more than 80% of our export earnings. In the broadest economic sense, therefore, we have a great many people relying on comparatively few.

Much of our production is greatly dependent on the growth of grass, which means on the amount of sunshine and rain we get. They are factors that can make us or break us if we get them in too great an abundance, or in too little quantity, or even not in the right proportions. Yet we have little or no control over them.

As a result, much of our life suffers the domination of seasons. Lambs have to be born in the paddocks while the grass is growing, and they have to be away to the freezing works when the grass stops growing.

Because we have narrow peaks of production in the freezing industry, we are faced with labour demands that come and go like the tides. It is a labour-intensive industry which is in top gear for only a few months before the tide recedes for many thousands of skilled men. Circumstances like this create a difficult climate for industrial harmony.

And one final point in this context — most industries create a product and can be regarded as assembly industries. We are different. We get a product and take it to pieces.

This is the internal situation. The seasonal patterns create pressures we cannot escape, pressures that have a major effect on our international operations.

The fact that we are half a world away from most of our markets does nothing to lessen the difficulties. We rely on ships to take our produce across the world. Those ships belong to other people, not to us, and so we have to enter each year into freight rate negotiations that are eating more and more into the income of our producers. This is an unhappy fact of our business life even though we believe over the years we have generally got the best deal possible.

Because we are so distant from our markets, we also have to take into account the time factor. An average meat ship takes four months for a round voyage between Britain and New Zealand. A container ship takes more than two months to complete a round trip between the East Coast of the United States and New Zealand. Time and distance add up to extra costs and they have become heavy penalties. We have been committed to them since the first meat cargo left New Zealand 90 years ago and we shall still have to contend with them in another 90 years.

The real problem here is that we are dealing with a large-volume, low-value commodity. We are selling this commodity to more than 100 different countries. In the last meat season there were 540 sailings from New Zealand of ships carrying meat. The freight bill was NZ\$60 million. It took all these ships — whether they carried a lot of our meat or a little — to cope with an annual export production now approaching 700,000 tons. Our export receipts were some \$530 million. No doubt a single container full of diamonds would fetch the same price. I think that comparison really exposes our problem.

We have vast quantities to take great distances. Our supply lines are long and this makes us vulnerable to all kinds of influences beyond our own direct control. A strike on the waterfront in North America can hurt us seriously, just as can a dispute among British seamen, or in any segment of the transport and supply industries of several countries. If we imagine our supply situation as a pipeline, we can see that any blockage anywhere along the pipeline will back up so that here in New Zealand we will be affected sooner or later.

Because of these circumstances we are forced to take costly precautions, such as the provision of cold storage in New Zealand capable of accommodating more than one-third of our annual production. We are also obliged — and I am referring to the Meat Board in this case — to take a direct part in the programming of ships to most of the big markets so that they arrive in our ports for loading at the times we want them, and they put our product on to the markets in a disciplined flow so that there is no oversupply causing damage to prices.

What, it might be asked, are these matters to do with marketing? They are everything to do with marketing. They are some of the basic ingredients of marketing because if we cannot supply our produce at the right time, at the right

price and in the right condition, we shall not even get a chance to think of the finer points of the operation. So I suggest that marketing begins right here at home. We have to ensure that the framework of our operation is strong before we can think about competing.

Competitive ability is of course paramount. While refrigeration made our frozen meat export industry possible, it was our ability to compete despite the penalties of distance and time that made it flourish.

First we traded in meat with Britain. We made some attempts to diversify in the 1920s and 1930s without much success, and then through the war years and indeed right up to 1954 we sold almost all our surplus meat to Britain on a government to government bulk purchase arrangement. Our attempts at market diversification, therefore, did not start with any real seriousness until less than 20 years ago. I think by any standards one would have to say that the results reflect tremendous success. Last year almost as much meat was sold outside Britain as to Britain itself. The figure was 324,000 tons or 48% of total exports. This year Britain will undoubtedly fall behind the rest of the world in tonnage.

Or to use another measurement — in terms of value, our receipts from Britain for bare meat (that is, without by-products) for the year ended June, 1971, were \$177.6 million. But from other markets we received \$237.4 million which was 57% of the total proceeds. The big buyers here were the United States (\$133 million), Canada (\$26 million), Japan (\$24 million) and the EEC countries (\$20 million). I list these figures because they show how quickly new markets have developed and how important they have become.

There are still three countries that are dominant in terms of volume — Britain for lamb, the United States for beef, and Japan for mutton. But we have many other customers buying our more expensive meats and we can expect them to become more important in the future.

I have heard the view expressed that some of these markets at least would have developed by themselves, simply on the basis of supply and demand. This may have been so in some cases, but certainly not in the majority. We should not be so quick to decry the efforts of the marketing people from our meat companies. We are in a private enterprise system of trading that includes overseas-owned as well as New Zealand-owned companies. These companies have international ramifications. They send men around the world, poking into all sorts of strange corners looking for new market prospects. The fact that we have more than 100 customers ranging from Tanzania to Tonga, from Christmas Island to Czechoslovakia is testimony to the work of these marketing men and their companies.

Where lamb is concerned, they have certainly been prodded along in recent years by the diversification scheme which carries financial penalties for those who do not come up to

the mark. Last season exporters were obliged to diversify 15% away from Britain. This season the target is 22% which is a very steep increase indeed and reflects the industry's determination to reduce its dependence on the British market. There are already indications that the 22% target will be achieved and that it will be achieved by improved sales to many countries rather than by much more lamb going to one particular country.

INDIVIDUAL MARKETS AND THEIR PROBLEMS

I have always believed that while we may have all the fancy theories we like about marketing, we must not remove ourselves from the practicalities that really count. The world is made up of people, not theories. People want food. They want good food and they want it at a reasonable price.

The formula that I see as having led to New Zealand's success with meat over the years is simple: quality product, at a reasonable price, and available on a year-round basis. I do not think the future will be any different. Fortunately, the indications for the next few years, at least, are that the international demand for red meats will continue to be strong. But demand alone does not give us a rosy future full of unbroken promise. Politicians have the habit of putting up road blocks to trade.

Our future hinges, first, on our ability to control inflation in New Zealand so that we remain competitive despite the penalties of time and distance. Then it will be dependent on access for reasonable volumes of our meat into the major developed countries. By access is meant a flow that is not dried up by crippling tariffs and duties or by unfair devices to do with hygiene or other restrictive measures.

In Europe today, these road blocks are everywhere. The entry of beef to the Common Market is controlled and restricted by a complicated system of variable levies. Lamb faces a 20% tariff and, in addition, an array of different restrictions in each country. France virtually bans frozen meat. Italy has laws preventing the sale of frozen and fresh meat in the same establishment and that really hurts our prospects. Germany has a small global quota for sheepmeats. Switzerland ties lamb imports to the volume of local production.

And so on it goes. As I have said, no matter how fancy the marketing theories, progress will not be made if the trade doors are shut. It is people who shut those doors, and they must be our chief targets.

The lamb trade to the United States provides an excellent example of what can be achieved if we concentrate person to person on getting understanding of one another's problems.

Devco was set up 12 years ago to ensure that we had *orderly* development in the United States. Had we allowed the trading companies to have a free-for-all in that market, I am sure we would have had quotas slapped on the entry of our lamb,

as indeed they are for beef, veal and mutton. Our prospects would have been dim — if we had been left with any at all.

Through frequent contact with the American sheep producers and their leaders, we have been able to win their confidence in our intentions. Right from the outset we insisted that we would put in only quality lamb and that, rather than undercut, we would do everything to improve prices. Naturally, they were suspicious. Would we not be in the same circumstances? However, we were as good as our word and we have now proved that we can help improve the image of lamb in that great country to the benefit of all.

I suggest that the co-operation we now have formally between the United States producers' organizations and the New Zealand and Australian Meat Boards, in educational promotion for lamb, is unequalled anywhere in the world. This is the Lamb Promotion Co-ordination Committee.

The North American lamb operation undertaken by Devco has still to achieve regular profitability but the key word here is development. Something of the order of 1,300,000 New Zealand lambs will be sold in North America this year, at an average return which is the best in the world. If Devco sold only to the obvious segments of the market and forgot about further development, it would make profits. We have to be long sighted enough to realize that if our British lamb market shrinks then perhaps North America will mean salvation for the New Zealand sheepman.

In any case, studies carried out at Lincoln College have indicated that Devco's operations have led to a strengthening of our prices in Britain to our overall benefit.

BRITAIN AND THE EEC

Frankly, we do not know what is in store for us. We have had promises from the British Government that there will be a special deal allowing access of our lamb to Britain in reasonable volume and at remunerative prices. The EEC so far has no common policy on sheepmeats and I am sure it is to our advantage that the drafting of such a policy be deferred until Britain is in a position to influence it. Even so, we simply cannot risk sitting back and taking for granted that the Europeans will look after us. They will not, unless we give them good reason to. Here again, it is people who are involved, not theories. We must have still closer contact with the leaders of the EEC, both the political leaders and the executives behind them who do so much to shape the decisions. We must get alongside them; make them aware of our problems and our needs; make them aware that we are not looking for something for nothing; that we are offering a consistent quality product, at a reasonable price, available the year round, and that we are prepared to spend money on promotion and consumer education.

If I am harping on these points it is because somebody needs to harp. As we did with the American sheepmen against

all odds, so we must do with the Europeans: we must win their understanding, their confidence, and their co-operation.

What have we done so far as a nation towards this goal? Our leaders went to Europe and won assurances when the negotiations were on. We were in the headlines then. What about now? Are we being forgotten in Europe? Has the old mantle of apathy cloaked us again? Let us put our public relations effort with Europe into gear. Here is one of the great trading areas of today; and it will be a greater one in the future.

The way most New Zealanders regard our situation, one would think New Zealand was a country lying just off the coast of Europe and automatically sharing all the benefits of its commercial strength. We need reminding that while we might still call ourselves "Europeans", we are 12,000 miles away from Europe and no doubt hidden from their view by the bulk of Australia and the clouds of European self-interest.

Let us get the perspective right — we are a group of islands on the edge of the Pacific. We are Polynesians rather than Europeans. We are agricultural producers trying to sell agricultural products to countries whose farmers are not so well off as our own.

Obviously we will risk big trouble if we do not get our point of view clearly understood. The Meat Board has announced its intention of opening an office this year in Europe, and that is a step in the right direction. I believe, however, that we need an intensive continuing campaign to promote our national interests properly and to sell ourselves to the Europeans. We need a New Zealand team, led by Government, representing trade, producers and manufacturers, to make a major effect in Europe so that people will understand people and so that the man in the street in Hamburg, Paris and Rome understands that we are a major factor in the production of foods, and that we have a place around the table when major decisions are made that affect the future prosperity of this country.

CONCLUSIONS

Yes, we do have problems of markets. We shall always have them because of our geographic situation, the seasonal pressures we experience and other peculiarities of the trade we engage in.

We shall continue to face problems in the future from market to market because of the political reasons outlined that bring restrictions on market access in one way or another. But we must not try to look so closely at the detail of these problems that they become magnified and distorted.

We are not strangers to the problems of markets. We have many advantages on our side. We have efficiency in production. We have technical knowledge. We are flexible enough to change when change is required.

The problems we have faced over so many years have kept us alert and given us initiative. We have never really been able to become prosperous and dull.

The future should hold no real terrors for us so long as we keep in mind that markets are simply people, that it takes people to make problems and people to end them, and that, therefore, communication on a personal basis should be our chief marketing weapon.

HOW RELIABLE IS ECONOMIC PREDICTION ?

A. T. G. McARTHUR

Senior Lecturer in Agricultural Extension, Lincoln College

In the ancient courts, the king had an astrologer to assist him rule the kingdom.

Nowadays, the economist is the modern equivalent of the astrologer. He advises government, businessmen and farmers and, like the astrologer, his job includes predicting the future. Like the astrologer he uses mysterious symbols — mathematical symbols like Σ and π and λ that impress the uninitiated.

Now the king's astrologer had to steer a difficult course between pleasing the king by telling him of the glories to come — we all are susceptible to optimistic forecasts — and warning against possible disasters. If his forecasts were too gloomy he was liable to lose his place at court. But if he failed to predict plague, famine, or defeat he could lose his head.

Today's economist has greater job security and better methods of forecasting. The object of this paper is to assess how reliable these forecasts are. With the aid of hindsight, this is a relatively easy task.

The reason I have been asked to investigate this matter is because practical men are starting to ask if economic forecasting is counter-productive.

Two examples are often quoted by those who feel bitterly about economists. In 1966-7, Government and the Wool Commission were advised that the current downturn in wool prices was only temporary. The Wool Commission bought 600,000 bales of wool with the idea of supporting prices paid to farmers, and making a profit on the wool it held in stock. The industry's reserve account of \$60 million was consumed, but the fall in wool prices proved to be semi-permanent at least. We have yet to count the multi-million cost of this incorrect forecast.

Canterbury's flood-irrigated country provides the second example. Twenty years ago the Winchmore Irrigation Station

showed that this country will produce 300 lb of butterfat per acre under dairying. At historical and present prices, dairying will outstrip any other type of production. The land is ideally suited to large-scale dairying, yet Canterbury farmers have believed the predictions of economists that the end of the dairy industry is at hand, and over the years have foregone very profitable opportunities with cows.

However, attempts to forecast future conditions are necessary in order to make sensible decisions at the national and grass roots level. As Abraham Lincoln said, "If we could first know where we are, and whither we are tending, we could better judge what to do and how to do it."

But in making decisions, the reliability of the forecasts must be borne in mind so that the appropriate flexibility can be built into plans for adapting to an uncertain environment. Some guide to this degree of reliability can be obtained from looking at how accurate forecasts have been in the past.

RELIABILITY OF ECONOMIC FORECASTS

In doing the research for this paper, it would have been amusing to have selected all the incorrect forecasts of my economic friends. However this would have been a biased approach on my part and would have depleted my stock of friends. To be fair, I looked for a long series of explicit price forecasts which were based on respectable forecasting methods. Sometimes economists will make a few forecasts, be successful for a year or two, then burn their fingers and give it up. However a New Zealand organization, Business and Economic Research Limited (BERL), hire the services of a panel of very competent and wellknown economists. These economists have made a wide range of economic and business predictions over the past 18 years including predictions of lamb and wool prices. These latter two predictions were guided by econometric methods. BERL published these predictions quarterly in *Business Forecasts* (Vol. 2, 1959 to Vol. 14, 1971). While the National Economic Research Institute also makes forecasts in its journal, *Quarterly Predictions*, they do not form a consistent and explicit series.

The BERL wool forecasts studied here were those made at the beginning of the wool selling season in September, predicting the average price for the 12 months ahead. The figure forecast was the average price per pound of greasy wool at auction as published each year in the *New Zealand Yearbook*.

Figure 1 shows the comparison between actual wool prices and the price forecast at the beginning of the season. The average absolute deviation is 7.8 cents per kilogram, an error of 11.4%. As a basis of comparison I designed a computer forecasting system which uses a variety of moving averages of past wool prices to predict the future (see Fig. 2). This exponentially weighted moving average was less accurate than the BERL forecasters. It gave an absolute deviation of 9.7

cents per kilogram. This comparison indicates that the BERL forecasters made a worthwhile contribution to accuracy by reducing the error by a couple of cents.

Close examination of Fig. 1 shows that the BERL forecasters picked that wool prices were going to rise in 1965-6 but they failed to forecast the magnitude of that boom.

They mistakenly predicted a rise in wool prices for the 1966-7 slump, the year the Wool Commission bought in a third of the season's wool into its stockpile. This was a critical error, as mentioned earlier. Furthermore, none of BERL

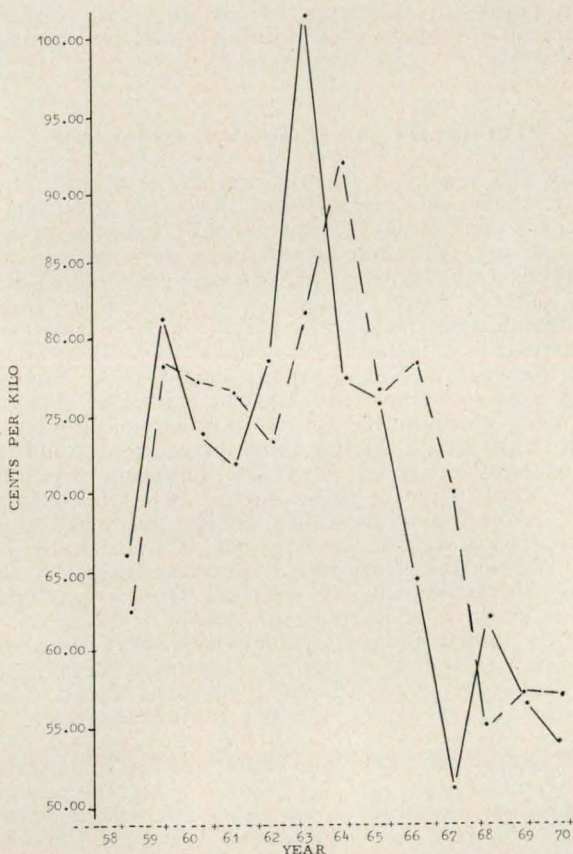


FIG. 1: BERL estimates of wool prices (actual = solid line; estimates = broken line).

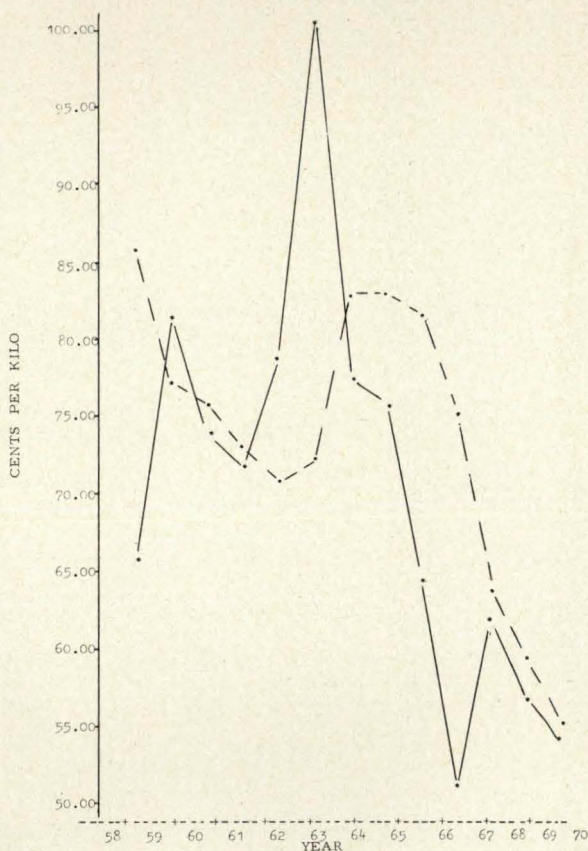


FIG. 2: EWMA estimates of wool prices (actual = solid line; estimates = broken line).

long-term forecasts foresaw the textile slump of the past few years and the reduction in the prices of synthetics.¹

The BERL lamb price forecasts were less accurate than the exponentially weighted moving average. The forecasters attempted to predict an index of lamb prices — the price per pound in March, June, September and December of 29 to 36 lb lambs on the Smithfield market. The BERL forecasters

¹ It should be mentioned that the fall in synthetic prices was predicted by the International Wool Secretariat. In fact the "running out of synthetic patents" and the likely increase in supply and decrease in the price of synthetics was a major plank in persuading New Zealand farmers to support the Woolmark Scheme in 1964.

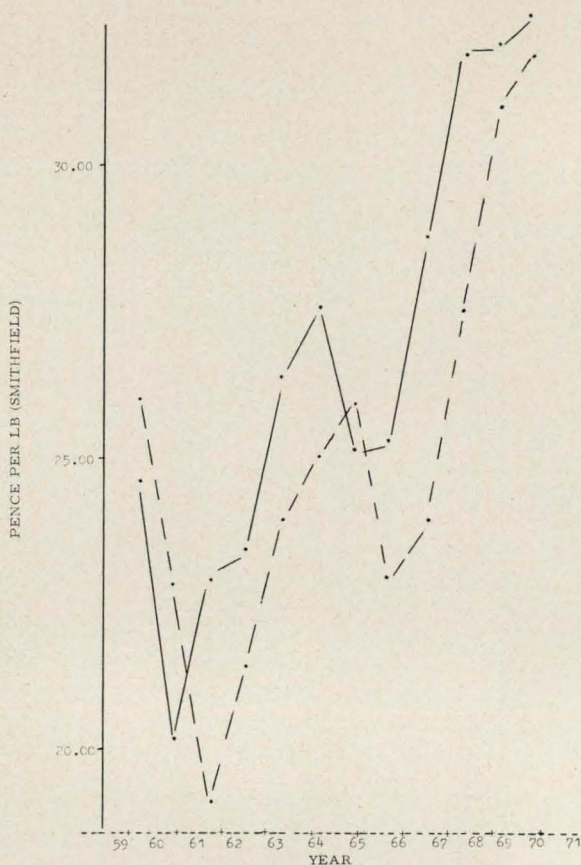


FIG. 3: BERL estimates for lamb prices (actual = solid line; estimates = broken line).

made their predictions at the beginning of each calendar year. Figure 3 shows a comparison of the actual price versus the predicted price. The average absolute deviation was 2.4d per pound which was 9.4% of the actual average price. Figure 4 shows the exponentially weighted moving average prediction which had an average deviation of only 2.2d per pound. This comparison suggests that BERL economists were not making a contribution to the accuracy of lamb price forecasts.

Close examination of the BERL lamb forecasts in Fig. 3 shows that there was a distinct downward bias (an average of 1.4d per pound) in their estimates. Each year a drop was expected because New Zealand was sending more lambs to England. The expected decline in prices did not occur be-

cause, among other factors, supplies of lamb from other sources were driven out by the relatively low lamb prices compared with opportunities in booming beef production. Incidentally most of the apparent upward trend in lamb prices in Fig. 3 is due to inflation rather than real price increases.

Table 1 in the Appendix summarizes the forecast accuracies for these two projects.

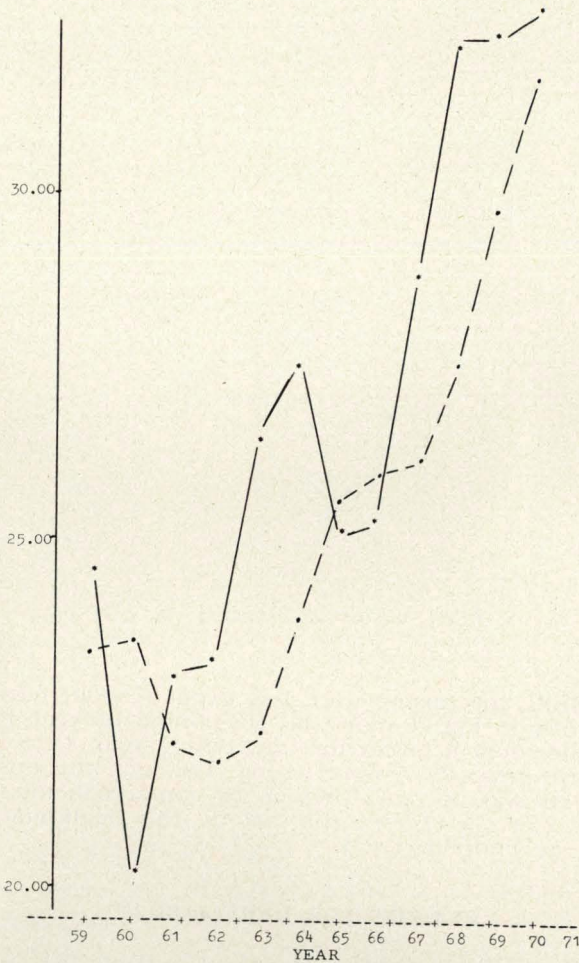


FIG. 4: EWMA estimates for lamb prices (actual = solid line; estimates = broken line).

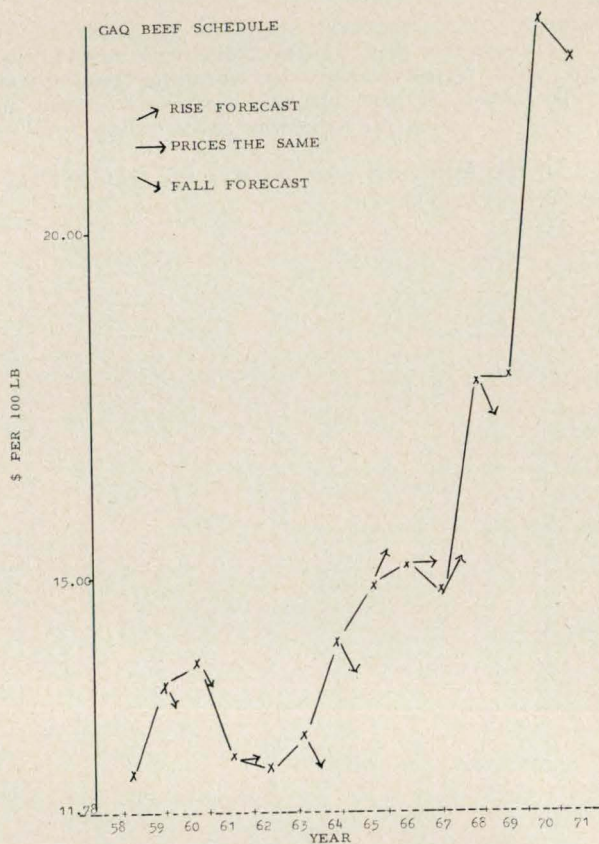


FIG. 5: BERL qualitative estimates for beef prices.

The BERL forecasters were less explicit about beef prices. The arrows in Fig. 5 show the "beginning of year forecast" of the direction of prices for the coming year. Of 9 of these qualitative forecasts, 4 were wrong. The long run upswing in beef prices was, in fact, foreseen by some economists; B. P. Philpott made a correct forecast at the beginning of the sixties (see Philpott, 1965).

REASONS FOR UNRELIABILITY

As these BERL predictions were far from perfect, something should be said about the methods used by economists to predict prices.

The econometric approach to forecasting prices is a 3-step process.

- Step 1:* Find out what underlying factors affect prices and measure the influence of each factor. For instance, if income per head goes up in the United Kingdom by 10%, how much will lamb prices go up? This is done by a statistical analysis of historical data.
- Step 2:* Predict how these underlying factors will change over the years ahead. For instance, income per Briton might be expected to increase by 3% in a year.
- Step 3:* Estimate the impact that changes in these underlying factors will have on prices — how much will increased prosperity of Britain influence lamb prices?

There are many possibilities for error "between cup and lip" in these three steps. First, economists cannot do controlled experiments as scientists can — the economist must harvest where he has not sown. He has to depend on statistics. He is rather like the dairy farmer who is unsure whether his increasing yields per cow are due to better breeding or to better feeding, because both have "gone together" over the years. Only a controlled experiment will sort this out. The most sophisticated statistical technique and the fastest computer will not untangle the impact of, say, increased wool promotion expenditure on wool prices, because the increased expenditure has been paralleled by declining prices of synthetics. In other words, the statistician cannot always measure the impact of the underlying factors when these factors are closely intercorrelated.

Secondly, the economist depends on historical records for his information. If an important factor was not measured and recorded, naturally he cannot know how important it was for prices. In fact in a statistical analysis other factors may be wrongly credited with unjust importance if all underlying factors are not measured.

Here I am reminded of the bright young educational psychologist who did a survey of children's handwriting. He uncovered a highly significant correlation between the speed of children's handwriting and the size of their feet. He was about to send off a research paper recommending feet-expanding exercises to increase the speed with which children wrote, when someone pointed out that he had not recorded the age of the children in his survey. He went back and collected their ages and put the data into the computer again. This time he found no correlation — the large-footed children wrote no faster. It was the older children who wrote faster and they had larger feet. In his first analysis, the size of feet, which of course is related to age, was wrongly associated with speed of handwriting because the data on age had not been included in the statistical analysis.

An economic example will help explain another limitation of historical records. An economist cannot tell how synthetic meat supplies will influence the price of manufacturing beef in the United States until some years of fluctuating levels of synthetic meat have been recorded. Even then his "raw" data may not distinguish between granular synthetic meat and the spun product.

There is a third reason why econometric predictions tend to be unreliable. It is because of the step-wise approach mentioned earlier. This compounds errors. Initially there is the error associated with predicting the underlying factor — the incomes of Britons may not rise as much as was thought. To this error must be added the error of determining prices from the income level of the Britons — the underlying factor. The two errors do not cancel each other out; they are additive.

Finally, it is very difficult to forecast those important "contingent" or catastrophic events — the start or finish of a war such as the Korean, the result of an EEC negotiation, a shut-out by quota or by a political hygiene regulation introduced by the veterinary profession, a strike, an exceptional drought, a new technological break-through like synthetic meat, or a severe economic depression. These events can be forecast only in terms of subjective probabilities. Experienced people closer to these events can estimate the chances of what will happen just as we can estimate the chance of a team winning a football game. Contingent events often have the largest impact on prices — the Korean War, for instance — and yet these can be predicted only in probabilistic terms.

This does not mean that econometric methods are useless for forecasting. Sometimes they can be very accurate, particularly when a change in an underlying factor precedes the change in price or demand. Such underlying factors are called leading indicators. For instance a timber miller can predict the demand for his 4×2 from the issue of building permits. When permits pick up, this leading indicator allows him to forecast greater timber sales in a few months' time.

Economists sometimes try to cover themselves by admitting that they cannot predict the underlying factors, and one reads this kind of statement:

"Given a population and income increase of some likely amount and given an increase in supply of each type of meat of some likely amount; and given the known relationships between income and the price of each meat and the demand for each meat; then the resulting price change can be projected." (Edwards and Philpott, 1969.)

By calling this forecast a projection (rather than a prediction) and hedging it about by enough "ifs" and "buts" and assumptions, the economist hopes that this semantic trick will give him a "let out". He also hopes that his projection will be accepted as a forecast. However, exactly how a farmer, a business man, or national leader can use these projections for making decisions is not at all clear.

It may be wrongly inferred that I am against economic predictions and *for* scientific predictions. In fact scientists have a dismal record for economic prediction. They love projecting past trends into the future. The world shortage of food is an example. Malthus, an early economic philosopher, predicted a world famine in 1798. The opening up of the New World proved him wrong. Since then economists have left the job of predicting famine to the scientist — now to the ecologist. After World War 2, Sir John Boyd-Orr made Malthusian predictions based on scanty information. Now nearly everyone believes in the impending starvation of the human race despite mounting world food surpluses, the green revolution, and the writings of Colin Clark, an economist who has questioned the predictions of the scientists and ecologists who are so arrogantly certain that a world-wide famine is just around the corner.

Other famine areas predicted by scientists since the war which have failed to materialize have been raw materials, coal, oil, and trained scientists. There is a paradox here that seems to defeat the long-term forecaster. If he is sufficiently credible and he predicts a famine then men seek new methods to solve the problem and in doing so create unsaleable and unprofitable surpluses (see McRea, 1972). At least world agricultural economists are on the side of the New Zealand farmer. They seldom, if ever, predict a future for farming and thus reduce the encouragement that overseas farming competitors receive from their governments. More power to their collective elbow — and confusion to the ecologists!

THE FUTURE OF ECONOMIC PREDICTIONS

Mathematical forecasting and prediction are quite recent skills acquired by economists. These new toys have not proved as accurate as perhaps they could have wished. However, it would be a gross error to dispense with economists because of inaccuracy in their predictions, for while their predictions may be wrong, the advice given is frequently correct.

In my view, the most important paper given to this Conference in the past dozen years was B. P. Philpott's research results on lamb prices. Presented in 1961 the paper showed that extra New Zealand lambs on the United Kingdom market were worth about \$80 a ton—not \$400 which was the average price. This was because the extra lambs bring down the price of all other lambs on the market. He recommended that the Meat Board divert lambs from the United Kingdom market to North America by using marginal pricing if necessary. The Meat Board took his advice and through Devco and diversification penalties they have established a market in North America. The Board made apparent losses in order to develop a new and valuable market.

Professor Philpott's advice was right, but his price prediction was wrong. In real terms, lamb prices stayed about the same in the United Kingdom despite growing New Zealand lamb export. This was partially because of the diversion of

New Zealand lambs to America (note the self-defeating paradox of prediction) but also because of declining British lamb production.

I think forecasts in the future can be better than those of the past. The econometric approach is only one of a dozen techniques, each of which has its place (see Chambers *et al.*, 1971). Much more technological forecasting needs to be done so that we are geared to exploit new technology as it comes along. We need a research and development policy orientated to the search for profitable opportunities in the field of production, processing, storage, transportation, and marketing the output from our farm-land. Refrigeration provided a tremendous boost in the 1880s. Surely at a time of exponentially increasing technology there must be equally important developments with which to exploit the 1980s. In searching for technological innovations and predicting their value to agriculture, economists, scientists, farmers and businessmen must pool their forecasting efforts.

It is usual at this stage of an address to call for more expenditure on market research, preferably at the home institution. Instead, I shall call for caution—care that the cost of additional market research does not outweigh the benefits of increased accuracy of forecasts. Fortune telling is a difficult business even when backed by first-class research services. There are some areas of market research that could have a worthwhile payoff—other areas are more dubious.

Finally I think it must be recognized that we have a limited ability to foretell the future regardless of how much is spent on market research. Estimates will always be wrong to some degree. Some will be more accurate than others—the dairy industry, for example, is a particularly difficult area in which to make forecasts. I think we should tell our economists to stop nailing their colours to the mast by naming one single price as their prediction. This is not heroic, it is foolish and misleading because it does not say how uncertain we are about a particular figure. Each forecast should have a standard deviation associated with it to indicate the degree of uncertainty. Standard deviations can be compounded to make risk estimates for plans and budgets. Figure 6 gives an example for a typical sheep farm budget, the risk estimates being based on the standard deviations of past BERL forecasts.

These risk estimates are for a typical 2,500-ewe Canterbury sheep farm budget made at the beginning of the 1971-2 season. The most likely budget income is indicated by the highest column of stars, a figure of \$2,700. This was arrived at using the BERL forecast for lamb and wool in September 1971 together with 100% lambing and 14 lb wool per ewe overall. The standard deviation of BERL's past forecasts together with standard deviation for the two technical factors have been combined using probability calculus to construct the frequency distribution of income in Fig. 6. This shows the wide variation in income that can be expected. With a low expected

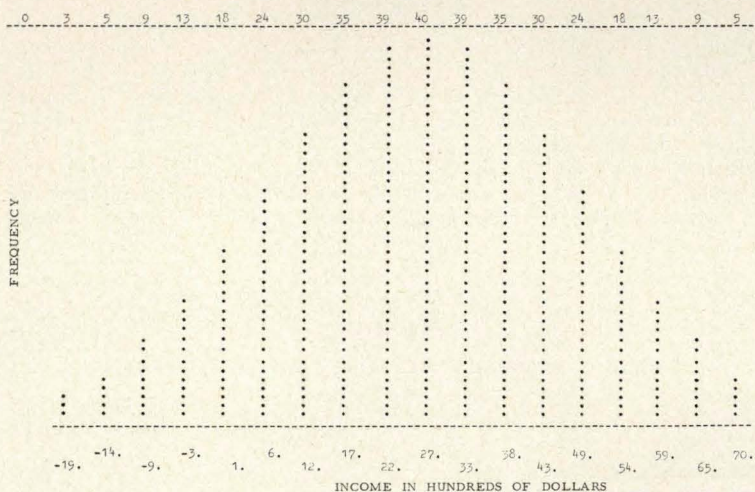


FIG. 6: Risk estimates for a sheep farm based on standard deviation of BERL forecasts.

income, it indicates the high risk the typical sheep farmer runs and the rather limited value of the finer calculations of the budgeteer.

However, if we know the degree of uncertainty faced from following a course of action, then at least we can make appropriate contingency plans to cope with the worst situation should it occur.

There is an implication here for New Zealand farmers and all those associated with the farming industry. We cannot be certain of the future and hence we must all be prepared to change our way of life if circumstances alter. Farmers already accept this to a degree. Mixed-cropping farmers are prepared to become extensive market gardeners, sheep farmers have shifted to beef and cropping, and a few have taken on large-scale dairying. Dairy farmers have shown they can produce beef instead of milk if they have to. The organization of the dairy industry allows tremendous product flexibility. But others associated with farming must be prepared to change too—freezing workers, waterside workers, sailors, traders, accountants, academics and research workers—if we are to adapt successfully to an uncertain future.

ACKNOWLEDGEMENT

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APPENDIX

TABLE 1: SUMMARY OF FORECAST ACCURACIES

				Wool (N = 17)		Lamb (N = 16)	
				BERL	EWMA	BERL	EWMA
Root mean square error ²	....	....	...	10.2	13.4	2.79	2.66
Mean bias of forecast ³	....	....	....	1.84	3.42	-1.53	-1.44
Mean absolute error ⁴	....	....	....	7.77	9.76	2.45	2.44

Notes:

¹ Exponentially weighted moving average =

$$F_{i+1} = aA_i + (1 - a)F_i + T_i$$

$$T_i = b(F_{i-1}) + (1 - b)T_{i-1}$$

where F_i is the forecast price at the beginning of the j th year and A_i is the actual price.

where T_i is the trend.

In this case a and b were set equal to 0.4, T_1 to zero, and F_1 was set to the average actual price for the previous three years.

$$^2 \text{ Root mean square error} = \sqrt{[\Sigma(F_i - A_i)^2/N]}$$

$$^3 \text{ Mean bias of forecast} = \Sigma(F_i - A_i)/N$$

$$^4 \text{ Mean absolute error} = \Sigma(|F_i - A_i|)/N$$

OPTIMUM USE OF FERTILIZERS

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As most of the fertilizer used in New Zealand is superphosphate on pastures, I shall concentrate on this aspect. It should be remembered, however, that other nutrient deficiencies and limiting factors such as poor drainage or drought may operate on some soils. To obtain the best or even any return from superphosphate, may mean attention to potassium, molybdenum, lime and even nitrogen under some conditions. These nutrients present interesting problems which will not be discussed.

There are one or two principles which it is helpful to understand. Figure 1 shows ways in which plants may respond to increasing fertilizer application on four soils. Curve (a) shows the response when a very severe deficiency is gradually corrected. There is a very low yield (Y_0) when no fertilizer is applied, a slow increase (Y_0 to Y_1) with the low dressings, a large increase in yield (Y_1 to Y_2) as more fertilizer is applied, and then from Y_2 onwards, a smaller rate of increase until the maximum yield is reached. No one has given me a satisfactory explanation for the increase being so small from Y_0 to Y_1 , but I believe it to be due mainly to the roots increasing rather more than the above-ground parts. Curves (b), (c) and (d) show more typical response curves on soils not so deficient in the particular nutrient being applied. A soil with no deficiency at all would of course give a flat curve across the top. It is clear that more fertilizer (A cwt/acre) is needed to get 90% of the maximum yield on soil (a) than, for example, on soil (c) which needs C cwt/acre. Except on very deficient soils, where there may be an almost linear response from Y_1 to Y_2 , the response becomes less and less for each additional amount of fertilizer—an example of the wellknown law of diminishing returns. It is also clear that soil or plant analyses may help to separate soils into groups that are very deficient such as (a), and (b), (c) and (d) which are not so deficient, and thus allow rational use of fertilizer, with most being applied to soil (a) and least to soil (d). Where soils on a farm

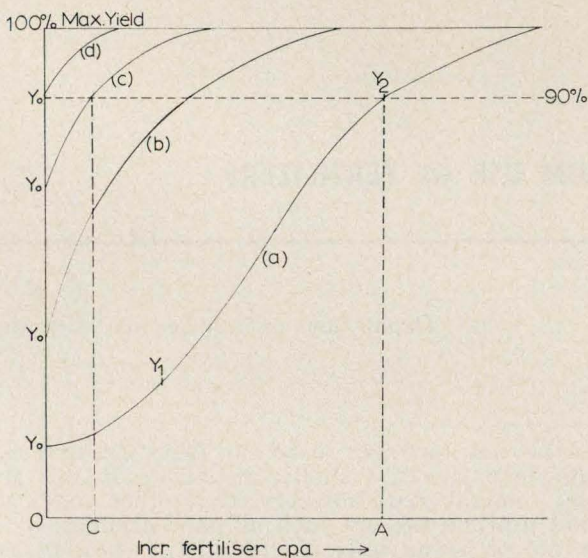


FIG. 1: Response curves of plants to increasing application of a deficient nutrient. Soil (a) is very deficient and soils (b), (c) and (d) are less and less deficient giving increasingly high yields (Y_0) when no fertilizer is applied.

are very similar, it is obvious that if money for fertilizer is limited it should usually be applied at similar rates all over, rather than as heavy dressings on some paddocks and low ones on others. Except on very deficient soils the biggest returns per unit of fertilizer are given from the lower dressings.

These growth curves can be given quantitative economic significance when we measure yields of dry matter, milk, meat, wool or wheat, in fertilizer trials, on different soils, over several years, and perhaps with different management, to establish the effects of soils, climate and management on the shape and magnitude of the response curves. The curves show that it needs relatively more fertilizer to get that last 10% of the maximum yield, and this fertilizer could cost more than the extra yield is worth. The optimum fertilizer dressing is defined as that which gives maximum profit—not necessarily maximum yield—and this depends on the price received for the product, and the costs entailed in buying and applying fertilizer, harvesting, storage and other overheads.

WHEAT EXPERIMENTS

A simple example from the use of superphosphate on wheat will illustrate some of these points. At a past Conference I

discussed nitrogen fertilizers and used some of the results of trials carried out by R. C. Stephen of the Department of Agriculture, which showed that it was much safer to risk 1 cwt of superphosphate on wheat than to spend money on nitrogen. Mr Stephen has carried on this kind of experiment (5 rates of phosphate $\times$ 5 rates of nitrogen on wheat) during the past few years and has now completed 62 trials. Of these trials, 50 have given significant responses to phosphate and I have averaged the main effects of phosphate over all trials. The phosphate dressings were equivalent to 0, $\frac{1}{2}$, 1, 2 and 4 cwt/acre superphosphate, and the responses in bushels/acre are given in Table 1. Assuming \$1.45 per bushel, and allowing 20 cents to cover extra costs of harvesting, storage etc., the net return would be \$1.25 per bushel, and the increased returns are shown using this price. The cost of superphosphate is also shown. The current unsubsidized cost of 1 ton of superphosphate landed at a farm 20 miles from the works is \$24.95 plus \$2.93 cartage, or \$27.88. At present there is a subsidy of \$7.50 a ton plus 9 cents a mile for the first 20 miles (\$1.80), giving a total subsidy of \$9.30 per ton, or a subsidized cost of \$18.58 per ton (93 cents/cwt). I doubt if any farmer in the world buys superphosphate cheaper than this; the British farmer pays over \$30 per ton for his (subsidized). Thank God we seem to have one efficient manufacturing industry.

TABLE 1: RESPONSES OF WHEAT (bu/acre) TO PHOSPHATE; VALUE OF INCREASE, COSTS OF FERTILIZER AND INCREASED PROFIT

Average of 6 Trials

	Superphosphate Equivalent (cwt/ac)			
	$\frac{1}{2}$	1	2	4
Increased yield over control (bu)	3.4	4.7	5.7	6.3
Value of increase at \$1.25/bu	\$4.23	5.88	7.13	7.88
Cost of subsidized super.	\$0.47	0.93	1.86	3.72
Value of increase less cost of super.	\$3.76	4.95	5.27	4.16

As shown in the first line of Table 1 there have been excellent responses to phosphate, somewhat at variance with results in the 1950s, when little or no response was given from phosphate in most trials; perhaps present responses to phosphate are due to more responsive varieties of wheat or higher levels of soil nitrogen building up under better pastures. The last line of the table shows that it was not profitable to increase superphosphate from 2 to 4 cwt/acre, the extra fertilizer costing more than the value of the extra yield. Superphosphate at 2 cwt/acre gave 32 cents more profit than 1 cwt/acre and would be somewhere near optimum. If soil tests gave low values for phosphate, it would certainly pay to use 2 cwt/acre superphosphate on average. A cautious farmer, or even an

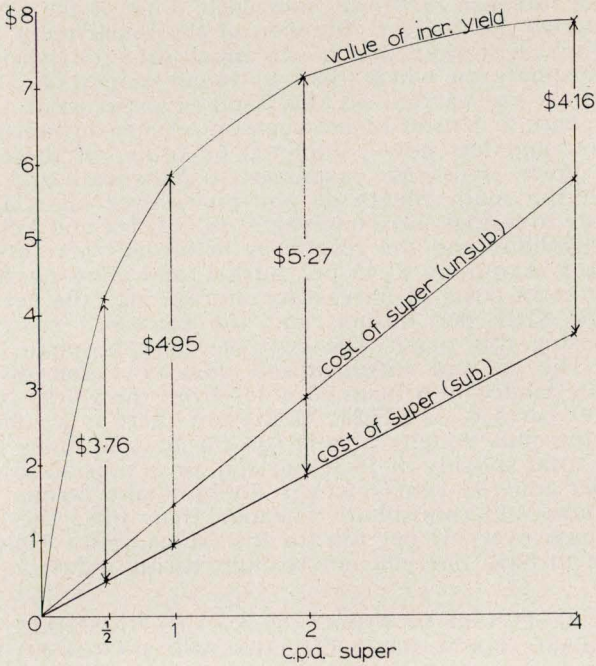


FIG. 2: The profit from the use of superphosphate on wheat.

adventurous one on a soil with a moderate to good phosphate status, might settle for 1 cwt/acre without much risk.

The same data are plotted in Fig. 2, which shows the smooth shape of the response curve. The narrowing profit gap at the higher rates of phosphate is clearly brought out particularly

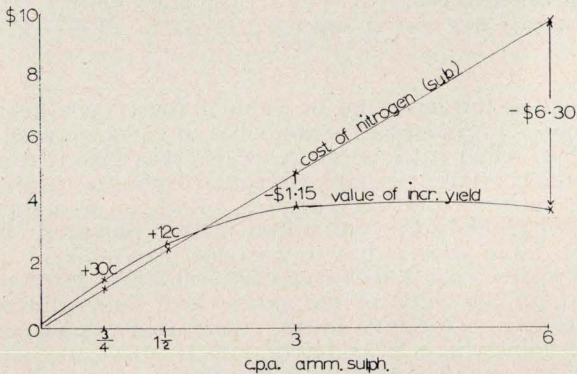


FIG. 3: The profit from the use of nitrogen on wheat.

with unsubsidized superphosphate. If superphosphate were not subsidized at all, it would still pay to use 1 cwt/acre, but no more. If a bushel of wheat were valued at \$1.40, it could be profitable to use 4 cwt/acre. Figure 3 gives the main responses to nitrogen in 39 of these trials, and, in marked contrast to phosphate, shows that on average there is little to be gained from the use of nitrogen.

PASTURES

Experiments over many years are needed on the important soil types to look at rates of superphosphate, stocking rates, type of stock, pasture management and even pasture species, for example, lucerne in Canterbury versus ryegrass-white clover pastures. Two such trials, carried out in the South Island by the Department of Agriculture at Winchmore and Invermay, provide some useful conclusions.

Winchmore Experiment (Rickard, 1968)

The treatments I want to examine from this experiment, carried out over 6 years in the 1950s, are 0, 1½, 3 and 4½ cwt/acre superphosphate on irrigated pasture on a Lismore stony silt loam. Hoggets were used to graze the pastures, and dry matter yields and liveweight gains were reported.

Subjective estimates were made of carrying capacity, and stock numbers were adjusted by the experimenter according to his idea of the amount of feed available. The numbers used would almost certainly be low by today's standards. Table 2 shows the average yields over 6 years. Liveweight gains are converted to yields of meat by assuming a killing-out percentage of 48 and meat has been valued at 10 cents per pound. Cost of fertilizer has been deducted to give increased income (see Fig. 4). An accurate estimate of profit would need to take into account wool, pelts, costs of application of fertilizer

TABLE 2: AVERAGE YIELDS OF DRY MATTER, LIVWEIGHT GAINS OF HOGGETS AND INCREASED INCOME FROM SUPERPHOSPHATE OVER 6 YEARS ON IRRIGATED LISMORE PASTURE

					Rate of super. cwt/yr			
					0	1½	3	4½
Yields dry matter lb/ac	....	....	....	....	4,400	9,000	9,800	10,200
LW gains lb/ac	....	....	....	....	460	704	767	797
Weight meat lb/ac	....	....	....	....	221	338	368	382
Value at 10c/lb	....	....	....	....	\$22.10	33.80	36.80	38.20
Cost of fertilizer	....	....	....	....	\$nil	1.40	2.80	4.20
Value of meat minus cost of fertilizer	....	....	....	....	\$22.10	32.40	34.00	34.00
Increase over control	....	....	....	....	—	\$10.30	11.90	11.90
Value of increase for each successive								
1½ cwt/ac super.	....	....	....	....	—	\$10.30	1.60	nil

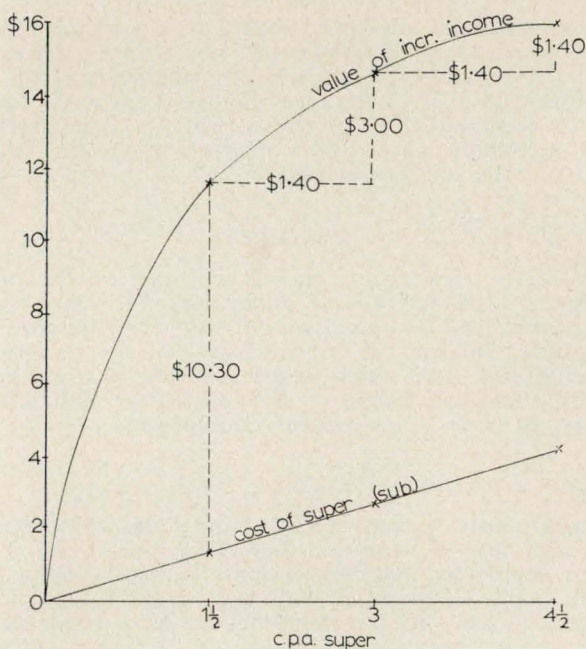


FIG. 4: Increased income from superphosphate on irrigated Lismore pasture (from liveweight gains of hoggets).

etc., and, at today's figures, extra income would almost certainly be higher than I suggest.

Not much Bayesian economics is required to appreciate that there is a rewarding 700 to 800% return on the first $1\frac{1}{2}$ cwt/acre superphosphate—\$1.40 on superphosphate returns \$11.70 on meat. One could, of course, make similar calculations assuming different returns for meat, but it would need a very low price for meat for it to become unprofitable to apply $1\frac{1}{2}$ cwt/acre. The last line of the table shows that increasing from 3 to $4\frac{1}{2}$ cwt/acre raises meat yield by 14 lb, worth \$1.40 which just covers the cost of the extra fertilizer. Superphosphate at 3 cwt/acre gives \$1.60 more than $1\frac{1}{2}$ cwt—in other words, it costs \$1.40 to give a return of \$3. Even the most risk-conscious farmer should apply $1\frac{1}{2}$ cwt, but a good grazier could safely risk 2 and perhaps even $2\frac{1}{2}$ -3 cwt on an irrigated Lismore pasture.

Table 3 shows that Truog soil-test values increased after 6 years, where 3 cwt/acre superphosphate or more had been applied each year. It was estimated that Truog values of 4 to 6 in the 0 to 3 in. layer would give 90% of maximum yield and could be maintained with $1\frac{1}{2}$ to 2 cwt/acre/annum.

TABLE 3: TRUOG SOIL-TEST VALUES FOR PHOSPHORUS AFTER 6 YEARS

<i>Initial Value</i>	<i>Super. (cwt/ac)</i>			
	<i>0</i>	<i>1½</i>	<i>3</i>	<i>4½</i>
4.0	3.0	4.0	6.4	10.0

If 1½ to 2 cwt/acre superphosphate is needed to maintain production on an irrigated Lismore producing about 10,000 lb/acre dry matter, an unirrigated Lismore yielding about 5,000 lb dry matter might get along quite nicely on 1 cwt/acre/annum, once the Truog phosphorus test had built up to 4 or more.

The trial was modified and carried on for another 9 years measuring residual effects from the 3 and 4½ cwt/acre treatments. Yields gradually fell but were still above control yields at the end of the trial. There were indications that sulphur deficiency was probably worse than phosphorus deficiency; in other words, phosphorus had built up in the soil during the previous 6 years and was being slowly released to plants, but sulphur was not retained so well. This accords well with our own theories and findings. As the phosphorus levels of soils increase from superphosphate applications, there may be a case for using slightly smaller dressings of sulphurized superphosphate rather than straight superphosphate. However, 2 tons of sulphurized superphosphate cost nearly as much as 3 tons of straight superphosphate today, so the financial advantages could be slight.

Invermay Experiments (Scott, 1968)

The major experiment I want to examine was a stocking rate × rate of superphosphate trial carried out for several years on a yellow-grey—yellow-brown earth intergrade soil in a rainfall of 28 in. a year. The four treatments were: 1, 1, 3 and 3 cwt/acre superphosphate at, respectively, 3.5, 6.0, 3.5 and 6.0 ewes and lambs per acre.

In the early years, lambs and ewes did just as well at 6 to the acre as at 3½, so the rates were adjusted to 6.4 ewes at the low rate and 8.0 at the high rate. Only at the high stocking rate was any response obtained from the use of 3 cwt/acre superphosphate over 1 cwt. One of the surprising and major discoveries during the past 10 years has been that animal scientists and farmers have grossly underestimated carrying capacity of pastures. Certainly in this trial stocking rates were more important than fertilizer rates, and after 6 years the general conclusion (along with other evidence) was that 2 to 2½ cwt/acre superphosphate would be the likely maintenance dressing for this soil and climate. Scott does emphasize the fact that when establishing a new pasture, and particularly where soil phosphate tests are low, as much as 6 cwt/acre superphosphate should be applied initially and perhaps also

in the second year before dropping to a maintenance dressing of 2 to 2½ cwt. This would give a carrying capacity of at least 6 ewes, with the better graziers carrying 8 or more. As one extra ewe and lamb gives an extra income of \$5 or more, this would more than cover the cost of even 3 cwt/acre superphosphate at \$2.79.

The important lesson from this trial was "Do not apply fertilizer if you are understocked; you will reap a profit only if you convert the extra grass to meat, wool or milk." Other conclusions from Invermay are: (1) When superphosphate is withheld, the yield declines by 7% a year, falling 20% in three years; and (2) Spring and summer are usually the best times to apply superphosphate to pastures.

CONCLUSIONS

These findings lead me to suggest the following maintenance rates of superphosphate for grazed pastures on various soils:

<i>Rainfall (in.)</i>	<i>Soil Type</i>	<i>cwt/acre Super.</i>
25 or less	Lismore, Eyre, Chertsey and other shallow, stony or light-textured soils. Dryland pasture.	1
25 or less	Lismore, Eyre, Chertsey and other shallow, stony or light-textured soils. Irrigated.	1½-2
25-30	Deeper over shingle and/or soils of heavier texture. Dryland pasture.	1½-2
25-30	Deeper over shingle and/or soils of heavier texture. Irrigated.	2-2½
>30	All soils.	2-2½

Almost certainly, if one is producing beef, or particularly milk, it could be profitable to raise these rates a little as the extra value of these products could pay to raise yield of dry matter to the absolute maximum. Only when heavier dressings than these are contemplated should one consider whether one's priorities are right. The growing of lucerne or grass for hay or drying instead of grazing would make greater demands on phosphorus, sulphur, potassium and other nutrients and fertilizer programmes would be more costly.

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EFFECTIVE FARM MANAGEMENT WITH MINIMAL LABOUR

M. G. YORKE

Farmer, Progress Valley, Southland

My farm, in Progress Valley, Southland, is 15 miles from the local centre, Tokanui, 52 miles from Invercargill and 62 miles from Balclutha. The port of Bluff, the fertilizer works, sale-yards and freezing works are all 50 to 60 miles from the Valley.

Rainfall, which is evenly distributed, has averaged 46 in. in the past 5 years. Frosts are not very hard because of the coastal locality. Strong south-westerly winds are fairly common but do not appear to affect pasture growth unduly.

This hill country in its natural state was covered with heavy bush. Some of this has been felled, burned and oversown since early settlement. Much of the easier country was cleared and cultivated in later years.

I started farming on my own account on my father's farm after his death in 1962. The stocking rate at that time was: Sheep—1,280 ewes, 380 hoggets, 40 others; cattle—90 cows, 10 bulls and others, or a total of 2,300 stock units. Cows were reduced in the first year to 36 to provide capital.

The farm, of 2,545 acres, is in two parts. The freehold area (1,045 acres) is on the Waikawa Harbour in south-eastern Southland, and the leasehold area (1,500 acres) is 8 miles away on the coast of South Otago. Five hundred acres are cultivated, 600 acres cutover bush, light scrub and tussock, and 1,445 acres are in heavy native bush; there are 1,100 effective acres.

The current stocking rate per effective acre is $4\frac{1}{2}$ stock units, and the total stocking rate 5,000 stock units—2,500 ewes, 500 hoggets, 100 rams and wethers, 175 breeding cows, and 200 weaners.

My production performance has altered very little during the 10 years. Lambing percentage has been 105 for the past two years, but for the 10 years has averaged approximately 100%. Lambs are now fattened, averaging 28 lb; ewe wool weights are approximately 9 lb.

Calving has been round 85% including heifers calving as 2-year-olds. Some steer calves are bought in but the aim is to breed all our requirements. These cattle are sold at 18 to 20 months.

OVERALL POLICY

During the first five years, I made only small increases in stock, and borrowed money was spent on development. In the second five-year phase, major expenditure was on stock increases.

Establishing farm priorities is the most important single factor in running a one-man unit, but there are also personal priorities to be considered. To manage a farm effectively is not necessarily to have the most sheep, the fattest cattle, the newest cowshed or the fastest racehorse. These are personal priorities. In my view, to manage effectively is to have a viable business that provides interest on capital invested, shows some capital gain, and provides labour with the same standard of living as do other industries. This third point is as important as the other two although it is sometimes overlooked.

A farm business consists of three resources—land, labour and finance. On any farm there is a most profitable position when these three points are equal. As an example, on a very small farm, labour could be the greatest asset and it could be used profitably by low-cost but high per-acre production. The man with a good supply of the third resource, finance, could aim for high-cost but profitable high production.

On my farm in 1962, land was the greatest asset; there was not very much of the other two. My challenge was to activate these three resources. I used the land to borrow the finance to provide the labour and in this way equalled my resources and "kicked off" my viable enterprise. When I say "to provide the labour" I am oversimplifying; this was where I learnt there are many methods, and to look for end priorities before planning working systems. I found, for example, that to achieve a lambing percentage of 110, the cost were one shepherd, Land-rover running costs, lambing pegs, and sundries. To achieve 105%, the cost was a reduction of 5% in lambing. In other words I could produce more per head but not necessarily show a greater profit. Some critics may consider this a negative approach; they may be right, but it is effective management.

Costing Jobs

Where possible, I cost all jobs at the contract rate. This I believe is the true cost where no permanent labour exists and casual labour is 50 miles away. Viewing labour costs in this way has helped considerably in pruning operations, so that I can manage effectively with minimal labour, and has also been the reason for my small capital outlay on machinery and plant (itemized in Table 1).

In costing operations and planning priorities I have sought the advice of professional advisers wherever possible. These include accountant, stock firm manager and budget man, bank

TABLE 1: CAPITAL INVESTMENT

<i>Equipment</i>	<i>Balance Sheet Value (\$)</i>	<i>Cost to Replace (\$)</i>
4 × 4	308	800
Motor cycle	256	450
Crawler	857	
Ford 3,000 tractor*	2000	
Sundries, including shearing machines and electric woolpress	1287	
Total	4708	

*The purchase of this machine was not warranted and it will be sold.
The motor cycle is the most-used plant.

manager, solicitor, and local farm adviser of the Department of Agriculture. I have also bought advice in the form of a farm consultant. There is, in addition, a valuable discussion group in our valley.

FARMING METHODS TO MINIMIZE LABOUR

All-grass Farming

Without doubt, this system has minimized costs and labour more than any other. Over 6 years of all-grass farming, fuel and machinery repair costs (including car) have averaged \$1,200 per year (1966, 50c per stock unit; 1972, 25c).

Easy-care Sheep

I have been changing over to Perendales because of the hard hill country and to help minimize labour. I first tried a few Perendales in 1967; they performed so well unshepherded that I decided to change the flock over to this breed, and today I have fewer than 900 Romney ewes. As a stud Perendale breeder, I do not advocate running Perendales on heavy flat land, although many Southland farmers are doing this successfully. I believe in time all breeds of sheep will be easy care.

In the past I carried 3,000 ewes with no replacements. It was a very simple system and I liked it better than rearing my own replacements. When good Perendale 2-tooths become readily available I shall return to this system.

Cattle

The greatest advantage of running cattle is the low labour input required. Also, the work falls at different times from that of sheep work.

To utilize the rough areas I hope to run 200 breeding cows and fatten their progeny at 20 months. At present, because of the "boom" in cattle prices in the South, I have been selling my steers on the store market at higher than schedule rates.

Contract Labour

The effect on wages and labour costs through the increasing use of contractors is shown in Table 2.

TABLE 2: USE OF CONTRACTORS—EFFECT ON WAGES AND LABOUR COSTS

<i>Year</i>				<i>Wages* (\$)</i>	<i>Labour (\$)</i>
66-67	....	....	....	2,860	?
67-68	....	....	....	2,060	825
68-69	....	....	....	1,750	290
69-70	....	....	....	1,480	106
70-71	....	....	....	1,610	Nil
71-72	....	....	....	1,550 (No lambs shorn)	Nil

*Including all woolshed work and tailing.

I employ contractors wherever possible though my advisers have not always agreed with this policy. A contractor is his own foreman or supervisor. This point is often overlooked, but anyone with experience of hiring labour will know how scarce competent supervisors are. Some operations carried out by contractors are shearing, tailing, dipping (both sheep and cattle), fertilizer spreading, cartage fencing and any ditching and dozing that might be needed.

SOME PROBLEMS SOLVED WITH CO-OPERATION

There are seasonal operations that require some help. To provide the skilled stockmen required for weaning lambs, marking and weaning calves, the young hard-up farmers in our valley work together. Working to a pre-arranged schedule it is possible to wean, crutch and drench one group member's lambs in a day. We have found that at least one spare day between each flock is necessary for unexpected holdups and mustering.

For cattle operations, two group members work together. This means that two or three mobs of cattle are handled on the same day. In future this work plan might be used to feed out hay with two members working together. At present my wife drives the truck for feeding out. This takes approximately one hour, two days out of five. In many cases this would not be practical, but in our case it works quite well.

In conclusion I would emphasize that this type of farming still has room for personal priorities. Next week my neighbour and his wife leave on a world trip. They will be away for a year while we manage two farms, after which it will be our turn for a break. It is a great challenge to manage 7,000 stock units, and I hope and believe it can be worked effectively with minimal labour.

AN APPROACH TO BREEDING EASY-CARE SHEEP

K. J. DUNLOP

Farmer, Winton, Southland

An easy-care sheep may be defined as one that gives the greatest financial return for the minimum input of feed and labour.

Obviously, the factors involved in this definition, the prices for meat and wool, and the cost of labour, are changing, relatively, all the time. Further, because it influences meat and wool prices, quality, whether it be of carcass conformation or fineness and style of wool, must be associated with quantity.

While I have approached the breeding of improved sheep from several angles, I have consistently used records of performance, on the one hand, and reasonable numbers of sheep, on the other, to enable the selection of genetically superior stock to be structurally sound.

To meet this criterion, I have found the National Flock Recording Scheme invaluable. While changes will need to be made from time to time, it is a standard national recording system which can be readily interpreted by any breeder or other interested person. To figures of performance can be added other information such as vigour of lambs at birth or whether or not assistance is required.

BREEDING PROGRAMME

In 1964 I began farming in partnership with my father on a 450-acre sheep, small seeds and cropping farm, 11 miles north of Winton. The farm is in two blocks, 4 miles apart, and in 1964 the home block ran 818 Romney ewes and the other block 836 Romney ewe hoggets at a stocking rate of 5.4 ewe equivalents (EE) per acre.

That year, all twin ewe lambs born unassisted were permanently marked at birth, but in 1966 I realized the limitations of twin marking alone. Consequently, Romney rams with a fertility backing of 200% lambs weaned on the dam's side were purchased and mated to the twin-born 2-tooths entering the flock. This was the beginning of an elite flock with 2-tooth ewes weaning good twins being identified and recorded.

In 1969, I joined the National Flock Recording Scheme and a large-scale sheep breeding venture, the N.Z. Romney De-

velopment Group. Today, 21 members are screening in excess of 65,000 Romney ewes. The best of these ewes are run on Wairunga, the central flock property of T. Parker, in Hawke's Bay. In return for ewes, rams have been received from this flock which, over 16 years, has developed an open-faced Romney requiring very little assistance at lambing. After what seemed an unrewarding performance at Wairunga for 10 years, the percentage of lambs docked has risen from below 100% in 1966 to 134% in 1971. The rate of assistance at birth has dropped from more than 10% to less than 1% in the past few years. Last year, of 1,500 ewes, only 10 were assisted.

Nonetheless, one could not ignore the claims of the Coopworth, so in 1970 I first used a stud Coopworth ram across selected Romney ewes. This was after he had 10 days with selected Border Leicester $\times$ Romney 2-tooth ewes owned by a neighbour, Hugh Simmers. This mating gave us 40 2-tooths which reared good twins to weaning, and was the beginning of another elite flock.

Currently, the situation is as follows:

Romneys: (1) Screening own Romney flock of 1,550 ewes (recording 450 2-tooths and 211 elite ewes); (2) Member N.Z. Romney Development Group; (3) Buying old, proven ewes from large stud recording 20 years of 150% lambing.

Coopworths: (1) Topcrossing Romneys with Coopworth rams; (2) In partnership with H. Simmers using his 2,200 Border Leicester $\times$ Romney ewes to fully record an elite flock mated to Coopworth rams (recording 300 2-tooths and 100 elite ewes); (3) Recording own Coopworth flock—initially bred from H. Simmers' flock.

The objective is to have three-quarters of the flock Coopworths and one-quarter Romneys. Only 300 Romney ewes were mated to Romney rams in the 1972 mating.

PERFORMANCE

In 1967, lambing percentage was depressed to 114% by increasing the stocking rate to 7.3 EE/acre. Stocking rates, lambing percentages and production per acre from 1968 to 1971 are shown in Table 1.

TABLE 1: STOCKING RATES, LAMBING PERCENTAGES AND PRODUCTION PER ACRE, 1968-71

					Lamb	
					Meat/ac (lb)	Wool/ac (lb)
			EE/acre	Lambing %		
1968	....	....	8.5	120	300	96
1969	....	....	7.5	129	310	84
1970	....	....	7.7	118*	280	90
1971	....	....	8.1	120†	320	88

*10% excess loss because of snow.

†Very dry autumn affected 2-tooths.

From these figures it can be seen that there has not been any significant improvement in per-head performance. But it takes 6 years before a flock undergoes complete change with normal culling practices. It also takes several years to identify enough high-performing ewes to breed sufficient ewe lambs to meet the flock's 2-tooth requirements. This appears to be borne out by the 10-year gap at Wairunga before definite improvement in fertility was recorded.

DIFFICULT BIRTHS

My definition of a difficult birth is one where either the ewe has to be assisted to keep the lamb alive or a lamb is found dead as a result of dystokia. With recording, this information can be fairly accurately documented. While the proportion of difficult births in my flock has been about 11% of the 2-tooths and elite ewes during the past three years, I am sure it will reduce to a lower figure soon. One aspect of which I am confident is that by selecting for vigour and unassisted births, fewer lambs require feeding before they get to their feet.

ROMNEY CROSS AND ROMNEYS COMPARED

Two trials comparing characteristics of Romney cross with Romney ewes have been carried out in association with H. Simmers. The first compared the milking ability of Border Leicester $\times$ Romney and Romney ewes. Before last year's lambing, ten 4-tooth Border Leicester $\times$ Romney ewes from Hugh Simmers' flock were exchanged with 10 4-tooth Romney ewes from my flock. These ewes, as 2-tooths in their respective flocks, had weaned twins of average adjusted weight the previous lambing. At weaning this year, they were compared with the same group of ewes of the other breed. The results are shown in Table 2.

TABLE 2: BORDER LEICESTER $\times$ ROMNEY AND ROMNEY MILKING TRIAL

<i>Farm A</i>	<i>Av. adj. weaning wt (lb)</i>	<i>Farm B</i>	<i>Av. adj. weaning wt (lb)</i>
BL $\times$ R 4-tooth ewes	68	10 BL $\times$ R 4-tooth ewes	73.7
10 Romney 4-tooth ewes	61.5	Romney 4-tooth ewes	67.1
10.8% superiority to BL $\times$ R ewes		9.65% superiority to BL $\times$ R ewes	

The second trial compared lambing performance of 122 Romney hoggets with that of 58 Romney $\times$ Coopworth hoggets. The results are shown in Table 3.

These results indicate that it is worth while lambing Coopworth $\times$ Romney hoggets, but that Romney hoggets are a doubtful proposition.

TABLE 3: ROMNEY AND COOPWORTH $\times$ ROMNEY HOGGET LAMBING TRIAL

					<i>Hoggets</i>	
					<i>Romney (122)*</i>	<i>Coopworth × Romney (58)†</i>
Body weight May 1 (lb)	....	....	....	....	77	77
Total lambs born	....	....	....	....	42	35
Lambs dead before 3 days	....	....	....	....	14	3
						and 2 aborted
Lambs weaned	....	....	....	....	27 (22%)	29 (50%)
Lambs' average adjusted weaning weight (lb)	....	....	....	....	46.3	56.5

*Progeny of recorded Romney 2-tooth ewes sired by Romney.

†Progeny of recorded Romney 2-tooth ewes sired by Coopworth.

Thirty-two Coopworth hoggets lambed at much the same level as the halfbreds. Until they began to lamb, these hoggets were part of a flock of 1,200 ewe hoggets run at 12 per acre.

I found it easy to foster lambs to halfbred or Coopworth hoggets while Romneys, again, were a doubtful proposition. Of the twins from a Romney hogget, one was fostered to a Coopworth. The lambs were of similar size at birth, but at weaning that reared by its mother weighed 45 lb, while the other, reared by the Coopworth hogget, was 57 lb.

Two halfbred hoggets reared twins and so did one Romney hogget. The halfbreds weaned a total of 98 lb and 101 lb adjusted weight, respectively, and the Romney 76 lb.

WEIGHT GAIN

I weigh lambs at 100 days after weaning. If it is important for beef cattle to have maximum weight gain, then surely it is just as important for sheep. If a ewe lamb has not reached a satisfactory weight at 100 days after weaning (end of March), then it would be unlikely to carry on growing at a sufficient rate to enable it to take the ram. Similarly, wether lambs, which in Southland can usually be grazed until this time, would be less profitable. At present, the lamb schedule does not favour lambs above 36 lb dressed weight but one hopes that, with precutting and market development, this will not always be the case.

As could be expected, there is a wide variation in weight gain from below 20 lb to 56 lb. The Romneys, which average 88 lb liveweight, average 36 lb gain, and the Coopworths, 94 lb liveweight, average 40 lb gain. The inheritance of weight gain

in sheep is not as high as that for cattle but would range from 0.25 to 0.3 which suggests that moderate success could be achieved if this factor were selected for.

SUMMARY

I believe there is a good case for improving many Romney flocks by simply replacing Romney rams with well-bred Coopworth rams. This is the only necessary change. This practice continues until a Coopworth flock is established. The advantage will be an open-faced easy lambing flock weaning a higher percentage of lambs at heavier weights. The wool will be of the same style and quality and the same weight.

This is not to say that all Romney flocks should be top-crossed with Coopworth rams because there are indications that the future will see a much improved pure Romney. The main question is time. Can the individual farmer or the industry afford to wait for the benefit from the improvement of a pure breed?

SYNDICATION AND CO-OPERATION

PETER ELWORTHY

Farmer, Maungati, South Canterbury

During a five-month look at overseas farming last year my interest was aroused by the progress made by the British farmer towards a group approach to matters agricultural.

This approach, stimulated by the Government through grant and free advice, is growing, and, in its present application in Britain, as well as its future implications to that country's agriculture, the concept carries clear lessons for New Zealand farming.

THE BRITISH SCENE

Farm Machinery Syndicates

Farm machinery syndicates are the most simple form of co-operation in Britain, though some farmers have a bewildering complex of syndicated assets—tractors, headers, silage equipment, silos, grain dryers, seed cleaners. Syndicate credit companies provide simple legal and financial rules, and the movement has been sponsored by the British equivalent of our Federated Farmers—the National Farmers' Union. The British Agricultural Development and Advisory Service (A.D.A.S.), which parallels our farm advisory division of the New Zealand Department of Agriculture, provides personnel (usually one person in each county) who are expert and experienced in the human and technical problems of group ownership. These men, who are, I consider, of high calibre, motivation and enthusiasm, fully understand the financial and legal implications of group structures. The success of any form of farm co-operation, taking whatever pattern, depends absolutely upon a sound financial base and expert, experienced and informed advice at the outset. I discovered some expensive failures where these criteria had not been met: I found success and financial gain to the participants only where a farm group, whether involved in production, processing or marketing, or vertically integrating all three activities, had been initiated with the proper advice and legal and financial structure.

Machinery syndicates benefit, as do individual farmers, from an income tax investment allowance and from substantial farm capital grants (up to 40% of approved expenditure on a wide range of items), the position of an individual member within a syndicate being exactly the same as though he wholly owned the machinery himself. So, with favourable financial terms organized through the syndicate credit companies, with tax allowances and substantial grants, the British farmer has not lacked encouragement to make effective use of most efficient and advanced new machinery and plant and he is often best able to realize this ideal as a member of a syndicate.

Central Council for Agricultural and Horticultural Co-operation

Successful syndication of farm assets, begun in Hampshire in England in 1955, has encouraged farmers to look towards further rationalization of resources by co-operation in a wider sense. In 1965 a White Paper entitled "The Development of Agriculture" foreran the Agricultural Act of 1967 which then hatched the Central Council for Agricultural and Horticultural Co-operation. This Council was set up to "organise, promote, encourage, develop and co-ordinate co-operation in agriculture in the widest sense." The Council and its aims had the support of all political parties in Britain.

The Government in the White Paper said that it "believed that cooperation had much to offer farmers and especially small farmers . . . to make a much bigger contribution to increasing productivity. Benefits would come from increased scale of operations and specialisation both on enterprises for which they or their farmers were best suited. Co-operation could also improve producers' realisation prices through sorting and bulking of produce, preparing it for sale, and finding the best channels and methods of disposal."

This belief, if it is true (and already we can see it being proved true in Britain) has obvious relevance to our New Zealand situation.

To give some picture of the Council's role, some of its conditions for granting financial aid are listed:

- (1) The Council grants co-operative *schemes*—not plant, machinery or buildings.
- (2) For a production group, the Council requires a minimum of three independently financed and managed businesses.
- (3) For a marketing group, the Council requires a minimum of seven members and the group must be either a society or a company.
- (4) The Council requires a guaranteed volume of produce or acreage for a given length of time.
- (5) There are expulsion rules for breaking loyalty agreements.

- (6) The period of time for which an individual is committed to a group varies from three to five years.

Again, the success of these groups is totally dependent on adequate preliminary appraisal, and the Council employs regional co-operation officers who work in closely with the A.D.A.S. officers handling machinery syndicates.

Table 1 shows some of the Council's maximum grant levels; Table 2 indicates the increase in the Council's activities from 1967-8 to 1970-1.

TABLE 1: CENTRAL COUNCIL FOR AGRICULTURAL AND
HORTICULTURAL CO-OPERATION
Maximum Grant Levels

	%
Surveys and feasibility studies	75
Formation costs of new groups	75
Managerial salaries and expenses	33½
(perhaps for 2 years, dropping to 20% in 3rd year)	
Management selection	75
Management training	75
Research	75

TABLE 2: CENTRAL COUNCIL FOR AGRICULTURAL AND
HORTICULTURAL CO-OPERATION
Activities for Month of June, 1967-8 to 1970-1

	June			
	1967-8	1968-9	1969-70	1970-1
Applications received (some withdrawn)	131	289	384	684
Applications approved	62	244	289	592
Total cost of proposals approved (£)	0.99m	2.89m	3.96m	4.65m
Total cost of grants approved (£)	0.30m	0.65m	0.96m	1.10m
Types of Proposals				
Feasibility studies	15	44	32	77
New co-operatives	15	53	70	372
Expansion of existing co-operatives	29	141	184	137
Other	3	6	2	4
Administrative expenses (£)	30,850	99,500	154,200	196,100

The steep rise in co-operatives in 1970-1, is, like other progress, a direct result of extra financial stimulus. The figures show that the Council's activities have been successful in stimulating the group approach, a fact borne out by my observations at the practical farmer's level in Britain.

It should be noted that in Britain less than one-fifth of the grants on a production basis have been paid out so far to livestock co-operatives.

CANADIAN SYNDICATES

Substantial progress has been made in Canada, particularly in machinery syndicates. The Farm Machinery Syndicates Credit Act 1964 empowered the Canadian Government to establish an agency, called the Farm Credit Corporation, which provides federal monies in much the same way as syndicate credit companies do in Britain.

GROUPED FARMS IN FRANCE

Very significant progress in the group approach has also been made in France. The French Government, since 1965, has stimulated the idea by offering medium-term credits at a low rate of interest, and financial inducements similar to those offered by the Council for Agricultural and Horticultural Co-operation in Britain.

Le Groupement Agricole d'Exploitation en Commun (the Union of Farming Groups), called the C.A.U.s, operate, primarily, by owning the complete working capital of the grouped farms; land is owned by the members. The traditional French farmer, like his New Zealand counterpart, has been saddled with the necessity of carrying on many operations simultaneously—buying, selling, managing, labouring, accounting—and often works 12 or 14 hours a day at work more basic than befalls the average New Zealand farmer.

Under the C.A.U. system, the French farmer/member continues to own his land within the group but is responsible for specialist tasks only, thus attaining skills and a freedom of mind and function not previously possible.

The majority of the groups are livestock groups, and the effects on farm structure, financial results and the living conditions of the French farmer-members and their families have been very beneficial.

SOME CONCLUSIONS ON SYNDICATION AND CO-OPERATION IN BRITAIN

- (1) British farmers who have embraced a co-operative approach, often from small beginnings, have in general been satisfied with the results.
- (2) These British farmers (with some exceptions) now look towards wider horizons than on-farm co-operation or syndication.
- (3) The farms concerned now move towards more complex forms of co-operation such as vertical integration, which might be defined as the formal co-ordination of successive stages of production, processing and marketing.
- (4) The extent to which this concept has accelerated in Britain can be illustrated by the move at present being made by the National Farmers' Union which is looking

at the possibility of a very large producer-controlled production and marketing structure embracing all existing British farmer-controlled groups. This policy could not have been contemplated before farmer opinion in Britain had swung away, because of the success of farm groups at farm level, and only very recently, from the hitherto sacred concept of the farmer being one of the last of the totally free individuals in modern society.

The British farmer, then, is increasingly aware of the necessity to use modern methods of management and technique, to make more rational use of his scarce resources. He may be able partly to achieve this by becoming very big and so make use of efficiencies of scale and size under the one financial company, corporation or conglomerate. But more often, farming a traditional family unit, he prefers (and is forced by this very circumstance) to try to achieve efficiency and at the same time retain the basis of his traditional structure by some form of co-operation with his fellows. The financial and other rewards have been such that he is prepared to forsake some independence of action to gain the benefits of group operation. And as he becomes more experienced in the advantages of this concept, so he spreads his ambition for more effective farmer co-operation at *every* level, including political.

He has found, furthermore, that a group approach leaves more, not less, room for the success of the outstanding individual farmer, and he relies, as before, on individual motive and enterprise at production, processing and marketing levels.

SYNDICATION AND CO-OPERATION IN NEW ZEALAND

We have, unwittingly, and in unrelated areas, gone further on the road towards farmers working as a co-ordinated group in this country than is perhaps realized. A progressive dairy industry, without government incentive, has co-operated for much of its processing and marketing, and some of its production, and makes excellent use of its group resource through its A.B. herd improvement programme. In 1970 the more conservative and individually-oriented sheep and beef cattle industries had spawned 21 sheep and 11 beef group breeding schemes. Group enterprise in the broiler industry has thrown up an integrated, market-oriented and profitable structure which makes our New Zealand production-oriented prime lamb industry look very haphazard indeed.

Beef syndication is expanding; there are a number of farmer groups now working, and I know of groups of farmers in particular areas who are looking at the feasibility of advanced co-operative structures.

But, unlike Europe, there has been no stimulus, financial or otherwise, in this country, and aspiring co-operatives requiring the expert advice on finance and technique so essential for

success just cannot find informed guidance in New Zealand today.

Government, in fact, has no fixed policy on machinery or any other syndicate. The 1964 Agricultural Development Conference Finance Working Party had reservations about syndication. It foresaw three main difficulties: (a) An inability on the part of the farmer to achieve a fair apportionment of cost; (b) Difficulties in establishing priorities in the use of the machines; (c) The undercutting of established agricultural contractors.

The experience of overseas syndicates does not substantiate the first two objections. The Agricultural Development Conference suggested that agricultural contractors should share in whatever financial or advisory assistance is given in this country and I would support that view. Thus, the objections to co-operation raised appear unjustified.

Alternatives for New Zealand Agriculture

Assuming that the high degree of motivation inherent in the personal ownership of land has been one of the reasons for New Zealand's comparative agricultural efficiency, and assuming that we wish to retain the traditional family-owned farm structure, for economic and social reasons, I am sure that one of the most certain ways to achieve this is for our traditional units to make use of those modern advantages that can accrue from size and strength and yet still retain their basic structure.

The two main alternatives to a rationalization of resources in New Zealand's agriculture are, in my mind, quite clear—complete state dependence, or total subjection to and control by a limited number of enormously powerful and wealthy conglomerate groups, or perhaps a ghastly mixture of the two, a prospect quite hideous to contemplate.

My experience and observations indicate that we need immediate action in this field, and I consider that the promotion of the group concept to the New Zealand producer should rank high on the priority list for the planners of the third stage boost to New Zealand agriculture.

Money spent in grants to stimulate more effective use of the industry's resources by co-operation and syndication is but a minute fraction of the financial support New Zealand agriculture may require if it is not encouraged to adapt structurally. New Zealand farmers have proved to be as adaptable as any in the world, and should be in the forefront of this move, not among the rearguard as at present. Furthermore, with the current retrenchment in the agricultural advisory service in Britain, men of high competence, enthusiasm, experience and ability could now be recruited to perform that most vital of functions—the sound initial structure of agricultural groups in New Zealand.

CONCLUSION

We should, then, start at farm level from a sound basis with initial encouragement by way of grant and expert advice.

From overseas experience, as our knowledge grows, so will our desire and ability to co-operate with our fellow farmers at all levels. This will mean, as in Britain, a much more cohesive and loyal rural group, and the results of the farmer exchanging his present somewhat illusory independence for a co-operative approach to mutual challenges and problems will, I believe, have very profound effects on New Zealand agriculture at all levels.

Hopefully, as a result of the success of the basic group concept, we can expect one farmer body in New Zealand, wielding *all* the political and economic power available to the farmer. At the moment, by overseas standards, the New Zealand farmers' voice is hopelessly weakened by being fragmented.

We should aspire to look further, then, and cross national borders for the promotion of common agricultural products.

MACHINERY SYNDICATES IN NEW ZEALAND

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Syndicates may be classified into two basic types. The first I call the "hire" syndicates. These involve each farmer purchasing an item of equipment and hiring it to the other members of the group. At present most New Zealand syndicates are of this nature.

The advantage of this type of syndicate is that it releases capital which would otherwise be tied up in small items of plant that stand idle for much of the year. The disadvantage is that it requires all machines to be of approximately comparable value, otherwise the onus of capital outlay is unequally distributed among members.

The second type of syndicate is the "group ownership" syndicate, which is the one most prevalent in the United Kingdom. The machine (or machines) is purchased jointly by a group of farmers, each farmer contributing a portion of the purchase price. Usually the amount contributed by each farmer is in proportion to his estimated usage rate. The advantage is that small farmers can have access to large and modern machinery at relatively low cost.

CASE STUDY

Last year, a case study was undertaken by the Department of Farm Management, Lincoln College, to investigate the feasibility of a "group ownership" syndicate for a group of farmers on the Canterbury Plains who were considering investing in a large tractor for their heavier cultivation work. We feel that these types of syndicates bear investigation at a time when many previously viable farm units are becoming marginally economic and the cost of replacement machinery has markedly increased.

The study was centred on four light land farms in the Canterbury area. There are three basic reasons for cultivation on these properties, first, renewal of pastures, secondly, provision of a winter feed crop to supplement pasture and

lucerne production, and thirdly cash cropping on the heavier soil types. Most of the cultivation is done between August and February, a period when labour demands on these farms are at a peak. At present all four farms have a marginal labour unit problem and are operating under significant capital constraint.

The Tractors

The four farmers were interested in a tractor in the 100 to 120 h.p. range. Two tractors of 100 h.p. and 120 h.p. respectively, were selected for evaluation as possible case study machines. With cabs fitted for driver comfort, the 100 h.p. tractor costs \$9,100 and the 120 h.p. \$11,600.

Once the tractors to be evaluated have been selected it is important to calculate their work capacity. This was done by use of the following formula:

Effective work capacity (acres/hour) = width of implement in feet $\times$ speed in mph/10

This allows for 17.5% waste time.

Using this formula the time spent per acre for the basic cultivation techniques of pasture renewal can be estimated for the possible syndicate machines and the farmers' present tractors (see Table 1).

TABLE 1: ESTIMATED TRACTOR TIME SPENT PER ACRE

					<i>Tractor h.p.</i>				
					50	60	70	100	120
Pasture $\rightarrow$ supplementary feed or crop									
3 chisel ploughings	....	....	....	....	0.625	0.600	0.500	0.238*	0.204*
2 chisel ploughings and harrow	....	....	....	....	0.417	0.400	0.334	0.238	0.204*
1 harrowing and rolling	....	....	....	....	0.179	0.167	0.143	0.089	0.079
1 rolling	....	....	....	....	0.139	1.143	0.111	0.070	0.065
Total hours/acre	....	....	....	....	1.360	1.310	1.088	0.635	0.552
Supplementary feed $\rightarrow$ pasture or new lucerne									
4 chisel ploughings	....	....	....	....	0.834	0.800	0.667	0.357†	0.306†
1 harrowing and rolling	....	....	....	....	0.179	0.167	0.143	0.089	0.079
1 rolling	....	....	....	....	0.139	0.143	0.111	0.070	0.065
Total hours/acre	....	....	....	....	1.152	1.110	0.920	0.516	0.450

*Reduced to two chisel ploughings.

†Reduced to three chisel ploughings.

Using these per-acre estimates for the cultivation practices the total estimated yearly usage rate can be worked out (see Table 2).

Another important consideration is the distribution of work of the tractors (see Table 3). Ample time should be allowed for contingencies.

TABLE 2: ESTIMATED ANNUAL USAGE OF SYNDICATE TRACTORS

				100 h.p.		120 h.p.	
				Hours	% of Total	Hours	% of Total
Farmer A	....	....	....	155	16	146	18
Farmer B	....	....	....	274	28	221	27
Farmer C	....	....	....	331	34	268	34
Farmer D	....	....	....	216	22	174	21
Total estimated usage	....	....	....	976	100	809	100

TABLE 3: DISTRIBUTION OF TRACTOR WORK LOAD

				Hours		
				Aug./Sep.	Oct./Nov.	Dec./Feb.
Availability*	....	....	....	520	520	780
Demand	....	....	....	160	75	671
Surplus	....	....	....	360	445	109

*The tractor is assumed to be available 60 hours per week.

Syndicate Organization

The next factor to be considered is the organization of the syndicate both in overall policy and day-to-day running. The most important point here is the form of ownership to be adopted. In the United Kingdom a partnership is common but in New Zealand this has the major disadvantage of unlimited liability. It was decided to adopt a private company as the case study form of ownership for three principal reasons. First, there is limited liability of syndicate members. Secondly there is separateness of the enterprise—that is, the syndicate exists as a separate entity for accounting and administration purposes. Lastly, when a member wishes to retire or a new member to join all that is necessary is a transfer of shares.

Labour

The next point of importance is the provision of labour to run the tractor. The peak work load for the tractor is from August to February, a time when labour demands on member properties are at a peak. It was decided to employ a full-time driver as this opened up the possibility of a labour pool in conjunction with the tractor syndicate; an extra labour unit would be available on demand on member farms when the tractor was not in use. In addition one operator provides for a greater degree of continuity of maintenance and servicing.

Operational Rules

The operational rules under which a syndicate is to be run depend largely on the type and scope of the particular syndicate. These rules should cover such items as:

Proportion of capital cost to be met by each farmer.
 Provision of insurance and storage for the machine.
 Provision for refueling the tractor on each farm.
 A roster system for priority of use.
 A format for solving any disputes.

Having decided how the syndicate is to be organized the next step is to calculate the cost to the farmers of the syndicate tractor. Using the estimated usage rates shown in Table 2 the hourly cost to the farmers can be calculated (see Table 4).

TABLE 4: TOTAL HOURLY CHARGE PAYABLE TO SYNDICATE

								Tractor	
								100 h.p.	120 h.p.
								\$/hr	\$/hr
Finance ¹	....	....	....	....	....	....	....	2.27	3.50
Insurance	....	....	....	....	....	....	....	0.05	0.07
Implement ²	....	....	....	....	....	....	....	0.70	0.85
Direct materials costs ³	....	....	....	....	....	....	....	0.05	0.06
Repairs and maintenance ⁴	....	....	....	....	....	....	....	0.23	0.25
Operator's wage	....	....	....	....	....	....	....	1.50	1.50
								4.80	6.23
Syndicate charge	....	....	....	....	....	....	....	5.00	6.50
Fuel (18.2 c/gal) ⁵	....	....	....	....	....	....	....	0.64	0.73
Total hourly cost to farmer	....	....	....	....	....	....	....	5.64	7.23

Notes

¹ 5-yr table mortgage at 7%.

² Implement finance and repairs and maintenance.

³ Oil, grease, etc.

⁴ Tractor only.

⁵ 3.5 gal/hr for 100 h.p. tractor; 4 gal/hr for 120 h.p. tractor.

The most important factor influencing the cost to farmers is the usage rate. With a high proportion of the hire charge made up of fixed costs, the greater the usage rate the less the hire charge becomes (see Fig. 1).

Cost Comparison of Farmer-owned and Syndicate Tractors

To compare the cost of the syndicate machines with that of the present machines owned by the prospective members, cultivation costs must be compared on a per-acre rather than a per-hour basis, because of the differing work capacities of the tractors (see Table 5). It can be seen that on a per-acre

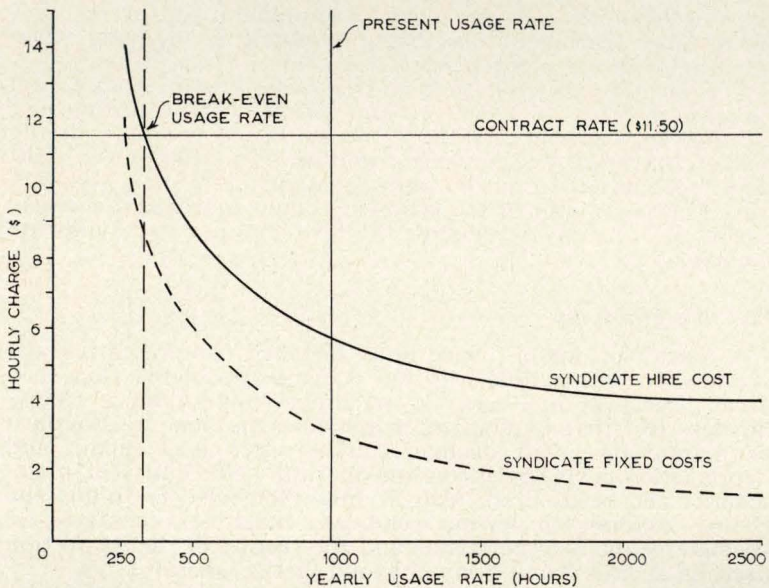


FIG. 1: Effect of usage rate on hire charge (100 h.p. tractor).

TABLE 5: PER-ACRE COST COMPARISON OF TRACTORS

	Tractors					
	Farmer-owned			Syndicate		Contract
	D	C	A & B			
	50	60	70	100	120	100
	h.p.	h.p.	h.p.	h.p.	h.p.	h.p.
Hourly cost* (\$)	2.95	3.20	3.80	5.64	7.23	11.50
Per-acre time (hr)						
Pasture→supplementary feed	1.36	1.31	1.088	0.635	0.552	0.635
Supplementary feed→pasture	1.152	1.11	0.921	0.516	0.45	0.516
Per-acre cost (\$)						
Pasture→supplementary feed	4.01	4.19	4.13	3.58	3.99	7.30
Supplementary feed→pasture	3.34	3.55	3.50	2.91	3.25	5.93
Cheapest	3	5	4	1	2	6

*Farmer's tractor costs include labour at \$1.50 per hour.

basis both syndicate tractors are cheaper than either the members' present tractors or the contract costs.

The effect of the tractor syndicate on member farms is several-fold. First, there is a reduction in per-acre cost of cultivation. Secondly there is a reduction in usage rate of members' tractors, which has the advantage of extending their replacement period because of the reduced work load. Thirdly

there is a reduction in the labour complement on the member farms, an extra labour unit being available on demand when the tractor is not being used.

The farmers also felt that with a large tractor they could increase the areas of greenfeed and forage crops resulting in a possible increase in carrying capacity. Since the bulk of the heavy cultivation on a mixed cropping unit falls in the light land "off" period from February to August, the inclusion of a mixed cropping unit in the syndicate could increase the yearly usage rate, effectively reducing the hire charge to all syndicate members.

Possible Problems

A matter of major concern to farmers contemplating the syndication of machinery is the possible problems that may arise. The first of these is machinery maintenance. Many farmers feel that by sharing a machine the general standard of maintenance will decline, causing increased repair and depreciation costs. By hiring an operator, continuity of maintenance can be assured. Also, it might be wise to follow the British example of having syndicate machines regularly inspected by qualified personnel and the results of the inspection used as a basis for a bonus payout to the operator.

The second and probably the major problem is the availability of the machine when required by the farmer. This is particularly significant in operations like heading and baling. The key to solving this problem is to ensure that the work load of the machine is not excessive and adequate provision is allowed for bad weather, transport and breakdowns. A roster system also helps to iron out any difficulties.

Another problem is the risk of disagreement among the farmers. This can be minimized by the selection of compatible members but a well-drawn set of rules ensures that minor difficulties are quickly resolved.

SUMMARY

In summary, a number of conclusions can be drawn from this case study:

There are potential benefits to farmers involved in syndication in the form of reduced per-acre costs of cultivation.

Owing to the high overhead costs associated with farm machinery, the usage rate of a syndicate machine largely determines its hire charge to members.

If the syndicate employs a full-time operator there are advantages in economies of labour on syndicate members' farms.

Although there are some problems associated with any co-operative enterprise, overseas experience shows that with goodwill among members, reinforced by well-drawn rules, these difficulties can be largely eliminated.

REDUCING FENCING COSTS

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Of the 370-odd papers presented at the Lincoln College Farmers' Conferences since their inception in 1950, only two have dealt with farm fencing. Even these two, one by W. R. R. Hewitt in 1959 on electric fencing, and the other by J. G. Hughes of the Tussock Grasslands Institute in 1963 on run country fencing, could be considered to be in the realm of "specialized fields" rather than general farm fencing.

It would appear, then, that fencing enjoys a place in the minds of most modern New Zealand agricultural researchers similar to that held by their American counterparts of the 1930s, causing one of them to remark: "It seems that fencing has seldom been regarded as a subject or problem of sufficient importance to warrant any considerable study on the part of agricultural research agencies, be they engineering or economic in character. When fence was thought of, it has been to wonder how we might get along with less or do away with it entirely. It has taken its place in the minds of the farmer, the teacher, and the research man similar to that occupied by sugar and flour in the mind of the grocer; a staple, necessary commodity, but nothing to get enthused over." He goes on to say: "Yet fence is almost as basic as the soil itself in most of our systems of farming, and over the major part of our productive agricultural area."

This statement, of course, applies equally truly to New Zealand with its pastoral type of farming. Some 40 million chains of fencing controls 62 million head of stock. Seven million fence posts are erected each year, representing an annual expenditure on fencing of well over \$20 million. At the farm level, an average size farm of 400 acres will have about 500 chains of fencing, with, at today's costs, a replacement value of more than \$12,000.

Consequently, the farmer might ask himself the following questions about his fencing:

- (1) With today's spiralling costs, am I getting best value for money from the fence materials I purchase?

- (2) Is No. 8 s.w.g. wire at 53 cents a chain that much better than 12½ s.w.g. high tensile wire at 23 cents?
- (3) Do I really need a barb wire at 67 cents a chain, considering the type of stock I carry?
- (4) Are the posts I am using the best I can get for my money?
- (5) Are the fence ends (or strainers) I am presently using strong enough to support the fence I erect if I use more wires and maintain their tension, so doing away with expensive droppers or battens?

WIRE

12½ s.w.g. High Tensile Wire versus No. 8 s.w.g.

The latest available price for these two wires is \$13.15 and \$15.25 a cwt for No. 8 s.w.g. and 12½ s.w.g. H.T., respectively. The minimum guaranteed length of a cwt of No. 8 s.w.g. is 546 yd and 1,458 yd for 12½, which makes No. 8 more than 2½ times as expensive as 12½ s.w.g. H.T. However, the advantage of using 12½ s.w.g. H.T. does not stop just at its cost.

Because 12½ s.w.g. is thinner than No. 8 it stretches further under the same load. A 10 chain length of 12½ will, in fact, stretch 17 in. under a 500 lb load, while No. 8 stretches only 7 in.

Conversely, an equal contraction—or shortening—of equal lengths of the two wires, when both ends are fixed, as in a fence, will cause a greater increase in tension in No. 8 wire. This is what happens in a fence line when there is a temperature drop. Both ends of the wire are held by the strainers, so that when the wire contracts under the temperature drop the wire tension must increase.

For example, with a 10 chain length of seven-wire fence, and a temperature drop of 16°C, the tension of No. 8 wire will increase by 230 lb in each wire, putting a total increased load on the strainers of over 1,600 lb. The total tension increase on a similar 12½ s.w.g. H.T. wire fence, on the other hand, would be under 600 lb, a considerable difference. Assuming this tension causes the strainers to move, and of course they do, and for the sake of argument that they move ⅛ in. for every 100 lb increase in load, then the strainers of the No. 8 fence will move 2 in. and the 12½ s.w.g. fence only ⅓ in. When the temperature rises back to its original level, the tension in the individual wires of the No. 8 fence will have dropped by 143 lb and the 12½ by only 22 lb. Consequently, the No. 8 fence will be much slacker than the other.

In practice, because it stretches further than No. 8 under the same load, care should be exercised when straining up 12½ s.w.g., particularly after being used to working with No. 8. In any case, it pays to use a tension meter when straining up a fence regardless of the wire used. Between 300 and 400 lb is a safe working load for both gauges. It is very easy with the

usual chain-type strainer to strain wire over its yield point (about 800 lb for both wires) causing it to lose some of its elasticity. Incidentally, both wires have, for all intents and purposes, the same breaking load. The use of a tension meter is illustrated in Fig. 1.

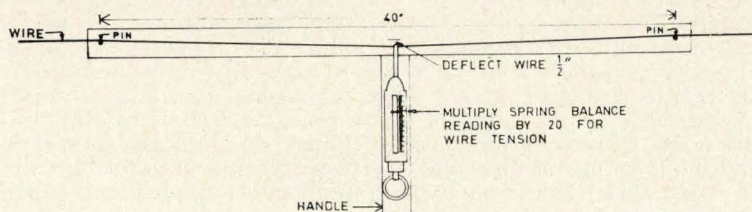


FIG. 1: *Tension meter.*

Take a board over 40 in. long and drive in two nails 40 in. apart. Draw a straight line between the two nails and another line $\frac{1}{2}$ in. below at the central point. With an ordinary spring balance measure the pounds required to deflect the wire $\frac{1}{2}$ in. at the central point. Multiply the reading by 20 and the result gives the tension on the wire in pounds.

Because $12\frac{1}{2}$ s.w.g. H.T. is thinner than No. 8 it will not last as long; generally $12\frac{1}{2}$ is rated as having seven-ninths the life of No. 8. However, this is a small price to pay when its performance in a fence, and its cost, are considered.

POSTS

Farming statistics for the year ended January 1969 give the number of fence posts erected that year as $6\frac{1}{4}$ million. Of this number 66% would have been wooden, 19% concrete, and the remaining 15% steel. So that, even though the number of concrete fence posts being manufactured has been falling during the past ten years, there is still a considerable number being erected where wooden posts could have been used.

Both prestressed and reinforced concrete posts, however, in all the tests carried out at the N.Z.A.E.I., have been shown to be weaker, and of course heavier, than even the small 3 in. diameter pine posts available. Both types of concrete posts are costing about \$1.35 each around Christchurch at present, and the small wooden posts only 72 cents each. Transport charges also favour the use of small wooden posts, reinforced concrete posts weighing upwards of 100 lb each, prestressed 60 lb, and wooden about 15 lb each, dry.

The durability of radiata pine posts should not cause concern. More than 375 timber treatment plants are registered with the Timber Preservation Authority which makes regular checks on their produce, so the chances of obtaining poorly-treated posts nowadays are fairly remote.

There does not seem much point in using large diameter treated wooden posts. It has been established in America, and verified in New Zealand, that wooden posts have a 50 : 50 chance of being pushed over or breaking off when set 10 times their diameter into most soils. Most New Zealand farmers set their posts 2 ft into the ground. This suggests the use of 2½ in. diameter posts, and to have some reserve of strength 3 in. diameter posts should be satisfactory. The practice of using large diameter wooden posts seems to be a carry over from the old days when naturally durable timber was readily available; using large posts was justified because it would take a long time for thick posts to rot away. Radiata pine posts, however, are entirely reliant on their preservative treatment for durability and, as preservative salts penetrate sap wood easier than heartwood, small posts made from tops, thinnings and limbs will have a greater percentage preservative uptake than larger posts with a greater amount of heartwood.

Steel posts are much weaker than wooden posts but cost about the same as small wooden posts. If ground conditions permit, wooden posts are a better buy. However, it may be that steel posts in certain conditions have to be used. Taking into consideration the 10 to 1 ratio for depth of set for wooden posts, and small wooden posts are about four times stronger than "Y" section steel, the use of 5 ft 6 in. rather than 6 ft steel posts is suggested.

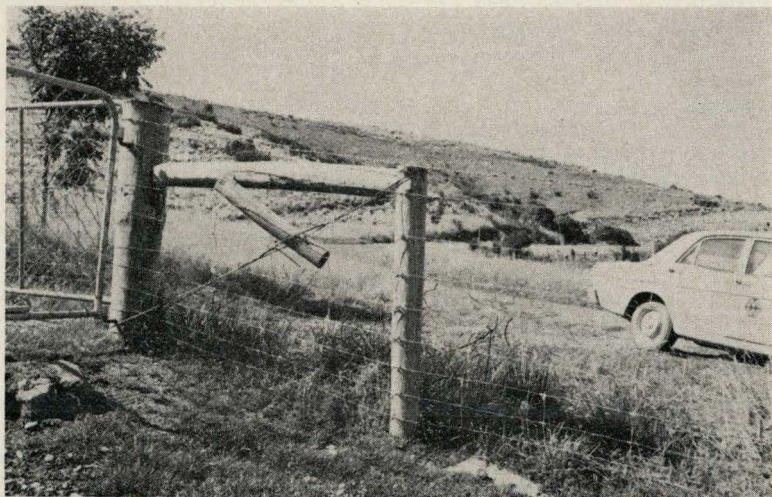


FIG. 2: Single-span horizontal stay strainer assembly made from inadequate materials—the rail is only 4 ft 6 in. long and the back post is a 6 ft long line post set only 2 ft into the ground.

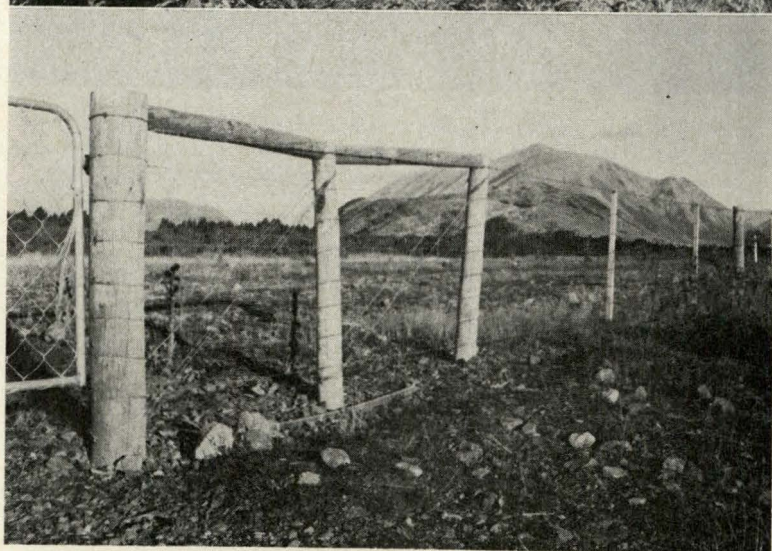
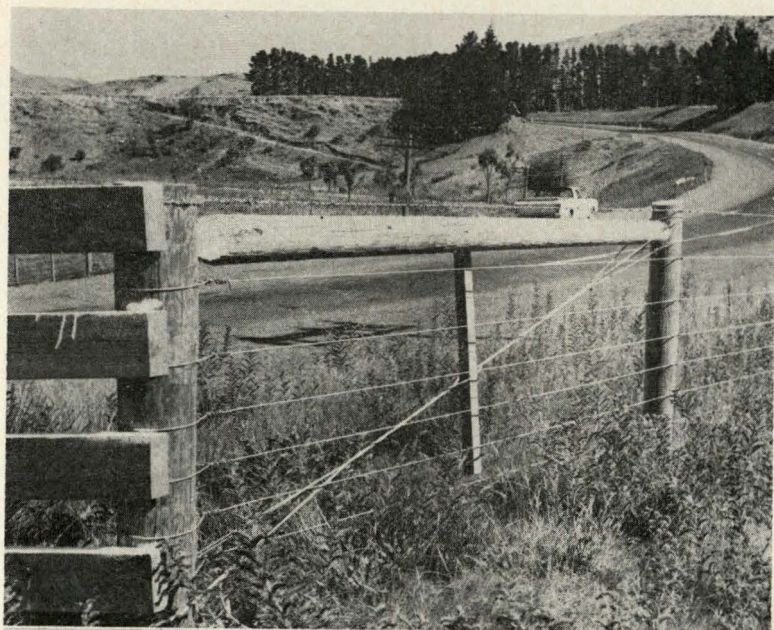


FIG. 3 (above): A well made single span strainer. The twitch stick could have been half a batten set further up the stay wire.

FIG. 4 (below): Typical failure of a double horizontal stay assembly made from inadequate materials—rails only 4 ft 6 in. long; both back posts ordinary line posts; twitch sticks not fitted; gate post starting to lift as centre post is pushed out of line.



FIG. 5: Well made double horizontal stay strainer holding a 9-wire, five post to the chain, battenless fence. No substrainers were used in this half-mile roadside fence line.

STRAINER AND CORNER ASSEMBLIES

Probably the most important part of a fence, from a structural point of view is the fence end, or strainer. The only strainer design that has been exhaustively tested appears to be the horizontal stay type. A double horizontal stay type tested by the N.Z.A.E.I. held a 6,000 lb load applied to the top of the strainer post for only $\frac{1}{8}$ in. movement at ground level. This load is far in excess of the load applied by even a 10-wire fence. Many of these strainers, both single and double stay types, are now making their appearance; many have been well made from adequate materials, others leave much to be desired.

The following points on horizontal stay strainers and corner assemblies should be noted:

(1) Assemblies with posts driven into holes bored to size hold half as much load again for less horizontal and vertical movement than assemblies with posts set by tamping in over-size holes.



FIG. 6: Use of horizontal stay assembly at a difficult corner. The rail would have been better fitted between the tops of the posts.

Almost twice the load, with half the movement, can be held with posts set 3 ft 6 in. deep as compared with posts 2 ft 6 in. deep.

Increasing the stay length of a single-span assembly from 8 ft 6 in. to 10 ft 6 in. will halve the horizontal movement for the same load.

Double-span strainers will hold twice the load for half the horizontal movement of single-span assemblies.

It should also be pointed out that, as the posts for horizontal strainers are best set by driving, the range of ground conditions in which the strainer can be erected is considerably widened. With a high water-table it can be extremely difficult to dig a hole 4 ft deep, while post-drilling becomes all the easier.

(2) Materials required for a double horizontal stay strainer are: Two 5 in. diameter and one 4 in. diameter 7 ft 6 in. long posts, pointed and treated.

Two 3 in. to 4 in. diameter at least 7 ft 6 in. long treated rails (conventional strainer stays will do).

About 14 loops of No. 8 wire for tension stays.

Two "twitch sticks" (a batten cut in half will do).

Three 9 in. lengths of $\frac{3}{8}$ in. diameter steel rod (for pinning the rails).

(3) *Construction details:* Drive one of the 5 in. diameter posts to take the wires and run out a line wire. Lay the rails end

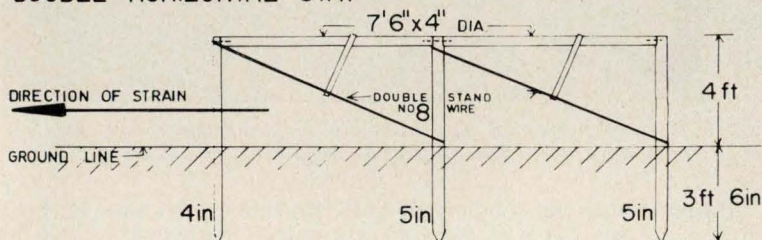
for end along the line wire. Drive the other 5 in. post where the rails abut and the 4 in. post where they end. If no power driver is available, 4 in. post holes may be augered first and the posts driven with an 8 in. diameter two-man driving tube.

Bore $\frac{3}{8}$ in. diameter holes through the three posts, 2 in. down from, and in line with, the post tops. Cut the rails to fit snugly between the tops of the posts.

Next fit the first rail and drive steel pins through the first and second posts and into the core of the rail, pinning it in position, but leaving about 2 in. of pin sticking out at the back of the centre post. Bore the core of the second rail to fit on to this pin.

Fit the second rail and pin in position through the back post. Small flats may be made on the posts where the rails butt. These should not be any more than $\frac{1}{2}$ in. deep otherwise the posts will be needlessly weakened.

DOUBLE HORIZONTAL STAY



SINGLE HORIZONTAL STAY

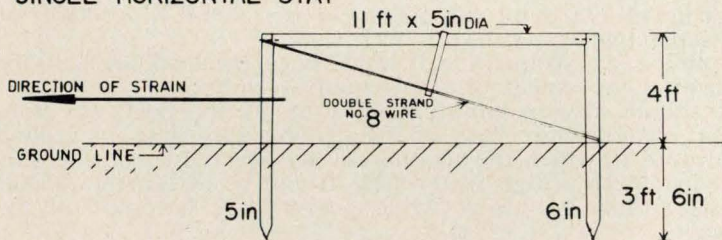


FIG. 7: Layout of double- and single-span horizontal stay strainers. Orthodox diagonal stay strainer stays could be used instead of the 7 ft 6 in. rails on the double-span assembly provided they were knot-free, minimum 4 in. diameter material.

Note that no footing wire is needed with the horizontal stay strainer; possible failure due to wire corrosion is then eliminated. As mentioned previously, this design of strainer is the only one that has been scientifically tested over a period of time. Nevertheless, farmers who have found the orthodox diagonal stay assembly adequate should continue using it if they have doubts about making a good job of erecting the horizontal stay type.

Double loops of No. 8 wire are now fitted from the top of the middle post to the bottom of the main post and from the top of the back post to the bottom of the middle post. The loops are then tightened with the "twitch sticks", and these are locked against the rails on the side away from the line wires.

Farmers may have doubts about 5 in. timber being strong enough for a strainer post. N.Z.A.E.I. tests, however, have shown 5 in. knot-free radiata pine posts to be at least as strong as well made 7 in. $\times$ 7 in. concrete strainer posts. But, if screw-in gate hinges are to be fitted, a 7 in. diameter post would best be used.

The single-span assembly should have 6 in. diameter posts and a rail at least 10 ft long and 5 in. in diameter. The double-span assembly, however, as mentioned previously, is a far stronger structure and good insurance for the cost of an extra post and rail.

Although the savings possible on posts and wire may seem small on a per-chain basis they are, nevertheless, well worth while.

Consider a mile of typical fencing at present costs using concrete posts, No. 8 and barb wire, and wooden battens, and allowing for a strainer every ten chains:

Concrete posts—4 to chain, 320 @ \$1.35 ea.	432.00
No. 8 wire—6 to chain, 480 ch @ \$0.53 ch	254.40
Barb wire—1 to chain, 80 ch @ \$0.67 ch	53.60
Wooden battens—20 to chain, 1,600 @ \$0.12 ea.	192.00
7 in. $\times$ 7 in. concrete strainers—8 to mile, 8 @ \$7.75 ea.	62.00
Concrete post staples—No. 8 3 ft 6 in. per post, 17 ch @ \$0.53 ch	9.00
Batten staples—11,200 $\times$ 1 $\frac{1}{4}$ $\times$ 10 130 to lb, 86 lb @ \$10.68 cwt	8.20
	\$1,011.20

The total weight of this material, if the posts were pre-stressed concrete, would be just under 16 tons.

On the other hand, a fence in wooden posts, and using 10 12 $\frac{1}{2}$ s.w.g. H.T. line wires, leaving off three of the battens between posts, would be:

Wooden posts—4 to ch, 312 @ \$0.72 ea.	224.60
12 $\frac{1}{2}$ s.w.g. H.T. wire—10 wires, 800 ch @ \$0.23 ch	184.00
Wooden battens—8 to ch, 640 @ \$0.12 ea.	76.80
Batten staples—6,400 $\times$ 1 $\frac{1}{4}$ in. $\times$ 10, 49 lb @ \$10.68 cwt ...	4.67
Post staples—3,300 $\times$ 2 in. $\times$ 8, 66 lb @ \$10.88 cwt	6.40
Double horizontal stay strainer	
2 stays (\$1.20 ea.)	2.40
1 post 6-7 in. $\times$ 7 ft 6 in.	1.95
2 posts 5 in. $\times$ 7 ft 6 in. (\$1.40)	2.80
1 $\frac{1}{2}$ chains No. 8	80

1 batten as twitch stick	12
Steel pins	15
	8.22
8 only @ \$8.22	65.76
	\$562.20

Note that by using the double-stay system, one line post per strainer is saved.

The total weight of materials for this fence would be approximately $2\frac{1}{4}$ tons so that transport charges would be just under six times less than the other if the delivery distance were, say, ten miles.

The latest New Zealand development in permanent fencing is the Flexi-Fence. This system of fencing employs the idea that stock do not like coming into contact with a fence capable of giving under their weight and then springing back again. The system has been expanded into the Flexi-Fence by H. C. H. Pearce of the Ministry of Works, Palmerston North, and utilizes a novel strainer assembly, few posts, $10 \times 12\frac{1}{2}$ s.w.g. H.T. line wires, and polypropylene strip for battens. Mr Pearce says the materials cost of a chain of Flexi-Fence varies between \$4.00 and \$4.50 according to terrain.

WHY SPEND MONEY ON A FARM ACCOUNTANT?

J. G. BUTTERFIELD

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In many cases the first experience the New Zealand farmer had with accountants was the introduction of unemployment taxation in the depression of the 1930s and probably as a natural corollary of this the farmer/accountant relationship has tended to develop pretty much along the line of taxation accounts. However, the accountant is able to do a number of other things for his farmer clients and a few examples will indicate the type of advice the farmer is entitled to expect.

But first of all consider the accountant's work each year in collating papers—cheque butts, stock firm statements, etc.—and converting them into livestock accounts, profit and loss accounts, and balance sheets. There are often other supporting statements but, from an accounting point of view, completing the draft of these represents an important point in the work flow and relationship between the accountant and his client.

The work to this stage represents a very high proportion of the total fee charged and must be done before any consideration is given to tax savings moves—estate planning, and the like—but it must be done and it must be done every year.

The farmer who expects his accountant to take his accounts only one step further than this and complete his taxation return (and perhaps remind him to pay his tax) is not farming on least money. Consider that, by the time the accountant has been "doing the books" for only a few years, he probably knows more about his client's financial affairs than anyone else; for he not only sees the details of how much was spent on fertilizer for the year or how much the last sale of cattle realized, but how much was spent on school fees and on necessary liquid supplies.

The farmer pays the accountant to accumulate a mental picture of his living standard and general attitude to life, as well as considerable files on his financial position. Should he not capitalize on this knowledge he has paid to be built up?

TAX SAVING

While it is well known how farmers' incomes fluctuate through circumstances beyond anyone's control, it is not generally realized the extent to which this can cost extra money by way of taxation.

An example of the effect of fluctuating income on taxation is given in Table 1 which is based on the income of a married man with three children and paying \$500 in life insurance premiums—i.e., having a total exemption of \$1,455.

TABLE 1: EFFECT OF FLUCTUATING INCOME ON TAXATION

	<i>Case 1</i>	<i>Case 2</i>	<i>Case 3</i>
Year 1: Profit/loss	—2,000	4,000	1,455
Year 2: Profit	10,000	4,000	6,545
Income over 2 years	8,000	8,000	8,000
Year 1: Tax	Nil	512.78	Nil
Year 2: Tax	2,150.06	512.78	1,476.34
Total Tax	2,150.06	1,025.56	1,476.34

The table makes clear the marked effect of fluctuating incomes on taxation. The cash fluctuation is in fact much greater than the example shows because of the system of paying provisional tax during the income year. The legitimate means of equalizing this income are numerous, including income equalization, nil standard values, and deferred expenditure.

In this respect, it is perhaps relevant to ask how many farmers would have filled in their livestock retention incentive papers and sent them off without a thought as to what effect that revenue would have on the tax payments due next March. How much would it have cost for a half hour's discussion with an accountant to see if it would not have been better to defer the income for three or four months and stall the taxation for 12 months?

ESTATE PLANNING

Probably nobody can lay down a system of estate planning that suits everybody or even a majority. Every state planning exercise must take into account the personal as well as the financial aspects of the individual farmer's problem.

Trusts and companies all have their part to play, depending on the individual circumstances, and professional advisers, often both accountant and solicitor together, must work out the best plan to meet the individual problem.

However, in many cases of proper estate planning there is also a side benefit of decreased taxation liability in the years between implementation and eventual death.

The legitimate splitting of income between various members of the taxpayer's family can result in quite large taxation benefits.

LIFE INSURANCE

The benefits of paying life insurance premiums as a means of reducing taxation should be well known and of course adequate life insurance cover is a very important consideration of every man. It can often, although not always, be an important part of an estate plan.

The first problem is to decide what is an adequate amount of life insurance. The second, what type—whole of life or endowment? Once these problems have been decided, the following examples of differing returns might be of interest:

				<i>Life Company</i>					
				A	B	C	D	E	F
Premiums (\$)	....	....	....	1248	1312	1292	1301	1262	1264
Bonuses (\$)	....	....	....	74.5	85.5	75	80.5	60	64
%	....	....	....	5.97	6.5	5.8	6.175	4.75	5.14

The companies have not been named, but they were selected by a farmer-client. It is true that, depending on the type of insurance required, differing companies would give returns which would alter the order in which these companies are placed. There is even one specialized policy available from one of the lowest companies on this list which is not available from any other company and which gives an exceedingly good return.

However, the point is that, in this case, the client got the best return available on the type of policy which met his needs.

So far the discussion has dealt with fields which are traditionally regarded by the farmer as coming within the compass of the farmer/accountant relationship. A few others can now be dealt with briefly.

BUDGETING OR FORWARD CASH PLANNING AND FARM MANAGEMENT

Most accountants cannot and do not regard themselves as farm management experts. A growing number of farmers are using farm management advisory firms for professional management advice, and this trend can be supported. These firms have systems of recording cash spent during the year and comparing these with budgets prepared by them in conjunction with the farmer.

It seems completely senseless for them to write up their cash analysis sheets and then for accountants to write up farm records in detail again at the end of the year.

TABLE 2: SPECIMEN OF RECOMMENDED TYPE OF CASH CROP ACCOUNT

CASH CROP ACCOUNT
For the Year Ended 30th June, 1968

1967 Total \$		Wheat Bushels	\$	Barley Bushels	\$	Peas Bushels	\$	Grass Seed Bushels	\$	Clover lb	\$	1968 Total \$
	Total Sales	500	800	630	504	350	700	400	880	2400	720	3604
	Less: Stock 1 July, 1967	50	80	20	16	—	—	—	—	—	—	96
		450	720	610	488	350	700	400	880			3508
	Add: Stock 30 June, 1968	100	160	40	32	—	—	—	—	—	—	192
	Current year's production	550		650		350		400		2400		
	Gross profit to farm working account		\$880		\$520		\$700		\$880		\$720	\$3700
STATISTICAL SUMMARY												
		Wheat		Barley		Peas		Grass Seed		Clover		
1966	{ Acres cropped	10		10		10		10		10		
	{ Yield per acre	bushels 45		bushels 55		bushels 40		bushels 35		lb 235		
1967	{ Acres cropped	10		10		10		10		10		
	{ Yield per acre	bushels 50		bushels 60		bushels 38		bushels 45		lb 230		
1968	{ Acres cropped	10		10		10		10		10		
	{ Yield per acre	bushels 55		bushels 65		bushels 35		bushels 40		lb 240		

If the farmer is concerned about the amount paid to his accountant rather than the amount the accountant can save him, and is also using farm management advice, this might be the one area in which some reduction in cost could be hoped for in the future. There are problems that must be overcome before such a suggestion can be fully implemented. Accountants will have to change their attitudes on some points, just as will the farm advisers. This will probably not happen overnight but it must be made to happen. This is an area in which Lincoln College could perhaps provide the initiative. Lincoln has done much for accountants and could perhaps be the ideal place to bring these two professions closer together.

In 1966, the N.Z. Society of Accountants brought out the "Farm Accounting Report" and there is no doubt that this has brought about a large improvement in the overall presentation of farm accounts throughout the country. This trend is continuing and there are groups throughout the country looking at what the next step should be. The indirect benefits that these improvements have brought to the farmer might be mentioned. First, consider the recommended cash crop account set out in Table 2.

Imagine the frustration of a banker, stock firm manager or State Advances loans officer in trying to understand farming operations from a study of the accounts prepared without this account. Unfortunately, many sets of accounts used just show the general heading—Cash Crop Revenue: \$3,700.00.

It is often said that this information is pointless from the farmer's viewpoint because he knows it anyway. This may be so, but it should be remembered that often the farmer's accounts which are prepared by the accountant are used by him indirectly by being given to his financier. If there is not sufficient information on them, how can he expect to get the best deal from that financier?

How many farmers use an accountant to help arrange seasonal finance? In many cases it may not be necessary but equally many examples arise where the accountant provides that vital link in the chain of communication between financier and farmer.

THE FUTURE

Since 1966, developments in farm accounting procedures have in New Zealand largely amounted to a consolidation of the work commenced in that year with the issuing of the "Farm Accounting Report".

Much more far-reaching trends have shown up in Australia where a costing concept has been given some emphasis. How soon these ideals will filter through to the stage where they are used by accountants on New Zealand farm records is hard to say. However, as farmers are now tending to regard their farms much more as business enterprises so will accountants have to provide more information to enable decisions to be made on a business-like basis.

ALL-GRASS WINTERING

R. CLARK

Farmer, Stavely, Ashburton

Most costs associated with farming are unavoidable—it is hard to reduce them—but there are some that can be side-stepped if we exploit our grass.

In a series of brassica trials at Invermay some years ago, good crops gave dry matter yields of 9,600 lb for swedes, 11,000 lb for choumoellier and 5,000 lb for turnips. When these are compared with a figure of 12,000 lb, that would be produced by a good pasture, doubts arise as to the wisdom of destroying pastures to sow winter crops. It would seem more intelligent for a farmer to regard his best grass paddock as his winter feed paddock, to conserve all its production in two cuts of hay and a cut of silage and the following winter still have it growing grass to winter some of his stock. In practice, of course, he would take a cut off several different paddocks.

Again at Invermay Agricultural Research Centre, in the intensive stocking trials, up to 11 ewes per acre are being carried under an all-grass system, the hay made off each farmlet being fed back. On one farmlet 7 ewes per acre were wintered at a cost of only 1/7 a bale of hay per ewe.

Equally remarkable results are being achieved on the high stocking block at Winchmore Research Station. Here, 9 ewes per acre are being run, with 5 lambs per acre being bought in to fatten on very old pastures composed of 60% weed grasses and with a grass grub population of 30 per square foot.

My farm is at Stavely, in mid-Canterbury, just under the hills, with a 48 in. rainfall well distributed over the haymaking and cropping seasons. Dry periods are almost unknown which means high stock numbers can safely be carried.

Of the 582 acres, 565 are in usable grass. This winter 8 sheep an acre will be run, with 3,166 ewes, 1,280 ewe lambs, and 100 rams, killers, etc.

The total hay requirement is 2,250 bales—i.e., half a bale per animal carried—but as much again is held in stock as a safety measure.

The first move each year is to split the flock into flocklets or “think units” of about 1,000 ewes each, plus a separate group for the hoggets. It has been found much easier to plan the

management of what are in effect four small flocks rather than one enormous one.

A block of at least seven paddocks is preferred for each "unit", which provides for a stocking rate of 8 per acre.

The first move is to set aside flushing feed on each unit. This is sacred, and I would sell sheep rather than use it. I like a basis of 30 acres per 1,000 ewes, though this proportion has not yet been achieved. The area is closed up in mid-February.

In theory it would be desirable to have all but capital stock away by then, but in fact most of the lambs, old sheep, grazers and strays are still being carried at that time. At flushing time the mobs are put on to their flushing paddocks. The rams go out on April 24 when the ewes have been moved to half the remaining area which has benefited from lack of grazing. After one cycle of 17 days, the ewes are moved to the unused half of the block.

After two such cycles, *i.e.*, on May 28, they are returned to one of the tugging paddocks which again will have grown during May. It is very convenient but not always easy to arrange that the 28th should be a Saturday as happened last year. Moved in on this day, the ewes will graze happily on adequate feed and permit a work-free weekend. On Monday a bale of hay per 100 is fed out. It is doubtful if all of this will be eaten, but the following day, it becomes more attractive and by Friday the hay is welcomed.

On Saturday, each unit is moved into the next paddock which will have been putting on growth since the end of the first cycle, *i.e.*, from May 11 to June 4.

The hay pattern is repeated and each Saturday the gate to the next paddock opened to provide a further weekend of good grazing.

The first round of paddocks finishes in the middle of July and experience indicates that an inch of regrowth can be expected on each new paddock as it is opened up. Less growth can always be balanced by a little more hay.

It is fundamental to this scheme to put the lambing date well back, so as to provide vital greenfeed from the increasing amount of grass that grows as the ground warms up. My lambing date is September 20; hence I can expect sleepy sickness trouble six weeks earlier, about August 12.

This danger period is covered by the flushing paddock, which has been left ungrazed from April 24, and by this time is in good-class autumn-saved pasture.

In effect, then, I winter on winter regrowth plus a bale per 100, 5 days a week, at 10 sheep per acre. The other two sheep per acre are represented by the autumn-saved pasture in each block saved, at a rate of 20 to 30 acres per 1,000.

The autumn-saved pasture is not essential. Last year the two-tooths wintered at 10 per acre and lamb ewes were bought in to use up their autumn-saved pasture.

Once greenfeed is adequate, there are two alternatives apart from the autumn-saved pasture. The sheep can either be

shifted twice as often, or set-stocked over the whole block. Last year I used both systems and had no trouble with either. The ewes came through very well. We fed out only half a bale per ewe, and neither I nor my man worked a Saturday afternoon or Sunday all winter.

Why does the system work?

(1) A high fertility has been achieved through high stocking, and the higher the fertility the shorter the dormant period of grass. Stavely, at 1,200 ft a.s.l. does not suffer from fogs and the bitterly cold easterly wind characteristic of lower areas. I believe that despite heavy frosts, there is so much sun, so much energy put into the grass, that better growth results.

(2) Sir Bruce Levy once said that the Canterbury farmer would never farm properly until he had sheep on all his farm all winter. The conventional sacrifice paddock system means that fertility is built up all summer and, on all but the run-offs, is leached away all winter. On this system the paddocks get a shower of dung and urine once every 35 days at a concentration of 50 sheep per acre.

The sheep may be short of food when they can afford to be short, but they do not have to change their diet (some will not eat swedes or hay, in any case). With this system, they are always on their natural food.

At Reading University a trial was conducted in which cows were fed on a 50/50 mixture of hay and concentrates. When the mixture was changed to 60/40, either way, the rumen took 30 to 40 days to settle down again. This suggests the value of all-grass wintering.

Instead of being hungry all winter, the sheep are fed well once a week. They are not being forced through a gateway twice a day, in mud and slush; they are not being forced to hurriedly eat 90% water in the form of turnips. Presumably this cuts down stress and thus conserves energy. Nor are they lying on mud all winter.

Why does the grass grow? Is it fanciful to suggest that this is typical of nature's struggle for survival? Grass may be like a drowning swimmer. He will fight to get his mouth 2 in. above water and then relax. In winter, grass appears to regrow up to an inch and then stop. This may mean that root reserves are being used but an inch of grass then is worth 4 in. in spring.

Wet weather does not seem to matter unduly, provided the paddocks are reasonably old and have formed a raft of grass. This is very important—the raft of grass. At 50 per acre, sheep will not break through this raft in a week; at 100, they will, but given a couple of weeks the paddocks are green again.

The whole flock was carried through in this way last year. It was cheap and labour saving and the grass came away particularly well in spring. During summer, all the paddocks are growing wool and meat; none is producing only 90% water, fathen, spurrey, and thistles.

There are interesting vistas ahead. Obviously there is the possibility of using nitrogen though the economics of it may be questioned when the results already achieved are from 15 cwt equivalent of sulphate of ammonia put in by good clovers. Probably the most that would be added would be an extra 2 cwt.

There is a distinct possibility of making a profit from direct drilling of ryegrass but this would involve additional outside expense.

On the present system, expenses will be overheads, labour and the cost of $1\frac{1}{2}$ cwt of superphosphate per year—no ploughing, no idle ground, no bill for grass seed, no massive strikes of thistles.

The paddocks will last indefinitely. A house paddock sown down in 1944 is still in first-class condition. If a paddock has been mismanaged, and is not giving satisfactory results, a pint of paraquat is applied in November to kill the so-called weed grasses and greatly strengthen the clovers. These will both fatten the lambs and provide a boost of nitrogen, adding to fertility. In autumn, I spray again, and 12 lb of 'Grasslands Ariki' per acre is drilled in. A few pounds of 'Grasslands Tama' may be sown as well. This causes some lost time, but the sheep will graze until the spray gear arrives in the paddock. Drilling is done the same day, and possibly the old ewes put on to trim the burnt-off standing hay for a few days before the new seeds strike.

That winter there will be a very strong new paddock complete with clovers and a reasonably good raft of grass.

This, I believe, is the only way I am going to continue to make a reasonable living from sheep.

INTENSIVE CROP PRODUCTION ON WAKANUI SOILS IN MID-CANTERBURY

A. J. MARSHALL
Farmer, Ashburton

INTRODUCTION

Ten years or so ago, a suggestion that two grain crops within a three-year cropping rotation should be attempted without white clover was regarded with some derision. However, after considerable thought and some two years' delay, it was decided to implement such a scheme. This paper describes how the scheme has developed from that year (1962) to the present.

The area of my farm is 240 acres, plus 45 acres of family trust land which will not be considered here. The land is all flat and level and, apart from small areas of shelterbelts, access ways, shed, house and yards, can be extensively cropped. Situated 2 miles south-east of Ashburton, the property has two distinct soil types—40 acres of Wakanui silt loam and 200 acres of Wakanui clay loam. The silt loam is easily worked soil, 12 in. deep on a sandy clay subsoil, with no associated drainage problem. The 200 acres in the clay loam category is completely different, having a soil depth of 8 to 9 in. on a stiff, mottled, clay subsoil. This area is subject to drainage difficulties in wet seasons, and naturally carries tile and plastic pipe drains where necessary. Quite a different cultivation technique is required for this area. Rainfall in an average season is 26 to 28 in.

In 1962, the rotation followed the usual 6-year pattern of the area (average yields for three seasons are given in parentheses): Old grass; wheat (40 ac at 70 bu); barley (40 ac at 73 bu); 'Grasslands Manawa' ryegrass seed (40 ac at 40 bu M.D.); white clover (40 ac at 206 lb M.D.); two years' grazing (74 ac) plus lucerne (6 ac).

In addition, 500 to 600 Romney breeding ewes were carried. These were lambed down and the lambs fattened on the property. No special winter feed apart from the lucerne was grown. The ewes were all 5 years old when purchased, so 200 to 300 of them had to be carried through the summer. This requirement, together with the necessity to finish off the

lambs, made quite serious inroads into the area available for cropping.

CHANGES IN CROP PATTERN

The first alteration to this long-standing practice came in 1963 when the second-year-old pasture grazing was terminated, which in effect increased the wheat acreage by 40 or so. At the same time it was necessary to graze the ewes elsewhere for a period until all the lambs were disposed of.

This procedure was followed for two more seasons until the 1965-6 season when no replacement ewes were purchased; the remaining ones were sold, and a change made to buying Romney wether lambs in January-February for butchers' winter trade requirements. At the same time, Manawa winter and grey oats were sown after the wheat crop to provide extra winter greenfeed. So at this stage there was a rotation very similar to the original but with the addition of greenfeed between the two grain crops and the reduction of one year's grazing after white clover. There was, and always has been, an endeavour to set-stock greenfeed areas such as these, if weather and ground conditions allowed.

The next change was to introduce a second wheat crop to give the following rotation for the 1968-9 season (yield averages for 3 seasons in parentheses): Wheat; wheat (120 ac at 65 bu); greenfeed; barley (40 ac at 75 bu); Manawa (40 ac at 40 bu M.D.); white clover (40 ac at 200 lb M.D.). There was some doubt whether, from the fertility-building point of view, the year's grazing of the old white clover pasture was worth while, so this was also dropped at this time.

Following the 1968-9 harvest, the winter feed position had changed somewhat, and in this winter some 1,400 hoggets were fattened.

The next season saw a change from Manawa to 'Grasslands Tama' ryegrass and the removal of white clover entirely. This complete change of grass seed production was mainly for reasons of certification, owing to the location of paddocks. At this time also, a long, hard look at the gross margins of the various parts providing income indicated that wheat, barley and Tama were the most profitable lines and that the white clover crops and the hogget fattening should take second place. This they did, and the present rotation was adopted (yields for 1971-2 harvest in parentheses): Wheat plus greenfeed (100 ac at 70 bu); barley (60 ac at 97 bu); Tama ryegrass for seed (80 ac at 63 bu M.D.). Variations in the areas of the crops have had to be made as the move to a rotation such as this must be made gradually.

In summary, therefore, to this stage:

- (1) The rotation has been shortened from six to three years.
- (2) The effective area of grain (wheat and barley) has been increased from 80 acres in 1962 to 160 in 1971-2.

- (3) The ryegrass area harvested has increased from 40 to 80 acres.
- (4) No white clover is now sown.
- (5) No livestock is now owned.

ADVANTAGES AND DISADVANTAGES

This system is believed to be as close as is practicable to the English intensive cropping system and able to be continued indefinitely. This type of cropping programme has many advantages but is of course restricted to certain soil types. Wakanui Clay loam seems to be a suitable type and it is intended to continue along these lines in the meantime.

No doubt the system has disadvantages also, but these should not be insurmountable.

The advantages might be summarized as follows:

- (1) The system is simple, because only three crops are being dealt with and at least two of them are low-risk crops.
- (2) Labour input is low.
- (3) Capital normally tied up with sheep is released.
- (4) Soil structure is improved.

The disadvantages might be listed as:

- (1) Disease.
- (2) Weeds.
- (3) Great fluctuations in labour requirements.
- (4) Higher costs for machinery.
- (5) Higher costs for fertilizer.

These various aspects may now be discussed in more detail.

Simplicity

No farming system appears to be more simple. There are only three crops to be concerned with, and bulk handling has dramatically lessened the labour input. Both wheat and barley are low-risk crops and with adequate grass-seed drying facilities Tama is not as risky as it once was, though some may disagree with this. The ryegrass is normally threshed at moisture contents in excess of 25%, which is felt to be the only way it can be harvested successfully. The harvest period in total has been shortened considerably by mere virtue of the fact that wheat and barley are mostly direct-headed.

Labour

The total year's labour input is low. For five seasons I have run this farm on my own with help for the harvest period only. In the past season, 400 hours' extra labour in January was sufficient to complete the harvest and go a long way with the autumn cultivation. For the remainder of the year extra labour is not needed. There are naturally violent fluctuations in labour requirements but with a 75 h.p. tractor I can manage quite comfortably. It may be opportune to mention at this point that 700 to 800 hours for the 75 h.p. tractor and 300 to 400 hours for a smaller 40 h.p. one are all that are required. Contractors are engaged for all cartage, gorse cutting, drain cleaning, windrowing, etc. A haybaler bales approximately 6,000 to 7,000 bales on the farm and 7,000 elsewhere on contract each year.

Capital Saving on Stock

Capital involvement has been reduced considerably with no stock owned. Stock requirements are taken care of by grazing hoggets and ewes, acquired when necessary and sent home when necessary. This is more advantageous than might appear at first, because closing dates for ryegrass in particular can be more strictly controlled. One does not have to worry about where the sheep are going to next; when the feed is finished, the sheep go home.

Soil Structure

Perhaps one of the most important factors involved with this type of farming is soil structure, and this is a part of the enterprise on which the closest watch is being kept. Particular care has been taken during the past two or three years to attempt cultivation only when soil conditions are suitable. It is absolute suicide to put a tractor and implement weighing almost 4 tons on to wet Wakanui clay loam. I firmly believe that the introduction several years ago of the winter greenfeed crop (and now the Tama seed crop) has been of great advantage to the soil structure. After several years of reasonably intensive cropping, soil structure does not appear to have deteriorated, but in fact to have improved. The reasons for this improvement would seem to depend on cultivating only when ground conditions are suitable, and the introduction of Tama and winter greenfeed.

Disease

So far no trouble has been experienced with disease. It appears from research in Britain that areas, and in some cases paddocks, have had a history of disease, more particularly take-all. This could be the major reason for any alteration in the present system. No take-all has appeared in my

18 years on this property and only on one occasion has barley yellow dwarf virus caused any concern, so disease has not been a problem.

Weeds

The weed problem also should be controllable. The main contender at the moment is wild oats which do not combine well with Tama. However, pre-emergence spraying will in future be carried out on all grain crops with confidence that the present wild oat population can be eliminated. This will necessitate some increase in costs but this should be compensated for by the premium of 5c or so for wild oat-free ryegrass seed.

Higher Machinery Costs

This type of farming naturally involves high capital costs for machinery which of necessity must have reasonable capabilities, particularly in view of the statement earlier about the cultivating of wet soil. Machinery use is also very spasmodic but the total capital cost has risen quite dramatically during the past three or four years, as a result of inflation and the trend towards higher powered tractors. Bulk handling equipment, of course, plays an important part on this particular farm. The total storage facility is indoors with capacity for 200 tons of grain in four metal silos. In addition are two Crosbie-style drying bins each holding 35 tons; an 8,500 cu.ft./min fan and diesel heater, and the usual style 8 in. auger. As a variation from the usual pattern, no grain is stored past the end of harvest. An arrangement has been made with an Ashburton firm which leases the facilities over the winter period to store feed-barley against shipments to the North Island. Ryegrass dressing by portable plant commencing immediately following drying is carried out on the farm, leaving the two driers free for use with grain if necessary. This enables much better use to be made of the capital involved and naturally means that all of the remuneration from the harvest has been received by about the end of March.

Fertilizer

Fertilizer requirements since 1962 have naturally risen although not as much as one might think. In 1962 fertilizer cost \$1,000; in 1972 \$1,325. Lime is applied as required to new grass to maintain a pH level of 6. It seems that 1 ton at approximately four-yearly intervals is all that is required. Soil is regularly tested for this purpose. Wakanui soils have traditionally quite high phosphate levels but payable responses from superphosphate can still be obtained in all crops. In the past three years trials have been carried out with nitrogen on grain crops. These have been both simple ones of my own and more sophisticated ones laid down by R.

Stephen of the Department of Agriculture and T. Ludecke from the Soil Science Department, Lincoln College. All have produced very variable results, but a pattern seems to be emerging, particularly with the uptake of nitrate-nitrogen in wheat crops.

Research by the Lincoln College Soil Science Department has also revealed that on Wakanui soils in the period February to November, 1970, upwards of 170 kg/ha of nitrate-nitrogen can be leached below 60 cm under fallow conditions. The nitrate-nitrogen was leached below the top 20 cm of soil by June when wheat is normally sown. The research also showed that under a greenfeed crop the losses were nil. These results are very significant, particularly when one adopts a rotation that includes wheat to wheat, or alternatively, wheat to barley. This forms part of the reasoning behind the greenfeed crops grown between wheat and barley.

For Tama, the policy for two or three years now has been to sow 20 units of nitrogen together with superphosphate at sowing time, in the form of diammonium phosphate, followed by 40 units of nitrogen in early August and a further 40 units some time after closing for seed in mid-September, both latter dressings being ammonium sulphate. Trial work in this field would be very appropriate and it is hoped to put down trials on a small scale this season.

FINANCIAL BENEFITS

The question "Has this been worth while financially?" can be answered quite positively as the following figures indicate.

For the purposes of comparison the cash farm income in the year ending March 1962 has been converted to a figure of 100 units per acre. The total farming costs in that year were 64 units, leaving a surplus of 36 units per acre. Under the 1971-2 farming system, this cash farm income has risen to 174 units and, with costs at 108, this year's surplus is 66 units. These figures are calculated before interest and without income from contracting. So the effective net return has about doubled in the ten-year period. It should be noted, however, that in 1962 the wheat price was \$1.35 per bushel and the barley 89c per bushel as compared with today's values and no adjustment was made to compensate for this. The wages item in 1972 was actually less than in 1962 but a substantial rise from \$10,000 to \$20,000 has occurred in the value of plant; this is due in part to inflation and also to the need for increased capacity.

WHAT OF THE FUTURE?

At present, farm development is towards a block system of cropping. There are several reasons for this decision. First, the layout of the paddocks is very suitable for this exercise and, secondly, it will mean that a complete cross-section of

the soil types in all the crops will be obtained. This is advantageous both in wet winters and at harvest time. It may also mean that in the future some or all of the internal fences can be removed.

At some future date consideration may be given to growing wheat and Tama alternately.

In conclusion, I have confidence that the present programme can be continued, provided wild oats can be controlled, and I believe they can, and provided also that take-all does not show its ugly head.

ACKNOWLEDGEMENT

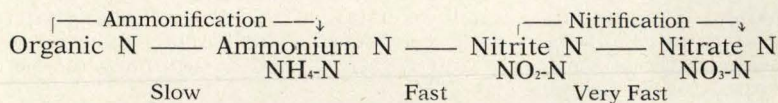
I should like to acknowledge the advice and help of Professor T. W. Walker, T. Ludecke and A. Bilbrough of Lincoln College in establishing the farming programme described.

NITROGEN FERTILIZERS FOR WHEAT IN CANTERBURY

T. E. LUDECKE

Department of Soil Science, Lincoln College

Under well-topdressed and managed pastures on arable soils in Canterbury, nitrogen builds up to very high levels, owing to symbiotic nitrogen fixation by legumes. Almost all this nitrogen in soils is in the organic form and has to be converted to the inorganic or mineral form before it is available to non-legumes. This conversion in the form of nitrogen is carried out by bacteria and involves three different groups of bacteria as follows:



The relative speed of the different reactions is shown; because the conversion of NO₂-N to NO₃-N is very fast, very little nitrite-N accumulates in soils. The NH₄-N and NO₃-N are considered to be available to agricultural plants.

The factors that affect the rate at which this conversion process takes place are:

- (1) Ratio of the amount of carbon in soils to the amount of nitrogen. If there is a small amount of nitrogen relative to carbon, as is the case under a runout browntop-dominant pasture, then little mineral N is released.
- (2) Factors that affect the biological environment: pH; temperature; moisture; nutrients; and aeration.

Nitrification is far more sensitive to these environmental factors; consequently NH₄-N accumulates in soils in drought periods and periods of low soil temperatures and in very acid soils.

In soils NH₄-N is retained owing to the presence of clays and humus but soils have no ability to retain the NO₃-N; consequently, if the soils remain fallow, the NO₃-N is readily lost by leaching during the wet winter months.

Because of the prices received in recent seasons for wool and lamb, wheat cropping has increased markedly. Farmers are seeking advice as to what fertilizers to use under these more intensive arable systems. In a paper to this Conference in 1969, on the use of nitrogen fertilizers. Professor T. W. Walker suggested that an intensive research programme should be initiated. I am pleased to report that, because of a substantial research grant by the three South Island fertilizer companies, the Department of Soil Science has been investigating the levels of mineral nitrogen in arable soils over the last 2½ years.

REVIEW OF PREVIOUS INVESTIGATIONS ON THE USE OF NITROGEN FERTILIZERS IN WHEAT CROPPING

In a review of 120 nitrogen trials on wheat carried out by the Department of Agriculture between the 1957-8 and the 1964-5 seasons, Wright (1967) showed that nitrogen responses were more certain after previous cereal cropping. Walker (1969) showed that it was difficult to predict responses to nitrogen fertilizers and that in some situations significant depressions in yield could result from their application.

In the three seasons, 1967-8, 1968-9 and 1969-70, a very extensive series of trials was conducted in north and mid-Canterbury by R. C. Stephen, Scientist, Department of Agriculture, Christchurch (Department of Agriculture Reports on Wheat Experiments). In all, 62 trials with rates of phosphate and rates of nitrogen were conducted. These trials covered a wide range of soil types and rotations and a summary of the results is as follows:

(1) Phosphate Treatments:

Significant responses to phosphate			52 trials
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(2) Nitrogen Treatments:

Significant responses to nitrogen			21 trials
No significant responses or depressions to N			20 trials
Significant depression to nitrogen	....	....	21 trials

Of the 21 responses to nitrogen, only 10 (less than half) would have been predicted on previous cropping history. Furthermore, responses would have been expected at 5 of the 20 sites where no responses to nitrogen were obtained. Hence it is difficult to predict accurately responses to nitrogen fertilizers based on previous cropping history.

In the 21 trials where significant depressions in yield resulted from applying nitrogen fertilizers, the nitrogen status of the soil would have been expected to be high at 18 sites, that is, the wheat crops were the first crops after well-topdressed pasture or the first crop after brassica or green-feed crops preceded by pasture. The maximum depression was 953 kg/ha (14.2 bu/ac) and in all cases the depressions in yield were greatest at the highest rate of nitrogen fertilizer. Hence,

nitrogen fertilizers should not be applied to first-year wheat crops where the nitrogen status of the soil has been built up.

Walker (1972) using these data showed that, on the average, the drilling of 250 kg/ha (2 cwt/ac) of superphosphate with wheat seed was a highly profitable practice whereas the application of nitrogen fertilizers was not economic.

LEACHING LOSSES OF MINERAL NITROGEN

Because soils have no ability to retain $\text{NO}_3\text{-N}$, appreciable losses can occur in fallow soils over the winter months. In studies at Lincoln College on a fallow Paparua sandy loam in 1970, it was found that 169 kg/ha (151 lb/ac) of mineral nitrogen was lost below 60 cm (2 ft) owing to leaching of $\text{NO}_3\text{-N}$ (Tham, 1971; Ludecke and Tham, 1971). Most of the $\text{NO}_3\text{-N}$ was lost between mid-May and early August. The $\text{NO}_3\text{-N}$ was leached from the top 15 cm (6 in.) of the soil by late June when wheat is germinating. On a fallow Wakanui soil at Lincoln College in 1971, only 41 kg/ha (37 lb/ac) of $\text{NO}_3\text{-N}$ was lost below 60 cm between late May and early August. The 1971 winter was a lot drier than the 1970 winter, hence the losses were much less. This supports the observation by many farmers that nitrogen responses are more likely to occur after a cold, wet winter.

In the 1970 studies, it was shown that virtually no mineral nitrogen was lost by leaching under a greenfeed crop or established pasture. Hence, on intensive cropping farms (e.g., A. J. Marshall's property), in order to minimize the losses of $\text{NO}_3\text{-N}$ by leaching, growing greenfeed is being recommended between first- and second-year cereal crops. Where cereal crops are the first crop after pasture, a minimum of time should elapse between starting cultivation and sowing the crop.

INVESTIGATIONS IN THE 1971-2 SEASON

At five sites in Canterbury, the levels of mineral nitrogen in a fallow soil and under an Arawa wheat crop were monitored from March 1971 to January 1972. Details of the sites are given in Table 1. At each of these experimental sites a factorial design trial with four rates of phosphate by four

TABLE 1: DETAILS OF EXPERIMENTAL SITES

Site No.	Farmer	District	Soil Type	No. of Years in Wheat
1	A. J. Marshall	Ashburton	Wakanui c.l.l.	1st
2	A. J. Marshall	Ashburton	Wakanui c.l.l.	2nd
3	A. J. Marshall	Ashburton	Wakanui c.l.l.	3rd
4	Lincoln College	Lincoln	Wakanui si.l.	2nd
5	A. F. & N. Q. Wright	Sheffield	Kowai f.s.l.	2nd

rates of nitrogen was laid down and harvested by R. C. Stephen. The rates of phosphate as equivalent rates of superphosphate are shown in Table 2. The phosphate fertilizer was drilled with the seed in late May. The rates of nitrolime (23% N), which was applied in late August, are shown in Table 2.

TABLE 2: DETAILS OF TREATMENTS IN FIELD TRIALS

<i>Phosphate Treatments</i>	<i>Superphosphate Equivalent kg/ha (cwt/ac)</i>	<i>Nitrogen Treatments</i>	<i>Nitrolime kg/ha (cwt/ac)</i>
P ₀	0 (0)	N ₀	0 (0)
P ₁	125 (1)	N ₁	190 (1½)
P ₂	250 (2)	N ₂	380 (3)
P ₃	500 (4)	N ₃	760 (6)

The kg/ha of NH₄-N and NO₃-N were determined at four depths (0-10, 10-20, 20-40, 40-60 cm) down to 60 cm (approx. 2 ft) at each site at monthly intervals. The soil moisture levels were also determined. At each monthly sampling the levels of mineral nitrogen and moisture levels were determined in a fallow soil and under the wheat crop in the treatment P₃N₀. Also at each sampling herbage samples were taken and the yields of dry matter determined for each of the four nitrogen treatments with the high rate of phosphate (P₃).

Significant phosphate responses in terms of increased grain yields were obtained at four of the five sites. The only site that did not respond was Site 1.

The grain yields for the main effect of nitrogen treatments are shown in Table 3. These yields have been adjusted to 15% moisture. The results of the three trials on the same farm at Ashburton proved to be very interesting. In the first-year crop, there was a highly significant depression of 680 kg/ha (10.1 bu/ac); in the second-year crop there was no response; in the third-year crop a highly significant response of 310 kg/ha (4.6 bu/ac) and the optimum treatment was N₁ (190 kg/ha nitrolime). At the Lincoln College site there was a highly

TABLE 3: MAIN EFFECT GRAIN YIELDS FOR NITROGEN TREATMENTS (kg/ha)

<i>Treatment</i>	<i>Site 1</i>	<i>Site 2</i>	<i>Site 3</i>	<i>Site 4</i>	<i>Site 5</i>
N ₀	5440 aA	5060 a	3140 bB	5870 bA	6300 a
N ₁	5150 bAB	5050 a	3430 aA	5970 aA	6330 a
N ₂	5020 bBC	5150 a	3380 aA	5910 abA	6210 a
N ₃	4760 cC	5040 a	3450 aA	5720 cB	6090 a

N.B. Statistical analysis by Duncan's Multiple Range Test; small letters refer to 5% level of significance and capitals to 1% level of significance.

significant depression in yield of 150 kg/ha (2.2 bu/ac) and at the Sheffield site no response.

In the spring, as shown in Table 4, the wheat at Sites 2 and 4 was showing big vegetative responses to nitrogen fertilizers. This did not result in increased grain yields; in fact, at Site 4 there was a significant depression in yield.

TABLE 4: DRY MATTER YIELDS OF SELECTED TREATMENTS IN OCTOBER 1971 (kg/ha)

<i>Treatments</i>	<i>Site 2</i> <i>26/10/71</i>	<i>Site 4</i> <i>15/10/71</i>
P ₃ N ₀	6,750	2,950
P ₃ N ₁	8,860	3,450
P ₃ N ₂	9,000	3,560
P ₃ N ₃	11,670	3,670

There is strong evidence from the soil moisture data to suggest that the reason for the failure of the wheat to give grain yield responses to nitrogen fertilizers after showing vegetative responses in the spring, is due to soil moisture stress. In Table 5 the levels of available soil water (mm to 60 cm) in the P₃N₀ treatment under the wheat crop are given for Site 2 on various dates.

TABLE 5: AVAILABLE SOIL WATER LEVELS (mm) UNDER WHEAT CROP P₃N₀ TREATMENT AT SITE 2 ON VARIOUS DATES

<i>Depth</i> <i>(cm)</i>	<i>1/9</i>	<i>27/9</i>	<i>Dates</i> <i>26/10</i>	<i>6/12</i>	<i>10/1</i>
0-10	15.10	10.06	9.57	-0.64	3.23
10-20	19.28	13.30	9.32	-0.22	1.14
20-40	34.65	23.93	11.72	0.08	-2.28
40-60	32.06	22.22	18.57	7.44	5.63
Total	101.09	69.51	49.18	6.66	7.72

The levels of available soil water during November and December when the grain is filling are very small. The moisture stress would be expected to be more severe in the nitrogen treatments where there was more vegetative growth and hence a bigger area to lose water by transpiration.

In the introduction to this paper it was stated that both the ammonium and nitrate forms of mineral nitrogen are considered to be available to agricultural plants. At all five sites in the 1971-2 season, it was found that wheat could not apparently utilize NH₄-N; Arawa wheat could be markedly deficient in nitrogen (*i.e.*, in the vegetative stage of growth respond to nitrogen fertilizers), and yet there could be up to 275 kg/ha of nitrogen in the ammonium form to a depth of

60 cm under the crop. This phenomenon is illustrated in Table 6 which shows the levels of mineral nitrogen at Site 2 in a fallow soil and in the cropped (P_3N_0) treatment on October 26. The wheat at the site was markedly deficient in nitrogen on this date as shown in Table 4.

TABLE 6: LEVELS OF NH_4-N AND NO_3-N IN A FALLOW SOIL AND IN TREATMENT P_3N_0 ON 26/10/71 (kg/ha)

Depth (cm)	Fallow		Cropped (P_3N_0)	
	NH_4-N	NO_3-N	NH_4-N	NO_3-N
0-10	21	25	20	2
10-20	29	25	25	4
20-40	50	31	48	4
40-60	64	34	58	4
Total	164	115	151	14

The levels of nitrogen in the nitrate form decreased from 115 kg/ha to 14 kg/ha in the cropped soil, whereas the levels of nitrogen in the ammonium form remained similar.

In the five trials conducted in the 1971-2 season it was found that the levels of NO_3-N to 60 cm depth in a fallow soil in August gave an indication as to whether a response, in terms of increased grain yields, to the application of nitrogen fertilizers was likely to occur. As shown in Table 7, at Site 3, where a significant response to nitrolime resulted, the levels of NO_3-N were lowest.

TABLE 7: LEVELS OF NO_3-N TO A 60 cm DEPTH IN FALLOW SOILS IN AUGUST 1971 (kg/ha)

Site 1	112
Site 2	88
Site 3	75
Site 4	102
Site 5	109

CONCLUSION

The studies undertaken in the past four years in Canterbury show that, even as wheat cropping has become more intensive, nitrogen deficiencies have not become more acute. This reflects the high standards of soil husbandry practised on mixed cropping farms in the province.

Nitrogen fertilizers should not be used on first- and second-year crops after well-topdressed and managed pastures. If nitrogen fertilizers are used, then depressions in yield are likely to occur owing to moisture stresses being created.

Economic responses to nitrogen fertilizers are likely to occur in third-year wheat crops or in situations where nitrogen exhaustive crops are grown for two years followed by wheat.

Arawa wheat appears to be unable to utilize the ammonium form of nitrogen and levels of nitrate nitrogen in a fallow soil to a 60 cm depth in late winter appear in a preliminary study to give some indication whether a response is likely to occur.

Care should be taken to minimize the losses of nitrate nitrogen by leaching between harvesting the previous crop and sowing the next crop or when going from old pasture to a crop.

All wheat should be drilled with 250 kg/ha (2 cwt/acre) of superphosphate.

ACKNOWLEDGEMENTS

Acknowledgement is made for the financial assistance being given by the three South Island fertilizer companies and by the Lincoln College Research Fund to undertake these studies.

I wish to thank R. C. Stephen, Scientist, Department of Agriculture, Christchurch, for laying down and harvesting the five trials in the 1970-1 season.

I am grateful to the farmers and farm managers for allowing these investigations to be undertaken on their properties.

Professor T. W. Walker and A. F. R. Adams are thanked for their advice, interest and direction of these studies. Finally, I wish to thank Miss R. F. Jagger for her conscientious assistance in field and analytical work.

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CONTRACT-GROWN LUCERNE AS AN ALTERNATIVE TO SHEEP

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N.Z. Lucerne Products Ltd., Ashburton

Today we are no longer farming for a way of life, but for a standard of living and financial reward in the later years of life. To this end we must look for further means of diversification in farming. In this paper, some of the benefits of factory farming for lucerne production are discussed, and a comparison made of the profitability of contract-grown lucerne with a sheep enterprise.

LUCERNE ON CONTRACT

An export dehydrated lucerne operation works something like this. During the winter months the farmer growing lucerne makes contact with the processing company nearest his property. A field representative of the company then visits him, discusses the operation, the availability of contracts, acreage, age of stand, price to be paid during the term of the contract, and such points as mileage from the dehydrator base, weed infestation, access to the property and timing of harvesting. In due course a contract is signed.

Early in October the farm is visited by a harvesting programmer and a decision made as to time of cutting. The truck and harvester arrive at the property to commence harvesting. Load by load the chopped lucerne is taken back to the factory until the field is finished—then on to the next field. This procedure continues throughout the season until the first cuts are finished, and then, respectively, the second, third, fourth and fifth cuts, if and when the season allows.

Payment is made direct to the contract grower in the month following harvesting. No levies or commissions are involved. Payment is a net figure calculated on a 2,000 lb ton dry matter basis.

PROFITABILITY OF LUCERNE VERSUS SHEEP

The property used in the examples that follow is on a light-to-medium Lismore silt loam, in a low rainfall, dryland area.

It comprises 530 acres (500 effective acres). Example A shows a sheep enterprise, with lucerne grown for hay. In Example B, lucerne is grown on contract for meal processing, and winter feed is sold as grazing.

Example A: Sheep (with Lucerne Grown for Hay)

Lucerne

Production: 6,000 lb dry matter per year.

Rotation: Old lucerne → winter feed → new lucerne → 9 years' lucerne.

(10 years × 50 acres = 500 acres)

Stock

2,670 ewes, 110% lambing, 10 lb wool.

(6 ewes per acre on autumn-saved grass)

Winter feed: Overdrilled 'Grasslands Tama' ryegrass on 150 acres each autumn, plus 1,000 bales of lucerne hay made each year on average, plus turnips.

Fertilizer

2 cwt superphosphate topdressed to two-thirds lucerne area.

2 cwt lucerne mix topdressed to one-third area (every third year).

Lime

2 tons per acre applied to 50 acres before winter feed.

Labour

One man. All cultivation by contract.

Financial returns are shown in Table 1.

Example B: Lucerne for Meal Processing

Lucerne

Production: 6,000 lb dry matter per year.

Rotation: Old lucerne → winter feed → new lucerne → 9 years' lucerne.

(10 years × 50 acres = 500 acres)

All lucerne sold to factory; all winter feed sold as grazing.

Fertilizer

2 cwt superphosphate topdressed to two-thirds lucerne area.

1½ cwt potash topdressed to two-thirds lucerne area.

3 cwt lucerne mix topdressed to one-third area (every third year).

Lime

2 tons per acre applied before winter feed to 50 acres.

Labour

Nil. All cultivation by contract.

Financial returns are shown in Table 2.

TABLE 1: EXAMPLE A—SHEEP: FINANCIAL RETURNS

<i>Income (\$)</i>		<i>Expenditure (\$)</i>	
Sheep		Interest, rent, advisory, rates	1,190
2,670 ewes, 110% lambing,		Insurance	120
@ \$5, + works ewes, 450		Stock purchases	
@ \$2.50	15,815	8 rams, 590 ewes	5,400
Wool		Wages	
26,000 lb at 70c/kg	8,370	Permanent	3,000
		Shearing	920
		Stock feed	660
		Contract cultivation	
		Winter feed, overdrilling,	
		balancing	1,200
		Cartage	210
		Fertilizer/liming	2,780
		Seeds	600
		Repairs and maintenance	500
		Incidentals	245
			16,825
		Cash surplus	7,360
	24,185		24,185

Interest Return

							\$
Land and buildings—530 ac @ \$150	....	....	....	....	....	....	79,500
Stock—2,700 ewes @ \$5.50	....	....	....	....	....	....	14,850
Plant—nil							
Working capital—in budget							
Total farm capital .....	....	....	....	....	....	....	\$94,350
Cash surplus ....	....	....	....	....	....	....	\$7,360
Interest return 7.8%							

Budget Parameters

						<i>Net Profit Change (\$)</i>
(1) Change in price of lamb of \$1	....	....	....	....	....	± 2,940
(2) Change in lambing of 1%	....	....	....	....	....	± 135
(3) Change in wool price of 1c/lb	....	....	....	....	....	± 260
(4) Change in wool weights of 1 lb/head	....	....	....	....	....	± 830

TABLE 2: EXAMPLE B—LUCERNE FOR MEAL PROCESSING:
FINANCIAL RETURNS

<i>Income (\$)</i>				<i>Expenditure (\$)</i>			
Lucerne				Interest, rates, power, etc			1,030
450 ac @ 3 tons/ac @				Insurance			100
\$12/ton			16,200	Wages, casual			500
Winter grazing				Cultivation			650
50 ac = 300 ac weeks =				Fertilizer/liming			3,340
15,000 sheep weeks at				Seeds			300
8c/head			1,200	Repairs/maintenance			500
				Incidentals ...			20
							6,440
				Cash surplus			10,960
			17,400				17,400
<i>Interest Return</i>							
Land and buildings—530 ac at \$150				....			\$79,500
Stock—nil							
Plant—nil							
Working capital—in budget							
Total farm capital							\$79,500
Cash surplus							\$10,960
Interest return 13.8%							
<i>Budget Parameters</i>							
							<i>Net Profit Change (\$)</i>
(1) Change in price per ton of \$1							±1,350
(2) Change in yield per acre of 1,000 lb							±2,700

POINTS TO CONSIDER

Sale of winter feed to graziers or purchase of own stock for winter fattening market.

Overdraft service considerably reduced.

Fewer buildings, sheep yards and general buildings.

Cultivation by contract—no plant maintenance/repairs.

No plant replacement costs.

Weed infestation minimized.

Less waste with harvesting.

Rising costs can be held.

Sixty per cent of gross income from sheep is used to cover costs. Comparative figure for lucerne—approximately 37%.

Least labour of all normal farming systems.

Only known market for nodding thistle and fathen.

POROPORO AS A CROP

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New Zealand could become a producer of raw material for hormone drugs, which are reputed to be the third most important group after vitamins and antibiotics. These drugs, with sales exceeding \$1 billion, are used as anti-inflammatory agents, metabolic stimulants, general stress reaction protectives, cancer palliatives, and in a very wide range of sex complaints. The production of cortisone from plant material nearly twenty years ago, led to this major breakthrough.

To manufacture these drugs synthetically is expensive and complicated, and, as yet, unsuitable for commercial production. World supplies, therefore, largely depend on basic steroid raw material available from certain plants. Three-quarters of the raw material used today is supplied as diosgenin, an extract of a wild Mexican yam of the *Dioscorea* species, and from this material many thousands of pharmaceutical compounds have been synthesized.

It appears that demand for diosgenin could outstrip the supply, and the situation could worsen because of the increasing cost of labour, and urban drift in Mexico.

This has aroused interest in the native Solanaceae, in particular *Solanum laciniatum* and *S. aviculare*, collectively known as poroporo, which can supply a replacement basic steroid raw material for diosgenin, in the form of solasodine. These two *Solanum* species have been under investigation in Russia, Hungary and India for some years, on quite a large scale. If poroporo can be taken to these countries and grown successfully, it follows that it should be possible to grow it even more successfully in New Zealand. If this is so, it does not necessarily mean that solasodine will replace diosgenin right away—the investment in the latter, involving millions of dollars, will ensure continued production of this material. Rather it is the future expansion of this industry that will require solasodine, provided that the world market can be supplied at a price competitive with that paid for diosgenin.

Research into the commercial cultivation of poroporo in New Zealand is being carried out by Ivon Watkins-Dow Ltd.

in Taranaki, and Crop Research Division of DSIR in Canterbury. In the main, this paper concerns the work carried out by DSIR.

The first aspect investigated at Lincoln was how to grow the crop successfully and as cheaply as possible on a commercial scale, under Canterbury conditions. The decision to evaluate its potential as an annual crop grown from seed was made because of the advantages this method appeared to have. They are:

- (1) Although both species are perennials, they are frost tender and growing them from seed each year would obviate the risks of overwintering.
- (2) Poroporo is subject to various virus diseases, especially cucumber mosaic virus, in the second year and onwards. Growing annually would probably obviate this problem.
- (3) The crop should be grown annually from transplants planted out in the spring, as is done with many tomato crops, but this is expensive, involving glasshouses, a lot of labour, and specialized equipment.
- (4) Canterbury is renowned for its excellent cropping capabilities because of its advantages in climate, large areas of flat land, "know-how", mechanization and the availability of irrigation, to mention some.

Although Ivon Watkins-Dow had been growing poroporo in Taranaki for some time, nothing was known about its establishment from seed in Canterbury, and it was necessary to start more-or-less from scratch and find out the difficulties as work proceeded.

This paper will discuss growing poroporo under five main headings: Species, establishment, management, harvest, and prospects.

SPECIES

When the project was started, it was thought that *S. laciniatum* would be the obvious choice for Canterbury, because of its greater hardiness and growth rate. On the other hand, *S. aviculare* has less dry matter (DM) production per acre and is more susceptible to cold, but it has two advantages:

- (1) Higher solasodine content per lb/DM—over 2% on the average compared with about 1.5% for *S. laciniatum*.
- (2) It is more resistant to virus diseases.

Trials indicate that the advantages of *S. aviculare* could possibly offset the disadvantages, after drying, and processing costs have been taken into account.

ESTABLISHMENT

Seedbed

Poroporo thrives on a free-draining, friable loam and as is customary for seeds of this size—e.g., white clover—the seedbed should be fine and firm. Just before sowing, trifluralin ("Treflan") should be incorporated into the soil to a depth of 4 in., at the rate of 0.5 to 1 lb active ingredient/acre ($1\frac{1}{2}$ to 2 pints/acre) for weed control.

Sowing Rate

Sowing rate will depend on germination, population density and species sown.



R. Lash, a technician at Crop Research Division, DSIR, Lincoln, pollinating Solanum laciniatum flowers.

Germination

This is slow and uneven, taking about 6 weeks before the first seedlings emerge. Various seed treatments, such as applying various forms of heat, cold, chemicals, and prolonged washing in cold water, have been tried with varying success under glasshouse conditions, but under field conditions have so far proved of doubtful value, probably because of the long period in the soil under indifferent conditions. An inhibition, probably solasodine itself, as well as genetical factors are thought to be responsible. Without doubt a suitable seed treatment will eventually improve this situation. Meanwhile, to attain a given population in the field, the recommended number of viable seeds sown per acre is 1,000 for both species, or a weight for *S. laciniatum* of 1.5 g and population $\times 4$ and for *S. aviculare* 0.5 g and population $\times 8$, on the principle that it is easy to thin if the population is too dense.

Population Density

Limited trials in 1971 with *S. laciniatum* showed the following:

Population/acre	DM (lb/acre)	Solasodine % of DM
4,000	4,000	1.8
10,000	6,500	2.0

It was therefore thought important to conduct a major trial on this aspect this year, particularly as it seemed as if ground cover could be increased to advantage.

Progress results of 1972 trials for DM only (with solasodine % still to be evaluated) yield the following:

Population/acre	DM (lb/acre)
10,000	8,600
15,000	9,301
20,000	12,600
30,000	12,800
40,000	14,800
60,000	13,700
120,000	20,000

It would seem than a density of between 20,000 and 40,000 plants/acre will be required. Higher populations, although producing more DM/acre, will probably produce too great a proportion of woody material.

Spacing

For optimum DM yield per acre a row spacing of 12 in. has given better results than a 24 in. spacing. However, this would not facilitate inter-row cultivation and 24 in. spacing is recommended.

Time of Sowing

It is necessary for emergence to occur after the risk of heavy frosts has passed, so assuming 6 weeks' germination period, late September or early August is recommended, depending on district. Sowings in 1970 were made in early September, and, at that time, slow germination was put down to the cold, wet soil conditions, so the 1971 sowings were delayed until early October. This did not make any improvement, emergence date being a week or so later. Present thinking is that the earlier sowing

- (1) Probably assists germination, with the wet conditions acting as a seed treatment.
- (2) Allows the earlier germinating seedlings to take advantage of favourable conditions, as soon as they occur.

Method of Sowing

It was hopefully thought that, to attain economic use of expensive seed (seed collection and extraction is laborious), single seeds could be sown with advantage. However, germination problems preclude this, and satisfactory results are obtained by either sowing in clumps with a Stanhay precision drill, or through the fertilizer box of a coulter drill. Broadcasting would be perfectly feasible, but would prevent inter-row cultivation.

CROP MANAGEMENT

Weed Control

This is essential for a period of several months after sowing, because of the long period before rapid growth commences. Recommendations are:

- (1) Trifluralin incorporated into the soil to a depth of 4 in. (rotary hoe, harrows, discs, etc.) before sowing at a rate of 0.5 to 1 lb a.i./acre will control most weeds except crucifers (e.g., shepherd's purse), storksbill, twitch, and yarrow.
- (2) Paraquat at 1 to 1½ pints/acre applied no later than 4 weeks after sowing will control all seedlings present. It is risky to apply later because poroporo seeds may have germinated but not emerged.

- (3) Inter-row cultivation as often as necessary, but make sure the implement tracks exactly behind the drill used.
- (4) Harrowing could be beneficial after establishment provided the plants can stand a little thinning.

Fertilizer

Trials at Lincoln this year show that a basic application of 1 to 2 cwt of superphosphate at sowing time is desirable, followed by a later application of $\frac{1}{2}$ cwt of KCl or 1 to 2 cwt of NPK fertilizer when the plants have started to make rapid growth.

Irrigation

As germination is better under damp soil conditions, pre-emergence spray irrigation is important, if rainfall is inadequate, and, although poroporo does reasonably well under dry conditions, later irrigations ensure optimum growth, particularly with the dry summers experienced in Canterbury during the last few years. By the time plant growth makes irrigation difficult, growth, both above and below ground, will lessen the need for it.

Pests

The main pest in Canterbury is the tomato stem borer, and attacks are likely in areas where tomatoes or potatoes are grown, and also in those districts where poroporo grows naturally. Where present, tomato stem borer can appear about the time of first flowering towards the end of December, and the damage resulting from the caterpillars boring into the stems can be heavy. A 20% lindane emulsion spray, at 2 pints/acre should be applied. Insufficient damage is caused by later attacks to warrant the cost of spraying, unless the berries are required for seed. Where there are ripe berries, tomato stem borer attacks are concentrated on these, with the caterpillars penetrating the fruit and ingesting the seed.

Aphids can also become a problem, and should be sprayed as for tomato stem borer, if necessary.

Disease

Virus disease, principally cucumber mosaic virus but also spotted and verticillium wilts, and potato X and Y virus to a lesser extent, are the main diseases attacking poroporo.

In Taranaki, it has been found that incidence of disease is particularly severe after the second season, particularly if the plants have been harvested previously on a perennial system. *Solanum aviculare* is much more resistant than *S. laciniatum*.

Under Canterbury conditions, with its dry climate, plus the fact that poroporo is being grown on an annual system, virus

disease has not so far been a problem. Aphids could possibly be responsible for virus build up in the future.

No control measures have yet been needed.

HARVESTING

The whole plant is utilized, apart from the thick, woody stem at the base. Although solasodine content is highest in the leaves, fruit and vigorously growing shoots, there appears to be enough in the stems to warrant processing these too. Economics will probably demand a one-cut harvest crop, even though total solasodine could be higher for a multi-cut one. This has yet to be proved. Solasodine concentration appears to increase with maturity, and so harvests to date have been left until growth finishes in autumn.

The easiest way of harvesting poroporo, is with a forage harvester, either direct or from a windrow formed by first cutting with a tractor-mounted mower. If the latter method proves feasible, and the crop could be partially dried in the windrow, large economies in drying costs could be made. Also this would result in less juice loss. A forage harvester of a chopper type is preferred because the size of chopped material can be controlled. The loss of material through unseasonable weather could perhaps be heavy.

The green or partially dried material will then be transported to a commercial dryer where it is ground afterwards. The ground material can be stored without deterioration until it can be processed, either on the same site or elsewhere.

PROSPECTS

As stated earlier, the cost of solasodine production per pound will have to be less than the world price of diosgenin which at present is approximately \$10/lb. This could be expressed by:

$$(\$10 \times \text{lb DM/acre} \times \% \text{ solasodine}) - (\text{Cost of growing}) - (\text{Cost of drying}) - (\text{Cost of processing}) = \text{Profit/acre.}$$

Results from the replicated 18 ft × 8 ft plots enable part of this equation to be filled in with estimates:

$$(\$10 \times 15,000 \times 1.5) - (\text{say, } \$200/\text{acre}) - (\$350/\text{acre}) - (\text{Cost of processing}) = \text{Profit/acre.}$$

$$\$1700 - (\text{Cost of processing}) = \text{Profit.}$$

In other words, there is perhaps \$1700/acre to spend on processing, including transport, etc., to break even. It looks very promising, but has to be proved by:

- (1) Large-scale growing trials to prove what plot-scale trials indicate. These have commenced and although there have been a few problems, they should prove successful this year.

- (2) Costs of commercial-scale drying have to be determined. This is being done but figures are not yet available. Methods of harvest can reduce these if natural drying proves successful.
- (3) Determining processing costs by the setting up of a pilot processing plant. This is necessary right away because by next harvest it will be the only big cost factor that needs to be evaluated to determine if the poroporo crop is a feasible venture.

Funds for this plant (designing and setting up) will be necessary from either commercial or Government sources.

CONCLUSIONS

The value of poroporo can be increased by:

- (1) Increasing DM/acre solasodine content, or both, by better techniques in establishment, management and harvesting. This is proceeding.
- (2) Selection of more suitable varieties, and breeding for better varieties. This has been started.
- (3) Lowering costs where possible—*e.g.* by natural drying, by economies resulting from larger scale activities.
- (4) Setting up an efficient processing plant by employing suitable designers and engineers.
- (5) Price alone will not govern the acreage required. It will depend on:
 - (a) Cost of production.
 - (b) Acreage necessary to provide enough material for efficient processing.
 - (c) Overseas demand.
 - (d) It is unlikely that New Zealand will have the capacity to do more than produce raw material for export, because of the tremendous amounts of capital involved.

So far all indications are that poroporo could form the basis of a very profitable industry.

ACKNOWLEDGEMENTS

I would like to pay tribute to R. Lash who has so ably and enthusiastically carried out most of the trial work at Lincoln. I would also like to thank A. Wallace of DSIR and Ivon Watkins-Dow Ltd. for their co-operation and help.

HERBICIDE RESIDUES AND CROP ROTATIONS

L. J. MATTHEWS

Scientist, Ruakura Agricultural Research Centre, Hamilton

Possibly the most complex field of herbicide usage is that of herbicide residues affecting resulting crop production. This paper will detail those factors that are within our reach—those factors that the herbicide user can manipulate.

THE PROBLEM

The most efficient herbicides for crop production are usually those with a short residual action in the soil—a residual action long enough to allow crops to establish weed-free. Such herbicides or mixtures of herbicides, however, are proving so effective that crops may be established and maintained weed-free until harvest, thus mitigating indirect losses through weeds harbouring diseases, insect pests, etc. However, residue problems may occur when a resistant crop is replaced in the rotation with a susceptible crop.

HERBICIDE BREAKDOWN

The factors responsible for herbicide breakdown in the soil or environment are complex and interrelated, and may be listed generally as leaching (rainfall), adsorption (inactivation on soil colloids and/or organic matter), volatility, microbial inactivation, weed species, temperature and irradiation. The soil may be viewed as an open, dynamic, multi-phased system resulting from the earth's litho-, aqua-, atmos- and biosphere. Man has little or no control over these complexes.

FACTORS THAT MAN CAN MANIPULATE

(Possible Order of Importance)

Specific Herbicides

Herbicide resistance to breakdown is known generally. Figure 1 lists some of the better known herbicides and the period these materials remain potentially dangerous to susceptible crops. To this list must be added the following

materials that are in use in New Zealand: Cyprozine (10 months), metobromuron, methabenzthiazuron, chlorbromuron (5 months), monolinuron (4 months), nitralin (6 months), pronamide, carbetamide (4 to 6 months), alachlor, propachlor, prynachlor (2 months), butylate, vernolate, cycloate, pebulate (1 to 2 months), pyrazon, terbacil, lenacil, bromacil (6 months), nitrofen, chlornitrofen, fluodiphen (1 to 2 months), metribuzin (6 months). Most materials have some residual action in the soil. The list for those materials having little or no residual action is much shorter: Paraquat, diquat, MSMA, DSMA, bromoxynil, ioxynil, glyphosate and bentazon, the last two being new experimental materials of high promise. Today for many crops a number of alternative herbicides are available and the most selective and the least persistent material should be employed, particularly in areas of low to medium rainfall and where the crop rotation is likely to be modified to include susceptible crops.

Soil Organic Matter Content

Most herbicides are influenced by the percentage of soil organic matter or percentage of fine clay particles (colloids) in the soil and in fact organic matter content has been shown to be the most important single soil factor influencing soil-applied herbicides. One per cent organic matter is equivalent to about 13,000 to 15,000 lb of organic matter content per acre—i.e., for every 1% increase in organic matter content there is some 13,000 to 15,000 lb of material reducing herbicidal activity for strongly adsorbed materials. Most New Zealand soils have a high organic matter content (8 to 10%), hence their capability of locking up and inactivating the applied herbicides. In high organic matter soils, increased rates of application are required for weed control and, provided moisture is not a limiting factor, residual activity for strongly adsorbed herbicides is unlikely. On low organic matter soils, high doses of even strongly adsorbed herbicides are not locked up completely and residual effects are likely to accrue. For example, for trifluralin, likely rates of application are:

<i>% organic matter content</i>	<i>Rate of application (oz/acre)</i>
1	2
2	4
4	8
8-12	12
16*	16

*Note: Above 15% organic matter, rates of herbicide applications are no longer linear.

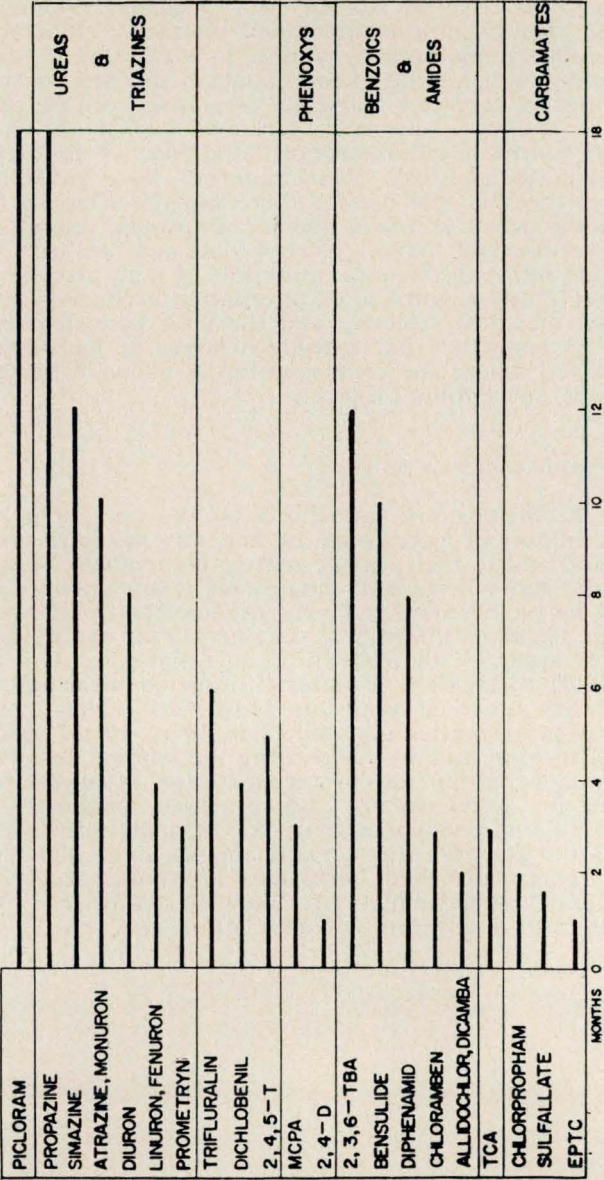


FIG. 1: Herbicide persistence in soil. Average time taken to decrease to less than 25% of amount applied at normal rates of application.

The organic matter content of soils should be known and a rate of soil-applied strongly adsorbed herbicides adjusted accordingly.

Leaching

Leaching of herbicides depends on physical properties of materials, organic matter content, and rainfall. The factors are interdependent. Herbicides may be listed as follows:

- (1) Readily leached in all soils—2,2-DPA (dalapon) and TCA.
- (2) Readily leached in low organic sandy soils, but some resistance to movement in others—allidochlor, chloramben, dicamba, 2,3,6-TBA, propachlor, alachlor.
- (3) Readily leached in low organic sandy soils but considerable resistance to movement in other soils—diphenamid, 2,4-D, 2,4,5-T, dinoseb.
- (4) Moderate movement in low organic sandy soils but little or none in others—atrazine, simazine, monuron, cyprazine.
- (5) Only slight movement in low organic sandy soils and essentially none in others—linuron, chlorpropham, diuron, sulfallate, dichlobenil, prometryn, trifluralin, nitratin, picloram.

That is, herbicides are likely to persist longer under dry conditions than where rainfall is adequate.

Cultivation Following Herbicide Usage

Thorough cultivation—*i.e.*, inversion and completely working the soil—is the most satisfactory method of inactivating herbicides. On no account should the herbicide layer be inverted and left as a band below microbial decay and also safe from leaching. Dilution of the herbicide through a 6 in. or so band of soil is important.

Crop Rotation

In low rainfall areas and where the soil is low in organic matter content, residual grass herbicides possibly should not be employed where a cereal crop is to follow and the reverse is true for residual broad-leaved materials—*e.g.*, picloram should not be employed for brassicas where a solanaceous or leguminous crop is to follow.

SUMMARY

Crop damage from the residual effects of soil applied herbicides may be minimized by:

- (1) Employing the most selective material where a range of herbicides is available.
- (2) For strongly adsorbed herbicides or persistent materials, adjust rate to soil organic matter content. This is particularly important for soils low in organic matter content (1 to 2%).
- (3) If dry conditions prevail, or in low rainfall areas, persistent herbicide should be employed with caution.
- (4) Thoroughly mix herbicide residues through a 6 in. band; do not just invert the herbicide layer.
- (5) The use of persistent materials should be considered in relation to future crop rotation.

ACKNOWLEDGEMENTS

My thanks are due to F. C. Allen, Research Division, Department of Agriculture, for providing case histories of residual damage to crops in Canterbury.

PIG PRODUCTION BASED ON CEREAL GRAINS

D. G. WATSON
Farmer, Canterbury

In recent years this Conference has heard eight excellent papers on various aspects of pig farming. In this same period, there has been no significant change in pig numbers.

It seems that, despite the very competent research material contained in these papers, and which is available to pig producers, the average farmer is still having difficulty in deriving a substantial profit from pig production. In fact, a recent statement by R. A. Oliver, Chairman of the Pork Industry Council, with reference to bacon and ham claimed that current schedule prices will *not* support economic pig production based on cereal grains (*Straight Furrow*, March 15, 1972). It should be pointed out that, since the above statement was made, pork processing companies have increased pig meat schedules by 8%. Hence some small measure of improvement in the situation has occurred.

Nevertheless, it is not easy to assess the true profit-yielding potential of pig production based on cereal feedings. Some of the basic factors to be considered before entering such a farming programme are discussed in this paper.

The first question to be asked is why do it? What is the objective? Why go into pig production at all, let alone with costly grains?

To a stock farmer the pig has many attractions. It matures at an early age, produces litters instead of the one, two or maybe three offspring produced by other animals. It has two-plus litters per year, and 20 weaners per sow per year is not impossible despite a national average of about 10. Pigs do not need crutching or shearing. The pig is a tidy animal and likes clean, tidy quarters and can adapt readily to all-year-round housing, and to caging.

It can be seen, therefore, that the pig, more than any other domestic animal, is suited to intensive, indoor "factory-type" farming. By factory-type farming I mean the kind of enterprise one can put inside a building and where the materials go in and are converted to other products. In the case of pig

farming, the feed goes in and the resultant products are pigs or pig meats (plus effluent and wastes). The pig is a good converter of food to meat. A boar tested last year at the National Pig Breeding Centre had a growth rate of 2.14 lb per day using 2.17 lb of food per pound of liveweight gain. A ratio of 3.5 : 1 is currently more realistic, but with a rapid generation turnover steady improvement is possible through careful testing and selection.

Physical work can be reduced in intensive units and the work made more attractive by the use of mechanical conveyors for dry foods and pumps for wet foods. The disposal of wastes can be dealt with by reducing all dung to a liquid form that can be pumped out and spread mechanically.

I have not yet answered the question of why go into pig production? The only valid reason for commercial production is to make money. Therefore, the factors to consider *before* entering pig production based on cereal grains in Canterbury, or anywhere, are those bearing on making a profit.

Having established profit as the primary objective, and having set a minimum acceptable level of profit, the following factors need to be considered:

- (1) The market for pork and bacon pigs.
- (2) The cost of cereal grains and protein supplements.
- (3) The type of production.
- (4) The scale of production.
- (5) The location of the unit or units.
- (6) The capital requirements.
- (7) The production goals: (a) for the units; (b) for staff; (c) for animals.
- (8) The controls.

THE MARKET FOR PORK AND BACON PIGS

The market for the end product is by far the most important factor, because, without a satisfactory market, efficiency—scale of operation—conversion rates, etc. have no value except in reducing or compounding the losses. With respect to marketing the following points should be noted:

- (1) The market is local; there are practically no export outlets for New Zealand pig meats at present. In the 1969-70 year only 364 tons were exported.
- (2) The market is subject to price fluctuations caused in the main by over or under supply in the absence of any floor price scheme.
- (3) Nationally, marketing is in the hands of a few companies plus some localized companies and small butcheries.

- (4) Bacon and ham prices to the consumer are currently subject to price justification.
- (5) With full grain feeding, food costs are likely to account for 65 to 80% of the total costs on the more efficient units.

A regular, reliable and relatively stable market is of the utmost importance and failure to recognize this could lead to disaster. The production of pig meats is for a local market and any grand thoughts of vast but nebulous overseas markets should be dismissed immediately. In fact, anyone entering pig production based on cereal grains in Canterbury, or anywhere else in New Zealand for that matter, would have sufficient to exercise their minds without having to fight for overseas markets.

The actual price to the producer for porkers and baconers would need to be studied and trends noted.

THE COST OF CEREAL GRAINS AND PROTEIN SUPPLEMENTS

Feed costs are about 65 to 80% of total costs in an all-grain feeding unit. Therefore, the cost of this feed is critical and any increase would adversely affect the profitability of the enterprise. An excellent paper entitled "Economic Pointers to Grain Feeding Pigs in New Zealand" was presented to the 1968 Lincoln Farmers' Conference by J. Baker, now with the Pig Improvement Company in England. One example from his paper would make the point. At a feed conversion of 3.9, a reduction of \$1 per ton in feed costs will increase profit by \$69 per 100 pigs to bacon. It should be noted here also that, at 2.8 cents per pound for food, an improvement of 0.16 in feed conversion would achieve the same result. Cereal grains are cheaper in Canterbury than elsewhere in New Zealand and with a food requirement of 5 to 6 lb to produce 1 lb of meat it must be more economical to use the grain as close as possible to the point of production.

To achieve economies in food prices storage and mill and mix facilities might need to be provided by the pig producer.

TYPE OF PIG PRODUCTION

Once a study of the market opportunities had been made, the type of production would need to be determined. It could be the fattening of bought-in weaners or the production of superior weaners for others to fatten. Or the production and fattening of weaners. Or the production of purebred and/or tested stock for sale plus the fattening of stock.

SCALE OF PRODUCTION

Factors to be considered are whether it is intended to do this job oneself, or to employ others to do the actual on-farm work either as employees or as contract breeders and fatteners

or growers. The scale of operation will determine the amount of selection for improvement and the rate of improvement possible.

LOCATION OF THE UNIT OR UNITS

Points to consider here are access to grain supplies, labour, water, killing and processing facilities, and the ability to dispose of effluent. In this respect, the relatively flat cropping soils of the Canterbury plains would pose fewer problems than any other area in New Zealand. Effluent from the pig unit can be used to advantage in the production of cash crops and at the same time any potential pollution problem can be avoided. Other points to watch are the distance from areas of population and from other pig units, because of wind-drift hazards.

CAPITAL REQUIREMENTS

How often we hear it said, "It takes money to make money". In the case of grain feeding this is very true as many have embarked on schemes to make money this way only to find they have insufficient capital to see the job through. In planning a grain fed pig business the points to watch are: (1) Initial capital to set up the business; (2) Working capital; (3) Reserve capital to tide the business over a trough in the market and/or a rise in feed prices caused by a shortage of grain.

PRODUCTION GOALS

An ounce of forethought is better than a ton of hindsight. In planning it is better by far to have goals (even if the cross-bar proves too high and has to be lowered later) than to have none at all.

These goals would cover the three basic elements: (1) The enterprise as a whole. (2) The staff. Production per man. The minimizing of deaths (numbers of pigs born/fattened). Attention to details of hygiene, performance, record keeping, etc. (3) The animals—Growth rate, efficiency, and carcass quality goals. Weaners per sow per year, etc.

CONTROLS

Care needs to be taken to devise the right controls to enable the business to achieve its objective of making a profit of a certain level.

I visited a pig unit in Scotland that really impressed me. The records the owner wanted to see regularly were: (1) Cost conversion ratio (cost per pound liveweight gain); (2) Conversion rates; (3) Days to bacon; (4) Bacon pigs sold; (5) Gradings; (6) Numbers per litter born and weaned.

Each type of enterprise has its peculiar critical points. Having established the nature of these and their relative importance to the success of the enterprise, it rests with the manager to steer a steady course, avoiding the rocks of despair—economic storms and the embarrassment of being grounded in shallow water for all to see—and the success of the venture is assured.

ACKNOWLEDGEMENT

The writer wishes to acknowledge the help and advice of M. G. Hollard, Lincoln College, and M. J. M. Hanley, Senior Advisory Officer, N.Z. Pig Producers' Council.

PIG PRODUCTION COMBINED WITH CASH CROPPING AND SHEEP

LESTER HOLDAWAY

Farmer, Blenheim

Our farm is of 64 acres situated three miles from Blenheim. The soil type is Kaiapoi silt loam which is very free working and affords no drainage problems. Rainfall averages 67 mm, reasonably spread throughout the year.

There are about 6 acres of sand on one part of the farm and this is prone to blow at times.

The usual cash crops have been grown—peas, barley, wheat, potatoes, small seed and lucerne. Yields of most of these crops have been average with the exception of lucerne which grows to perfection.

The reason for venturing into pig production was the size of the unit; we considered that the day had passed when it could survive as a traditional sheep and cropping enterprise. What we endeavoured to do was to set up a pig unit that could make use of the farm's ability to grow lucerne, contribute towards fertility while not limiting the growing of crops on the rest of the farm, and provide enough dollars to make the whole exercise an enjoyable experience.

Accordingly we set up a mealfeeding unit of 60 sows, grinding and mixing our own feed. We chose Berkshire sows because of their grazing ability, mating them with Landrace boars, and they have performed well. However, they are now being phased out and replaced with Berkshire × Landrace sows which we believe will give a better performance from a grading point of view. We market most of our pigs as baconers.

A total of \$6,000 was spent on housing of three types:

(1) Ark type accommodation, which is completely mobile, for the dry sows.

(2) We built 30 12 ft × 12 ft open-fronted "deep litter" houses that are used for sows and litters and growing pigs.

The term "deep litter" may be a little misleading. The pigs live on straw, hygiene being facilitated by the addition of barley straw which covers up the dung and gives them a dry bed to sleep on. As much as a bale per pen per day is used

as the pigs grow and produce more urine and dung. About 4,000 bales of barley straw are used for this purpose.

(3) We built a 60 ft x 30 ft totally-enclosed fattening house capable of accommodating 180 pigs from 100 lb liveweight to bacon weight.

ROTATION

The farm rotation that has developed over the past four years is shown in Fig. 1.

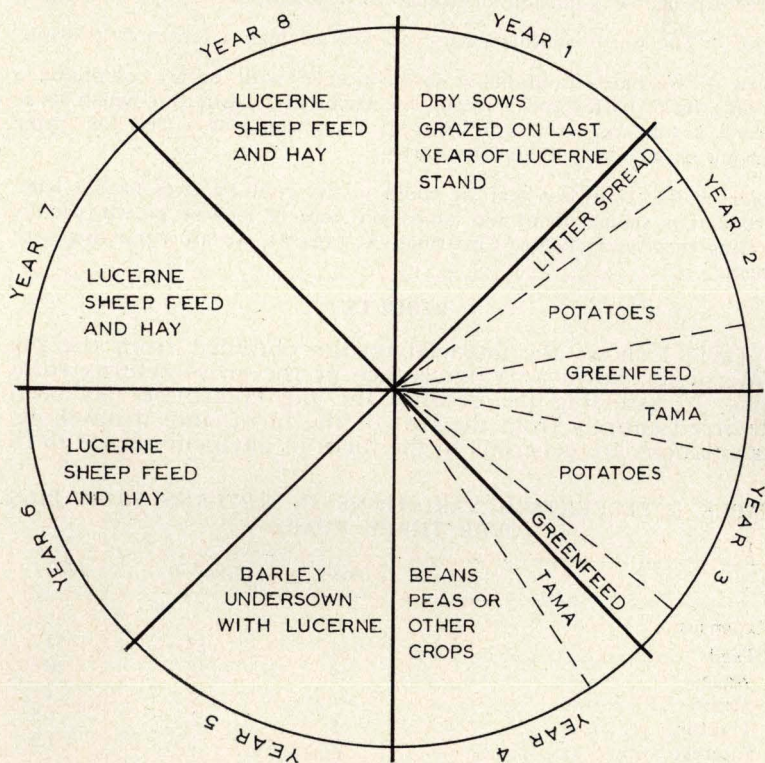


FIG. 1.

NOTES TO FIGURE 1

Year 1: Sows use the lucerne stand, subdivided with single wire electric fences, in its last season. Any rooting they do is of little consequence. We find them a good grazing animal making good use of the lucerne; they are selective in that thistles, docks etc. are left to grow.

The ideal management is to divide the grazing area into two and after grazing run the mower over it and spell it for 3 or 4 weeks.

It has been our practice to spread most of the litter from the deep litter houses on to this area, usually just prior to getting it ready to plant in potatoes.

Year 2: Potatoes are chosen for this place in the rotation as there is no difficulty in planting them into the soil, which has had a large quantity of trash (straw and dung) incorporated into it. The potatoes are Ilam Hardy and are grown for table potatoes. Some good crops have resulted.

If the potato crop can be marketed early enough a useful amount of greenfeed can be grown which is used by the pigs during the winter and also by the sheep.

Year 3: The reason for growing a second crop of potatoes is the very practical one of a maximum acreage on a small farm.

Year 4: The aim is another cash crop with as high a return as possible.

Year 5: We have traditionally sown lucerne with barley, obtaining a good crop of barley and a reasonable strike of lucerne but which takes nearly a year to reach its full vigour. There could be a case for spring sowing of lucerne without the barley.

Years 6, 7, 8: Until last year we could justify running ewes for fat lamb production, selling about ten lambs per acre of lucerne grown, usually getting them away before Christmas. At present, we are persisting with them.

RESULTS

Table 1 shows the financial results obtained from the pig enterprise, shown as a percentage of the gross returns from pigs. In assessing the results, the pig enterprise has been divorced entirely from the rest of the farm, and, if anything, calculations are generous to the farm in payments made to it.

TABLE 1: PERCENTAGE VARIATIONS IN RETURNS FROM PIGS OVER THREE YEARS

	1968-9	1969-70	1970-1
Expenses:			
Feed	51	53	74
Wages	14	10	10
Straw	5	3	2
Tractor	3	2.5	1.5
Interest	3	1.5	1.5
Land rent	2	2	2
Truck	2	2.5	1.5
Health	1	0.5	0.5
Depreciation	1.5	1.5	1.5
Repairs	0.5	0.5	0.5
Total expenses	83%	77%	95%
Surplus	17%	23%	5%
	100%	100%	100%
Cost per lb of pigmeat sold	18 c/lb	18 c/lb	23.6 c/lb
Average price per lb received	21.7 c/lb	23.3 c/lb	24.9 c/lb

NOTES TO TABLE 1

Feed: Actual cost of feed purchased—barley, meatmeal and minerals. All home grown barley is paid for at \$1 per bushel.

Wages: One man's wages—up to this time we have not spent one man's full time on the pigs, so this is reasonably generous.

Truck and tractor expenses: A generous figure paid to the farm for the use of these vehicles.

Land rent: A rental of \$30 per acre on the land used by the pigs during the growing season.

Interest: 5% interest on the capital actually involved in the pig enterprise. The cost of buildings, feed on hand and value of stock.

Straw: The straw used by the pigs is paid for by the pig enterprise, and for the purpose of these calculations no value has been placed on the resultant litter that has been returned to the farm.

Compared with other meal-feeding units, the percentage spent on feed is misleading as milling and mixing of feed mean that what would normally be a feed cost finds its way into wages and tractor expenses. Similarly, in grazing the sows, some feed costs end up as land rental.

The small profit for 1970-1 was due in part to a most difficult year in the supply of barley. We paid up to \$1.50 per bushel for part of our needs.

This year, we have built four silos capable of storing 240 tons of barley or about 130% of annual requirements which means that we will not need to pay unnecessary cartage or outside storage costs.

THE PERSPECTIVE FOR IRRIGATION IN CANTERBURY

G. A. G. FRENGLEY

Senior Lecturer in Farm Management, Lincoln College

At the outset, several points need to be made quite clear as my own results and those of others at Lincoln who have conducted economic research in the field of irrigation have been somewhat misunderstood.

(1) There is absolutely no doubt that irrigation *can* be used very profitably in Canterbury by individual farmers. But the word *can* should be noted, as particular conditions must be fulfilled for successful results. Most of the comments in this paper are concerned with these necessary conditions.

(2) It is very difficult to extrapolate from one individual's experience to that of others, especially to dissimilar groups of farmers. Many reasons for this are obvious, but, broadly, the conditions that must be met to make irrigation profitable for an individual farmer are expanded when a group is involved and several more factors have to be added.

(3) Rightly or wrongly I feel that most of the recent concern about irrigation and its profitability seems to have been based on the wrong assumption that there is more than adequate supply of cheap water for everyone. However, it is increasingly obvious that those who are using irrigation very profitably have evolved particularly successful management systems, in many cases with very limited supplies of water. It appears that the emphasis placed on providing unlimited water to enable farmers to continue to operate existing dryland management systems, but now in a wet-land or irrigated environment, has not encouraged new management ideas. Those who have evolved new systems have profited greatly.

Irrigated management systems can be derived from a wider range of possibilities and are more flexible than dryland systems. It is notable that almost all efficient irrigators can suggest further ways of increasing their profits without changing the quantity of water they use. This implies that it is most important to look closely at existing ways of im-

proving present irrigated management systems before considering further investments of capital in irrigation. After all, it seems a particularly good business practice to increase profits when it costs nothing to do so.

(4) Any assumptions that our markets are unlimited for all existing or new agricultural products that could be developed are wrong. Certainly some products will be less affected by increasing supplies than others, but exotic products and those intended solely for the New Zealand market have a restricted future.

(5) It is my belief (subject to confirmation by research) that dryland management systems have been evolved that are much closer to their known technical and profitable limits than irrigated land. There is much to learn about irrigation methods and management systems, let alone the more difficult problems of designing new schemes which must suit these requirements.

There are, of course, other important points that arise but these few may alleviate the doubts of people who have accused of fence sitting those of us at Lincoln involved in economic research on irrigation. Equally, these points help explain why it is ridiculous to state unequivocally that irrigation is always profitable. There are a large number of provisos and many of these will become apparent in this paper.

Recently a research project was undertaken to study the profitability of irrigating a limited area of a 500 acre shallow Lismore soil property at Pendarves. And for this I am indebted to the assistance given by B. K. Cameron, on whose property the irrigation system was about to be installed, and McEwans Machinery Company for the financial assistance that made the research possible.

A flow of $\frac{1}{2}$ cusec was obtained at 200 ft and a scheme designed to irrigate 180 acres of the farm. This contrasts markedly with flow rates of 1 cusec per 100 acres considered by some people to be essential. Note that with respect to the whole farm, flow rate is 1 cusec per 1,000 acres, but it is approximately $\frac{1}{4}$ cusec per 100 acres or 3 in. over 4 acres per day on the irrigated area.

The management system devised and now adopted by Mr Cameron was cunning. The system had to fulfil two particular conditions, first, it had to suit the water supply, and secondly complement the management of the remaining 320 acres of dryland since it was pointless to turn the 500 acres into two separately-managed and unrelated units.

By devising a precise watering schedule of paddocks to be covered in each month, a selection of crops was chosen which had sufficiently flexible sowing dates and stages of growth at which production responses were known to occur, to fit together as a rotation. These included wheat, barley, 'Grasslands Tama' ryegrass, linseed, fodder beet, and red clover.

The importance of relating the selection of crops to the watering schedule cannot be over-emphasized.

Apart from a limited area of lucerne on the irrigated area the programme allowed for most of the area to be sown in Tama each autumn for winter feed.

Thus the management system allowed surplus spring growth to be absorbed by cash cropping and the winter early spring feed shortage to be bolstered by winter Tama and fodder beet. The dryland management was also changed to provide for the whole 320 acres to be sown in lucerne, as winter feed was now assured and the early spring feed shortage was minimized.

We had expected the result to be like that shown in Fig. 1. Area A represents the additional profits the irrigation was expected to create, but in years when rainfall is high irrigation

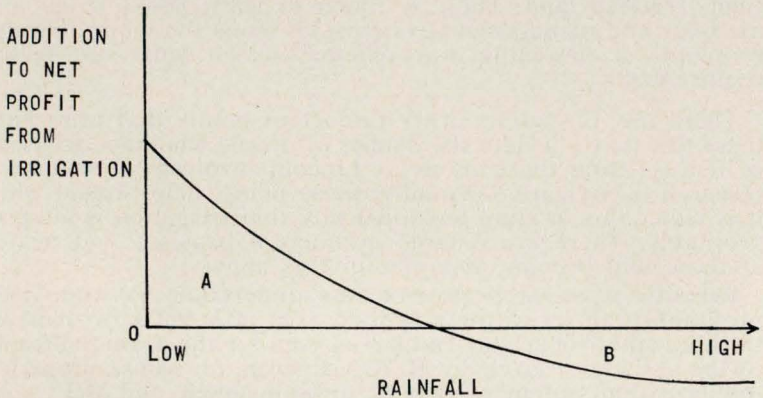


FIG. 1: Hypothetical graph of irrigation profitability and rainfall.

becomes less necessary, and, eventually, if rainfall is high enough the plant becomes an expensive heap of unwanted machinery costing money in depreciation and interest. Therefore at high rainfall a loss occurs.

In fact, the result was as shown in Fig. 2. The dip in income is caused by the water limitation affecting production under moderate drought conditions. In extreme drought any water is a godsend so profits rise again. However the most notable difference occurs in years when rainfall is high; profits do not drop as expected. Although I overlooked it in my first assumption, the reason is clear. Dryland farmers cannot adjust stock numbers upwards in a year they get 35 in. of rain or more on the assumption that it will happen again the following year, but an irrigation farmer has assured growth and can adjust management systems with much more certainty; consequently he can stock up to the expected level of production. Thus the irrigation farmer using the management system outlined here will continue to have greater profits even in wet years.

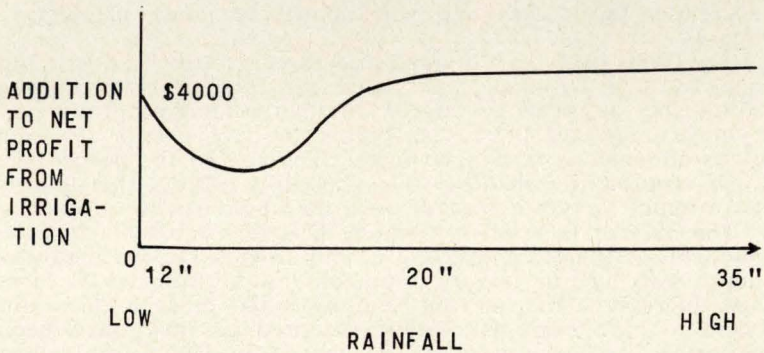


FIG. 2: *Actual graph of irrigation profitability and rainfall.*

This irrigation proposal is returning 28% on the total capital invested and its operation in the past two summers supports the original estimates.

It should not be inferred, however, that irrigation will always be very profitable. It depends on the farmer. If he is already competent, and his thinking is not stereotyped, he will probably evolve a very profitable management system and be delighted with the irrigation results. If he is a muddler, then his scope to muddle is much greater under irrigation and he will not be pleased with the results. He could be worse off financially.

Finally, as stated at the outset, it is very difficult to assume that the results obtained by one farmer can be applied to other farmers or groups of farmers.

In recent research we have sample-surveyed the farms in the suggested Rakaia irrigation area (172,000 acres). Table 1

TABLE 1: RAKAIA IRRIGATION AREA: FARM SIZES, SOIL DEPTHS AND PRODUCTION FIGURES

<i>Farm Area (ac)</i>	<i>% Cash</i>	<i>Winter</i>	<i>%</i>	<i>% Ewes to</i>
<i>Group A: >24 in.</i>	<i>Crop</i>	<i>Carrying (EE)</i>	<i>Lucerne</i>	<i>Down Ram</i>
(1) 200-399	42	4.1	6.6	100
(2) 399-800	33	4.4	7.5	90
(3) 800 and above	14	3.3	9.0	70
<i>Group B: 12-24 in.</i>				
(1) 200-399	23	4.8	19	81
(2) 399-800	15	4.1	11	98
(3) 800 and above	15	2.9	9	86
<i>Group C: <12 in.</i>				
(1) 200-499	5	3.8	10	40
(2) 499-800	7	3.5	10	50
(3) 800 and above	11	3.0	6	63

correlates farm sizes and soil depths to some production figures.

The farms have been divided into three groups by depth and also by area. On the deeper soils the intensity of cropping diminishes as farms get bigger but in the shallow group percentage crop area increases. Again, for each group, stocking rates diminish as farms get bigger. The rise in the percentage cash crop on the shallow soils probably reflects this and is an attempt to retain control over the rapid spring growth.

The area in lucerne is variable. On the deep soils it rises as farms get bigger and cropping diminishes. On the medium-depth soils lucerne is very important but diminishes as farm size increases. And on the shallow soils, lucerne does not seem to have been as readily accepted as may have been expected. Lastly the numbers of ewes to the Down ram reflect the emphasis on breeding replacements. The trends in groups A and C are evident—increasing replacements in group A and the reverse in group C. At a guess the group C effects result from a longer life span of the ewes, with low numbers carried per acre, plus the increased cash cropping affecting summer feed production and forcing farmers to reduce stock numbers rapidly in early summer.

The irrigation example discussed earlier was taken from Group C1. Table 1 supports the point that management systems differ significantly for different groups and it would be quite incorrect to suggest that the results obtained by farmers in one group will be identical with those for other groups. Indeed they may be significantly better or worse, so much depends on the abilities of the individuals in the groups. Equally it is probable that the ideal management systems which evolve under irrigation will be no more uniform than the ones shown in the table.

Finally, I reiterate that irrigation can be used very profitably but it is expensive and will not be worth while unless it is planned adequately and competent management advice is sought.

A LITTLE WATER CAN GO A LONG WAY

S. J. MORROW

Farmer, Lowcliffe, Ashburton

In the very dry spring of 1958 I bought an old Field Marshall tractor for £135, fitted a pump to it, hired some pipe and embarked on my first irrigation venture. After 14 seasons of spray irrigating, I shall try to show how far a little water can be made to go and describe the benefits being obtained from its use.

I farm an area of 832 acres in the Lowcliffe coastal district of mid-Canterbury. Of this, 320 acres form a separate light land block of Lismore very stony silt loam which is not irrigated and does not come within the scope of this paper. On the remaining 512 acres the soil is a Temuka silt loam peaty phase consisting of 5 to 8 in. of topsoil on 10 to 20 in. of clay over shingle, and varying from some low-lying, inadequately drained peaty areas to strips which dry off rapidly in drought conditions.

The average annual rainfall is 24 to 25 in. with variations from 16 to 34 in. In the past 10 years, during the critical months of October, November and December, only 11 falls of more than one inch in a 3-day period have been recorded. During this time of high evaporation and high plant demands for moisture a fall of less than an inch is scarcely significant.

The present farming policy is one of total crop on the heavy land. This means that from the closing of the last ryegrass and clover seed stands in late October until after harvest all the stock are carried on the light land. Present stock numbers are 2,000 breeding ewes and 300 to 400 replacement hoggets. Maximum use is made of stubble feed, greenfeed, and ryegrass and clover seed stands and aftermaths, and the stock carried on these would equal 2.5 ewe equivalents per effective heavy land acre the year round. The part played by these crops and stock is important in maintaining soil fertility and structure.

The labour force consists of one married man, a student, and myself.

The crop rotation is flexible and adapted to seasonal climatic and market situations. The present aim is to grow

maximum acreages of wheat and peas, with linseed and barley as alternatives, and ryegrass and white clover as restorative crops. The growing of cocksfoot or timothy on some of the wetter paddocks may also become part of the programme. Table 1 gives a three-year crop acreage on an effective area of 472 acres.

TABLE 1: THREE-YEAR CROP ACREAGE ON EFFECTIVE AREA OF 472 ACRES

	1970-1	1971-2	1972-3
Wheat	119	168	149
Peas	65	125	128
Linseed	44	29	43
Barley	49	41	45
Ryegrass	90	84	44
Clover	77	19	40
Beans	12		
Rape	10		
Cocksfoot			17
Pasture	6	6	6
Total	472	472	472

The water supply is from catchment board drains and the entire farm can be covered. The present plant consists of two direct drive diesel units, one capable of pumping 600 gallons per minute or $1\frac{1}{2}$ cusecs, and the other up to 2 cusecs, together with 3,800 ft of mainly 5 in. hand shift pipe. The length of spray line averages 20 chains. One line is operated with double nozzle sprinklers at 40 ft spacings and moved an average of 75 ft, while the other with single nozzles at 50 ft spacings is moved 85 ft. This gives an average coverage of $2\frac{1}{4}$ and $2\frac{1}{2}$ acres per shift. The average application is $2\frac{1}{2}$ in., ranging from 2 in. on peas to 3 to 4 in. on pasture or ryegrass seed crops. Line shifts take an average of $1\frac{1}{4}$ man hours and paddock shifts 4 man hours. This means that with both plants putting, say, 2 in. on 20 chain paddocks of peas, one would do four $3\frac{1}{2}$ -hour shifts of $2\frac{1}{4}$ acres and the other three $4\frac{1}{2}$ -hour shifts of $2\frac{1}{2}$ acres, or a total of $16\frac{1}{2}$ acres a day. Of course better results may be obtained if the pipes are shifted at night. However, as a regular nocturnal occupation, shifting pipes by hand in a thick, knee-high crop of peas does not appeal, as those who have tried it will agree.

The capital invested in irrigation is listed at cost in Table 2. This is an investment of \$27.50 per effective irrigable acre and is of course tax deductible. Government capital valuation of the 512 acres averages \$293 per acre so \$13,000 would buy, say, 45 acres of similar land. This could be expected to give a net surplus of, say, \$30 an acre or a total of \$1,350. I hope to show that this return can be bettered by investment in irrigation.

TABLE 2: CAPITAL INVESTED IN IRRIGATION (AT COST)

	\$
2 diesel pumping units	5,400
3,000 ft 5 in. pipe	4,500
800 ft 4 in. pipe	800
Sprinklers, bends, fittings	1,675
2 tankers	340
Pipe wagon	85
Culverts, drain diversions	200
	<u>13,000</u>

In the past season our watering programme covered 731 acres:

<i>Spring (to Christmas)</i>	<i>ac</i>	<i>Autumn</i>	<i>ac</i>
Ryegrass	84	Ryegrass and clover	127
Wheat	98	Greenfeed and young grass	116
Peas	219	Cocksfoot	17
Barley	29		
Linseed	41		
Total	471		260

Water requirements for this programme were: Say, 800 acres at $2\frac{1}{2}$ in. average application—2,000 acre-inches or 166 acre-feet.

The season would begin with cocksfoot in September followed by ryegrass, with the peak time from early November, when the wheat is entering the shot blade stage, to Christmas when the last of the peas are filling. During this 8-week period the two plants are fully committed. Table 3 shows the estimated yield increases from irrigation. While these can only be estimates based on observation I am confident they are conservative.

TABLE 3: ESTIMATED YIELD INCREASES FROM IRRIGATION

	<i>Est. Dry Yield</i>	<i>Irrig. Yield (5-yr av.)</i>	<i>Est. inc. from irrigation</i>
Wheat	62bu	72 bu	10 bu
Rhonda peas	53 bu	78 bu	25 bu
Barley	58 bu	78 bu	20 bu
Ryegrass	43 bu M.D.	58 bu M.D.	15 bu M.D.
Linseed	15 cwt	22 cwt	7 cwt

WATERING OF MAJOR CROPS

Wheat

Most of the wheat watered has been spring-sown Hilgen-dorf. We have not watered much autumn-sown wheat as this is felt to be a fairly marginal proposition under our conditions, and liable to lead to more lodging and disease. It is also much harder work. We try to water at the early shot blade stage. Watering any earlier than this, unless conditions are very dry, probably encourages too much vegetative growth leading to increased water demands and disease problems in the later stages. In the past season a second watering at the flowering stage would likely have given good results had the plants been free.

Peas

We have been growing peas for only four years (previously we thought the land was unsuitable for them). The variety has been Blue Rhonda and all crops have been watered once, sometimes twice. This year 102 acres which had received two waterings averaged 80 bushels, ranging from 71 to over 90. Of the twelve crops grown in four years, only two have yielded fewer than 70 bushels. One yielded 65; the other was on a poorly-drained paddock on a newly-purchased part of the property which was overwatered and yielded only 43 bushels. After spending \$45 an acre on tile drains, the two following crops have been 90 bushels of Gamenya wheat and 76 bushels of Blue Rhonda. I make this point to show, first, that consistent pea yields have been obtained, and, secondly, that reasonable drainage is essential where irrigation is practised on heavier soil types. Timing of irrigation is most important with peas. It is vital that they have adequate moisture from early flowering to pod fill. This year a crop of White Prolifics was also grown; it was watered once and yielded 65 bushels.

Barley

This has been grown only as a late substitute crop for wheat or on some of the poorer paddocks. As with wheat it is normally watered at the shot blade stage, but has been watered earlier, even before drilling with some very late crops. In that two of the four crops grown in recent years would have been near failures in the early stages had it not been for irrigation, I feel that at least a 20 bushel increase has been achieved.

Ryegrass

The response from irrigation of ryegrass seed crops has been a very real one even in good seasons. If the early spring is dry, crops may be watered as early as September, but the

important watering is at closing time when nitrogen is applied. This ensures that maximum benefits are obtained.

Linseed

Many of the linseed crops have been sown late after drafting lambs from the paddock and these usually need irrigating before either ploughing or drilling, and perhaps again in the early growing stage to aid establishment. However crops sown at the normal time in early October, in a good season, require only one watering and this is given at the early flowering stage. Irrigated crops have yielded up to 36 cwt. In recent years, however, yields have fallen because of seasonal conditions and the limited place pasture now has in the rotation.

White Clover

Yields have probably been doubled on occasions by one well-timed watering. In most seasons, however, the result is a good hay crop so water is used only in extremely dry conditions, or to repair the damage of a late or badly-timed application of paraquat.

RETURNS

What then would be a reasonable estimate of the monetary gain from irrigation in the past season? In Table 4, the returns shown are net of sacks, dressing and cartage, all other charges having to be met regardless of yield.

TABLE 4: ESTIMATED GROSS PROFIT FROM IRRIGATION
1971-2 SEASON

<i>Crop</i>			<i>Acreage</i>	<i>Yield/ac</i>	<i>Return (\$)</i>	<i>Total</i>
				<i>bu</i>	<i>per bu</i>	
Wheat						
Hilgendorf	....	....	64	10	1-70	1,088
Gamenya	....	....	34	10	1-45	493
Peas						
Blue Rhonda	.....	....	102	25	1-55	3,952
W. Prolific	....	....	23	10	2-14	492
Barley	....	....	29	15	0-94	409
Ryegrass						
Ruanui	....	....	45	15	1-75	1,181
Manawa	....	....	39	15	1-40	819
				<i>cwt</i>	<i>per ton</i>	
Linseed	....	....	41	7	68-00	976
						9,410

From this gross profit of \$9,410, irrigation operating costs must be deducted. These are set out in Table 5. The 800-acre programme requires 1,500 hours of pumping. It also requires a labour input of 560 man hours, *i.e.*, 337 line shifts at 1½ hours and 35 paddock shifts at 4 hours. A tax saving of \$4,000 on the \$13,000 capital outlay is assumed, and interest charged on the balance of \$9,000. Depreciation over a ten-year period from the original net cost of \$9,000 to \$5,500 equals \$3,500 or \$350 per annum.

TABLE 5: IRRIGATION OPERATING COSTS PER HOUR
(1,500 hours per annum)

	\$
Fuel	0.36
Oil and filters	0.03
Repairs and maintenance	0.07
Truck and tractor expenses	0.04
Labour (337 × 1½) + (35 × 4) = 560 hr at \$1.60	0.60
Interest 7% on \$9,000	0.42
Depreciation, \$350 per annum	0.23
	1.75

An operating cost of \$1.75 per hour equals \$1.31 per acre-inch, equals \$3.28 per acre, equals \$2,625 per annum. \$9,410 minus \$2,625 equals an annual net gain from irrigation of \$6,785, or a reward to investment and management of \$14.37 per effective irrigable acre.

I believe that similar returns from irrigation would be obtainable on many of our cropping soils were water made available.

No attempt has been made to assess the monetary gain from autumn irrigating, but the advantages might be listed as:

Better recovery of ryegrass and clover seed stands after harvest with resultant quicker fertility build up.

Provision of flushing and tugging feed.

Reliable establishment of young grass and greenfeed.

Enables more stock to be carried on the heavy land so that the light land can be shut up for autumn-saved pasture.

In general, the benefits from irrigation may be summarized as follows:

A worthwhile financial gain.

Job satisfaction in achieving better yields.

A consistent level of returns.

Confidence in planning and budgeting.

Flexibility in management.

A LITTLE WATER GOES A LONG WAY

A. G. WRIGHT

Farmer, Hinds, Mid-Canterbury

I farm 520 acres of Lismore stony silt loam situated five miles above Hinds. The property is 530 ft above sea level in what is regarded as a 25-in. rainfall area, although the 10-year average is 28 in. The average for the past three years was 23 in., with a range of 17 to 39 in. Not only is there this variation but the distribution of rainfall throughout the year varies considerably, with winter months recording up to 7 in., and the three months of late spring/early summer recording 1 in. We are also exposed to a hot, dry, north-westerly wind, which renders much of the spring/summer rainfall ineffective.

Add to this climate a shallower-than-average 4 to 5 in. Lismore soil and it is obvious that moisture is the limiting factor to production in the area.

This past year 243 acres were border-dyked, with all but 26 acres of this area prepared for automatic irrigation; in addition, 205 acres were wild-flooded. In all, 640 acre-feet of water were used. I contract to take 520 acre-feet at 85c, with extra water at 50c, from the Ministry of Works, and this entitles me to three days and nights of water per week. This should be sufficient if the total area were border-dyked, but with half in wild-flooding last year we irrigated for 10 days continuously in November, when the demand from crops and pasture was at its peak. With wild-flooding we rarely achieve better than one acre per hour, compared with a minimum of two acres and up to 3.5 acres on the automatic borders. Although wild-flooding is obviously inefficient in water use, by confining it mainly to cash and winter feed crops, two waterings normally produce a year's income. Pasture, by comparison, may take seven to eight waterings to produce one year's gross income.

Wild-flooding has been the best tool I have had in developing the farm. For a capital cost of about 50c per acre for ditching, it is possible to earn \$300 to \$400 per day by wild-flooding. For example, two waterings of Maple peas has lifted the yield from 10 to 50 bushels in a dry year. I obtain 80%-plus cover in all paddocks, and, as the soil has not been disturbed by

graders, this is where the top crop yields have come from. Nonetheless, I regard wild-flooding as a development tool only, and propose to border most of the farm.

Until this year, the cost of bordering has averaged round \$20 per acre, but with a higher grader hire rate, plus more undulating contour paddocks remaining, this figure has increased considerably. One paddock this year cost \$45, and I expect others to cost \$30. I am quite satisfied with the \$45 paddock as, with wild-flooding, it produced 53 bushels per acre of Partridge peas this year and last year 104 bushels per acre of malting barley. Both seasons were very dry which is hard on spring-sown crops on light land.

Of the farm, 149 acres is in the final stages of clearing from heavy pine plantation. The trees have been bulldozed out and burnt during the past eight years, and the top soil stirred up to the extent of shingle showing in many places. The cost of initial dozing of blocks ranged from \$66 to \$110. Water is vital on this area as its moisture-retention ability has not yet recovered. Thirty acres have been border-dyked, and a further 80 acres will be completed this autumn/winter. Wild-flooding here is not impossible, but almost so. Without water, however, growth of pasture has been nil during a six-month summer.

STOCK 1971-2

Last year, we reduced ewe numbers from 1,700 to 1,560 and increased barley acreage on the plantation area. This was partly because grass grub destroyed 20 acres of pasture on a wild-flooded paddock, and partly because two waterings of the barley would produce a higher gross return per acre. The ewes are Corriedale $\times$ Romney, the two-tooths and hoggets, Border Corriedales (small studs of Southdown, Ryeland and Suffolk are run as well). We tailed 114% lambs and this could be regarded as average. We also mate the hoggets, and tailed 170 lambs. The ewes clip about 10 lb of wool and the hoggets 4 lb, February, 6 lb, September, 6 lb, February. Last year we finished thirty-eight 18-month steers purchased in June and sold four to six weeks later.

CROPS

Last harvest produced only average yields though the crops had looked very promising in September/October. The season was so hot and dry that the normal number of waterings was insufficient to produce maximum yields, although the quality of all seeds and grain was maintained. Yields are shown in Table 1. All barley, lupin, linseed and 23 acres of white clover were harvested off the plantation block and although yields were not high the unirrigated areas were not worth heading. The income will more than pay for border-dyking 80 acres this autumn.

TABLE 1: CROP YIELDS

<i>Crop</i>	<i>Acres</i>	<i>1971-2 Yield</i>	<i>Best Recorded Yield</i>
Wheat			
Arawa	27	58 bu (approx.)	68
Hilgendorf	19	43 bu (approx.)	—
Gamenya		—	70
Aotea		—	60
Peas			
Maple	40	54 bu	65
Blue Rhonda	5	43 bu	—
Barley			
Malting, Zephyr	56	59 bu	104
Lupin, Uni-white	10	30 bu	—
'Grasslands Ariki' ryegrass	16	30+ bu	40
Red clover	26	320+ lb	560
White clover	23	133 lb	—
White clover	17	43 lb	240
Cocksfoot	18	300 lb (approx.)	—
Linseed	17	0.8 ton	—

MANAGEMENT

I acquired the plantation area in 1961 and two years later purchased the 370-acre block from my stepfather. The first 15 acres of trees were bulldozed in 1963, and the same year 112 acres bordered; 1,260 ewes were being run, 17 acres were in wheat and 26 acres white clover. During the next two years all available cash was used to bulldoze a further 33 acres of trees; ewe numbers were increased to 1,400, with 250 ewe hoggets.

Then a development loan was secured to bulldoze the final 70 acres of trees and a start made on converting all headraces on existing borders to automatic. This released labour to increase the area of pasture wild-flooded. In 1966 I wild-flooded wheat (56 bushels); barley on a bordered area (88 bushels) was followed the next year with Maple peas (65 and 51 bushels). Until 1970 I lived with heaps of trees and temporary fences in the plantation and because of dry summers only early-spring and late-autumn grazing was possible. All available cash was used for new borders and generally improving feeder races for wild-flooding. Ewe numbers had increased to 1,700, hoggets to 450, and 150 acres were in crops.

From 1970 until the present, irrigated crops and pasture have generated enough income to continue irrigation development, plus the systematic cleaning-up of heaps of trees. Only one heap of less than three acres remains. The cleared areas were cropped this year to cash in on the little accumulated fertility we have. As much as possible of this area will be bordered. (I believe the graders would have squandered this fertility during bordering.)

These new borders will go to Maple peas, to 'Grasslands Tama' ryegrass and then to lucerne. We obviously cannot crop here in the near future, and lucerne should provide a lift in dry matter production. The reason for bordering before peas is that the contour is extremely rough for wild-flooding and not only is labour for wild-flooding becoming short, but with the area I am watering, sufficient water is becoming a worry. A further development loan has been raised for this bordering as I believe it is vital to get water on this block, if returns on the earlier development are to be achieved.

Sheep, Crops and Irrigation

Two years ago we increased the crop area to 250 acres and maintained stock numbers. Performance was unchanged. In fact, feed shortages at peak periods did not seem as severe as when there had been 100 acres less in crops. The most acute period of feed shortage has always been December/January. Last December was no exception but a stack of the previous year's ryegrass-straw was cheap feeding and released extra paddocks to maintain 1,200 lambs. With water, I was happy not to work up winter feed paddocks until just before Christmas, and water the worked ground (if it did not rain) for turnips and giant rape. By mid-January we were heading grass and barley, and peas followed; then the wheat undersown with red clover and short-rotation ryegrass. The ewes stay on stubble until three weeks before the ram goes out (mid-February). Watered crops produce more stubble feed than dryland, especially barley and peas. The Down lambs left get the best feed and a good draft was away at the end of January. The 800 wool breeds are still only stores and are shorn mid-February; by then there is good watered feed on white clover, ryegrass and seeds paddocks, followed by green-feed on new sow-downs and Tama. These lambs do really well on this feed and I prefer this system to buying in stores on an expensive market to utilize it. With water I can maintain these lambs over summer and have them ready on the place for autumn feed. Also, while the ewes are on stubble, I am able to shut up several bordered paddocks for flushing and this helps give an average lambing percentage.

The ewes stay on pasture for five weeks after the ram goes out, then all pasture not to be cropped the next year is shut up for autumn-saved pasture. The ewes are moved on to a runoff and spend $\frac{3}{4}$ to one hour per day on oats, which fits in between wheat and peas, or barley and peas, plus two bales per 100 of straw. The oats are spread with the bulk-truck spinner and grubbed in.

Maple peas are sown in June and July as soon as the oats are fed off. The sheep then graze the turnips and giant rape, and wheat follows these crops in July and early August. The ewes are not fed the autumn-saved pasture until they have lambed as I find this bank of feed necessary with the stocking

rate I have on spring grazing. I aim to draft as many Down lambs as possible (usually 600 to 800) and they get the best paddocks and are not weaned until shearing in early December. The wool breeds are weaned at 7 to 8 weeks of age, without being drafted, on to a clover-dominant watered paddock. My shearing date may need revising, as it clashes with the second watering of crops.

The availability of water has made this programme possible. The sowing time for all crops, wheat and peas in particular, is now later. Yields have held and I have the bonus of one to two months extra grazing for sheep during winter.

Undersowing of crops is a reality not a gamble. Not only is there sheep feed when the header pulls out, but the paddock does not require cultivation. The area undersown with red clover and short-rotation ryegrass becomes, in the following spring, the hay paddock, and usually yields about 70 bales per acre on December 5. It is shut up again on December 20 for red clover seed and two waterings in January are required. Here bumble bees dictate the yield; the range is from 0 to 3½ sacks of dressed seed per acre.

As much clover as possible is grown in pastures in the January/February period as this is when soil temperature is highest and white clover fixes 90% of its nitrogen. This is a bonus dryland farmers have not had in recent years. On a first-year pasture this management is vital and sets the pasture into top production in the first autumn.

Artificial nitrogen can be used on crops with confidence as moisture, before or after application of the fertilizer, can be guaranteed. There is also the confidence that there will be sufficient moisture to finish the extra crop yield produced with the nitrogen.

Direct drilling of Tama or new pasture after crops is cheap and quick. The bare ground can be watered the day before drilling, or at any stage afterwards, and as the soil is consolidated and not disturbed, it does not go hard and the grass yellow off. Soil structure is maintained and this is the key to cropping on a Lismore soil.

Crop Rotation

I have no set crop rotation, but generally pasture goes to winter feed, wheat to undersown red clover or cocksfoot to peas. The peas can be followed by pasture of specialist ryegrass → barley undersown white clover → specialist white clover → wheat. In other words, two white straw crops never follow each other and this rotation can go on indefinitely. The expensive paddock that was bordered this year has been cropped seven years running, and the last two crops were the best with soil structure beautiful after the peas. This type of rotation is necessary to maintain crop acreage, as I like to leave newly-bordered pasture down five to six years to recover from initial bordering. I put up borders with the grader blade

every time I work a paddock and get the graders in before a sow-down. This keeps costs at a reasonable level and if borders are not spread too far with cultivation the grader blade does a good job.

Water gives me a choice as to what I produce. I can move with the markets and carry most stock or crops reasonably well. For example, I could grow lucerne for the factory, winter beef calves on Tama, grow sugarbeet if the industry comes, or milk dairy cows. I am not a "market chaser", but neither am I limited to sheep and 10% crops as I would be under dryland farming. Under dryland farming cropping would be limited to a winter wheat, early barley and occasionally ryegrass and white clover.

Grass grub is a very real problem. Contrary to what W. R. Lobb finds at Winchmore Research Station, water will not control them on my farm. The only prevention I have is lindane for pasture and this cost me \$1,100 two years ago. With water, returns justify this expense. With later sowing of crops, grass grub does not worry wheat and peas but if I suspect it after crops, I dribble in 10 lb of "Gessapon" granules, with good results.

Porina is different. Water and birds (gulls and starlings) give very good control except when a paddock has been regularly watered at night in January and February, and the birds have not had a fair opportunity.

Labour

At present I have one pre-Lincoln College student all year and two at harvest during January/February. Here again, water has provided the income to employ labour and this has been vital in development of both the plantation and the irrigation plant. To me there is no such thing as a one-man firm.

RETURNS

Comparative returns for 1965, 1970 and 1971 were:

	1965	1970	1971
Capital value per acre	\$98	\$120	\$170
Total farm capital	\$138	\$196	\$250
Gross profit per acre	\$31	\$63	\$68
Interest earning capacity	8.8%	13.5%	10%
Spring grazing stock units	4.7	7.8	8.6

To compare irrigation farming on this property with a dryland system is very difficult. In my case, with the expensive plantation development and without water, I would today have a job in town. For comparison I asked my farm adviser for figures on farms of similar soil type, rainfall and management.

A sheep, plus 10% crop farm would be averaging \$38 to \$40 gross per acre. After deducting costs, he arrived at a figure of \$10 to \$12 an acre net additional profit for irrigating.

In summary, I believe that the cropping programme described can be continued successfully on a Lismore soil. The main limiting factor is soil structure but provided good restorative crops are grown in the rotation, *e.g.*, a good crop (watered) of peas, white clover, or Tama, the structure should be maintained, whereas a poor dryland crop puts nothing back and the cultivation further depletes the soil. I am not quite so sure about our future water supply. Government is still undecided on its policy, and last time I was in the local Ministry of Works office the advisability of bordering too much of the farm was questioned as it was felt that I might be over-committed on the water available.

THE FARMER'S CLAIM FOR WATER

J. R. COCKS

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Water use is a subject with which every citizen is vitally concerned, and one that involves the planning of water resources for the benefit of society generally and to make maximum use of a valuable national resource. Comments in this paper referring to Canterbury should in most instances be interpreted to include the other regions of the South Island where further irrigation schemes are practicable.

I accepted the invitation to present this paper with extreme reluctance because I have been, and still am, very closely and personally involved with practically every important issue associated with the implementation of the Water and Soil Conservation Act. I speak here as a private citizen who has had a greater opportunity than most to study and consider the social as well as the economic aspects of irrigation development. I speak also as one who is about to suffer the ignominy of prosecution for carelessness in not observing the provisions of the Water and Soil Conservation Act.

However some of these matters are of such urgent national importance that I believe they transcend personal considerations. I leave you to judge my sincerity.

It was the desire to study irrigation and the solution to problems of water allocation that gave me the opportunity to study irrigation and water legislation overseas. I would like to quote from the report I wrote in 1964 at the conclusion of that study, as it summarizes my thinking and forms the basis of this paper.

Wherever water is available throughout the world, modern techniques have made possible its increased use in agriculture, and there is no doubt that its use and importance in this sphere will increase considerably in the future.

At the same time, increased consumption for domestic, industrial, and other purposes, is making heavy demands on available supplies everywhere.

A study of the problems associated with the growth of spray irrigation and irrigation generally brings an increasing realization

that their solution cannot be dissociated from a study of the wider issues embracing the best use of a country's water resources, water conservation and control for all purposes, and a study of the relative priorities of use for all sections of the community concerned with the use of water.

Consequently, the problem of increasing competition for available supplies, for agriculture and other uses, can only be met by integration of the needs of the community as a whole, and requires planning on the widest scale and at the highest possible level. With the economy of New Zealand largely dependent on agriculture, and because of the rising need for water in agriculture, wider conservation of water resources, and more comprehensive planning of their use will be needed.

The fact that water is very often a flowing asset and cannot readily be reduced to possession, coupled with the facts that water is scarce in some areas and abundant in others, and can be readily transferred from one area to another, means that the solution to water problems often goes further than the boundaries of one state or one country and requires national or international agreement.

(This applies in the context of current local discussions as New Zealand's major water sources, such as the Waimakariri, Rakaia, Rangitata, and Waitaki rivers, are all interrelated.)

THE BROADER ISSUES

Several consistent facts emerge from a study of water problems:

(1) Water is becoming increasingly scarce in nearly every country, or, more strictly speaking, consumption of water has greatly increased.

(2) This has meant increasing conflict among various users, and also among agricultural users as a group. These conflicts will increase in the future rather than decrease.

(3) Water is a difficult commodity to administer because of its very nature. It cannot be treated like land. It cannot be reduced to possession, and it is seldom available in definite amounts. Its availability varies considerably in different areas, from season to season, and at different parts of the season. Peak demand for irrigation is often when flows are smallest. Water can be an embarrassment at certain times, and at other times it can be priceless.

All one can have is a right to use the water if it comes by one's land, or to use or conserve it if it happens to rain on one's land.

(4) For efficient administration water should be considered as a single resource and not as three—flood, surface, and underground water—with several sets of rules, and several bodies responsible for administering them.

(5) The real problem is how to give a city, an industrial corporation, a home-owner, business man or farmer a sufficiently secure right to water so that considerable investment in projects involving its use is justified, and at the same time protect the public rights to water, and retain sufficient flexibility in control to provide for changing patterns of use.

There must be sufficient stability in a country's water policies to permit agriculture, industry, and other users to make long-term plans for optimum development of total resources.

(6) Control alone will not increase the total amount of water available. The consistent answer to most of the above problems lies in the provision of more water both by increased conservation, even involving in some cases artificial recharge of underground aquifers, and by bringing in more water from areas of abundance to areas of scarcity. Storage projects, both large and small, can play an important part in making maximum use of a catchment area.

(7) To attain this objective, considerable research is often necessary. Collection and analysis of hydrological data and information pertinent to water policy decisions are primarily a government responsibility.

(8) Re-use of water, particularly by industry, should be encouraged wherever possible.

(9) Water for domestic purposes and the watering of livestock should in all cases have priority.

(10) beyond this, priority for beneficial uses for a specific area should be decided after a study of the availability of water and the importance of the uses.

(11) Ability to pay is no criterion in deciding who shall have the water. Scarce products are often sold to the highest bidder, but this is not necessarily the most equitable method with water.

(12) As problems are often acute in one area, and non-existent in others, consideration should often be given to some form of zoning, or establishment of critical water areas. Decisions on licences should be made at as local a level as possible.

(13) If it is necessary to withdraw licences for abstraction because of expanding urban development, or for other reasons, adequate compensation should be paid to licence holders.

(14) There should be adequate right of objection to the granting of licences.

(15) There should also be adequate right of appeal against decisions by a licensing authority.

(16) Maintaining purity of water supplies and control of effluent disposal are often problems associated with control of water.

(17) Soil conservation work is also very closely allied to water conservation and control.

PARTICULAR PROBLEMS OF IRRIGATION

(1) The necessity to give a farmer a firm enough right to water to warrant considerable capital expenditure and a re-organization of farm programmes and layout—this is the outstanding problem in relation to irrigation.

(2) Overall planning is necessary to permit the best engineering design and the widest spending of capital from an individual and national point of view.

(3) In the interests of not rendering land unproductive for all time, consideration should be given, where practicable, to the use of the same channels, or existing channels, for several uses.

(4) It is necessary for the controlling authority to have power to restrict abstraction in an emergency, but once licences are granted restriction should be resorted to only in the most exceptional circumstances.

(5) The farming industry should have adequate representation on any controlling body.

With the passing of the Water and Soil Conservation Act 1967, we have a measure that should allow comprehensive planning to meet the needs of all members of society. I believe that both the national councils and the two Canterbury regional water boards deserve congratulations on the progress that has been made to date. There is now the machinery to allow us to plan for the future. I suggest that now is the time to start in earnest.

To quote S. G. Hamblett, Senior Design Engineer, Ministry of Works, Christchurch, as reported in the *Christchurch Press*. "There is no possibility of finding a single, simple solution to Canterbury's water problems and the present attempts to find local solutions to individual problems are likely to continue indefinitely.

"How much better it would be if these local attempts would all be co-ordinated within the frame-work of a long-term, overall, water resource development plan; a flexible plan that would allow for various stages to be undertaken, each as its cost was justified; a plan that put each stage in logical sequence considering both immediate and long-term benefits; a plan that catered for needs of all water users with management of storage and power generation; a plan that allowed unpolluted water to flow in rivers abounding with fish and eventually for every acre of drought prone land to have access to its own regular supply of water.

"Is such a plan possible?

"Quite certainly it is, but such a plan will need the co-ordinated efforts of a host of specialists."

Hamblett concludes his paper thus: "At this stage we need a plan. A plan that marries the soil and water resource surveys of the past and the present to our hopes of a splendid future for Canterbury."

Minimum Flows

One of the first basic steps in irrigation planning is the determination of minimum flows, and these can be determined only by an examination of flow data over a period of years. The record low flows experienced over the past few years have provided extremely valuable information in this respect.

Minimum flows will be necessary for allocation purposes, but in many instances in time of shortage, careful management of resources depending on the particular circumstances prevailing at the time may be the fairest method. There is a strong and just case in times of emergency for adversity to be shared by all users, but, as pointed out earlier, we must manage our resources in such a way that emergencies do not become an annual event.

Social Effects

The record low flows measured in the past few years have also drawn attention to the social implications of water shortages, where the necessity for restriction has caused some conflict between farmers themselves and between farmers and other sections of society. No member of society enjoys having restrictions placed upon him, whether he be a homeowner wishing to use his garden hose, a business man in pursuit of leisure, or a farmer whose daily livelihood is affected.

In these situations it is logical to examine means of improving the supply, and in most cases some round-table discussion between interested parties is a good first step.

As Burton (1970) points out "In this type of situation the objective of future water development may have to be increased resource utilisation efficiency, perhaps at the expense of dollar efficiency." Johnson (1970) stated "The rule for expansion of supplies simply states that the marginal value in use of water should be in excess of the long-run marginal cost of supply, which means that if the demand for water has increased such that consumers will pay the extra cost of delivering it to them, then capacity should be enlarged." I agree completely. Even if the cost is greater, if a reliable supply of water can be provided in a particular area this obviates conflict, eliminates the accompanying social problems, and allows farmers to plan their capital expenditure and farm programmes to take full advantage of irrigation. We should strive constantly towards this goal.

It must never be forgotten in water resource planning that we are dealing not only with water but with people. The greatest benefit that irrigation can confer is a feeling of security, which in turn gives peace of mind—the greatest benefit of all. If borrowing finance for irrigation development is based on a short-term water right, there is neither confidence, security, nor peace of mind.

Because farming involves a constant battle with the elements, irrigation offers a fascinating and stimulating challenge. I speak of many farmers when I say they are keen to adopt techniques such as irrigation which will improve their productivity; they also desire to live at peace with their neighbours, and at peace with society, of which they are an integral part.

Resource Utilization Efficiency

Improved resource utilization efficiency can take the form of improved water use efficiency, by more efficient application techniques, elimination of wastage, or by increased conservation to iron out the effect of minimum flows. This can be achieved by storage projects as in many overseas irrigation schemes. If such projects are well planned, greater sporting and recreational facilities can also be provided. In this respect the proposals put forward recently by Dr I. D. Blair deserve consideration. In many instances integration of hydroelectric power and irrigation projects ensures the best use of both water and capital.

I will never forget the sight of a bulldozer working in the fens of Cambridgeshire in the United Kingdom excavating a reservoir for spray irrigation eight acres in extent. This was land worth at that time \$600 per acre and capable of growing 80 bushels of wheat per acre without nitrogen.

And yet here in New Zealand, where irrigation need is far greater, we have the spectacle of a major river, the Rakaia, capable of irrigating perhaps one-third of a million acres without considering storage, flowing out to sea untouched.

In many areas we have a long, long way to go before we see full development of the easily developed free flowing sources.

Underground Resources

There are in some parts of Canterbury considerable resources of underground water. The extent of these resources is in many areas largely undetermined. Regional water boards must have the power and the financial resources to enable them to explore the extent of these supplies, particularly where they obviously exceed the requirements of the overlying country and could be used to boost supplies in adjacent areas where water shortage prevails.

Value of Irrigation

In a recent study, Brown (1971) examined a particular water resource (the Opihi Catchment) in relation to its value to the nation, the region, and the individual farmer. He assessed the national benefit, representing the real contribution to national income accruing from the scheme, as \$34,250 per annum; the increase in net post-tax income to the farmers in the area as \$34,650, and the probable magnitude of the regional benefits as being in the vicinity of \$59,000. He pointed out also that these results could be increased substantially.

All members of society would be well advised to ponder the significance of these proportional benefits.

In recent years we have witnessed tremendous government spending on removing our natural resources of hydroelectric power from the South to the North Island and this is likely to continue. We have witnessed companies transferring large sections of their manufacturing industries to the North Island. We have also witnessed staggering rises in freight rates between the two islands. Unemployment figures in Christchurch at present are higher than practically any other area in New Zealand. If these trends continue they can affect the level of confidence, the level of investment, and the general welfare of all sections of the community. I believe that in these circumstances the South Island has a strong case on both social and economic grounds for a substantial share of government money to be made available for the development of irrigation projects.

It is the story of the chicken and the egg. If we delay irrigation development we prevent the establishment of the industries based on that development, where a reliable supply of high-quality produce is necessary to ensure a sound investment, and we deny ourselves the opportunity of developing further export markets for these products. Cost-benefit analyses do not always consider these facts. Experience in mid-Canterbury over the past three years with the establishment of a lucerne processing industry has shown just how important irrigation is in ensuring that overseas commitments are fulfilled, in order that long-term export opportunities are developed to the full.

The future prosperity of Canterbury is largely based on the agricultural industry and its associated servicing industries. It is up to both town and country to work together to ensure that natural resources for expanding our agricultural industry and expanding secondary industry based on it realize their full potential. This development will not be cheap, nor will the development phase be easy, but the overall benefit to the whole community will be enormous.

Two outstanding papers presented to this conference by practical farmers clearly demonstrate the economic worth of irrigation development. Analysis of these farmers' water usage and their financial results can give a useful guide to future planning.

After 14 years' experience, during which time he has expanded the capacity of his pumping units to fit his requirements, S. J. Morrow, one of the most capable and experienced spray irrigators I know, working on some of the heaviest and most retentive soils in Canterbury, finds that even with a good range of crops and sowing dates to spread peak demand, his irrigation plants are fully extended at the time of year that determines his income to cover 370 acres of crop watered, working 14 hours per day with a flow of 1 cusec per 100 acres. A. G. Wright has shown that his programme, at present using approximately 1 cusec per 125 acres, with spare water available, will, if taken to full development, require 1 cusec per 100 acres. He has expressed concern about the availability of this water. Mr Wright has also shown that he has been able to adopt a management system with irrigation that would not otherwise have been possible.

Allowing for the fact that top performances are being considered, it can be deduced that at present rates the net value of 1 cusec of water to agriculture is in the range of \$1,000 to \$2,000 per annum, assuming a duty of 1 cusec per 100 acres. Brown's findings and other studies bear this out. A study of the water resources of the Mackenzie Basin (Inter-Departmental Committee 1966) showed potential gross figures of \$4,000 to \$8,000 per cusec which compared very favourably with returns from hydroelectric power development. Use of water in horticulture can be shown to return values of up to \$30,000 per cusec. As our agriculture steadily intensifies, per-cusec returns will increase accordingly.

Importance of Cropping

Arable cropping in Canterbury has emerged as a significant part of our agriculture. As New Zealand's population rises, cropping land will be called on to produce much more in the future. An ideal harvesting climate, flat topography, and considerable water resources make Canterbury an area ideally suited for further intensification. Average yields of arable crops rank as some of the highest in the world and irrigation offers great potential for raising them still further. We have for many years been selling peas and herbage seeds competitively on world markets, and, given proper promotion, this trade is capable of expansion. We have this season been exporting barley and have the capabilities, given adequate port facilities, to produce and sell much more.

The per-acre value to New Zealand of these arable crops in overseas exchange is equal to, or exceeds, that of alternative livestock production from the same land. The integration of intensive arable production with livestock production, utilizing stubbles, crop residues and grazing from small seed areas, enables higher per-acre carrying capacities per available grass acre.

A few years ago we witnessed the effect of the imposition by France of a high tariff on our herbage seeds; this virtually

killed a developing export trade to that country. This year a substantial lowering of that tariff has enabled considerable quantities of seed to be exported at satisfactory prices.

If we are to continue to intensify the production of arable crops, I believe it is important, when Government is endeavouring to make satisfactory access arrangements for the export of our primary products, that arable exports are not overlooked.

The Future

There is a widespread demand from farmers for further irrigation development covering a very wide area. Farmers are asking for action, not talk.

A thorough review of all aspects of irrigation policy has recently been carried out by a Committee of the Water Allocation Council. This was a good planning decision and some sound recommendations were made. It is to be hoped that these recommendations will form the basis of an early announcement of an imaginative, positive, and clear-cut policy for future irrigation development.

What other agricultural investments are there that will give benefits comparable with those outlined by Mr Wright and Mr Morrow? What other investment can provide such a tangible and lasting asset? What other agricultural investment is capable of doubling production on a million acres of land?

Private enterprise can cope with most other forms of agricultural investment, but in areas where large-scale irrigation schemes are practicable, private enterprise cannot proceed until there has been government participation in off-farm works.

Throughout this paper I have endeavoured to stress that our water resources, which belong to the people of New Zealand, should be developed to the full for the benefit of society. We are one society, one people. Our future is bound up together. We should be working together with a common aim, the betterment of our standard of living, and the betterment of our way of life.

My plea is for greater understanding and appreciation of the value of irrigation to the nation, the region, and to individual members of society. When most beneficial use of water is being considered in the interest of society, agricultural use has a very strong claim for high priority.

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A COMMENTARY ON IRRIGATION

Review of Papers

W. R. LOBB

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My first impression of the papers on irrigation was the excellence of the two farmer papers. They present the case for irrigation without embellishment—obviously no overstatements. They confirm that irrigation is *the thing*, not the method of applying it. They confirm also that correcting soil moisture deficit is *the thing*, not the soil, nor its fertility, not whether it has stones or no stones—which allows me to say that all this confirms what Winchmore has always said, that soil moisture deficit limits production in Canterbury. It is noted that S. J. Morrow values his land at \$293 and A. G. Wright his at \$170, and I would agree this is about right. Irrigation, however, adds productive value to both. After irrigation these differences are likely to remain, at least for a long time.

If one can extract figures from papers presenting different information in different ways, one would deduce that Mr Morrow's property has a performance rating of about 20 bushels per acre of wheat, peas, barley and grass seed above that obtained by Mr Wright. This may be used by some as an argument for using water on the heavy rather than the light land. However, this would oversimplify the position and ignore many social aspects of far greater significance than the mere earning of dollars and cents per acre. It ignores the relative abilities of hundreds of farmers on light land to survive economic recessions, drought and grass grub. Such farms have little ability to manoeuvre as is pointed out quite strongly by Mr Wright. In the January 1972 issue of the *N.Z. Journal of Agriculture*, comments by Cameron *et al.* confirm this point. Further confirmation would no doubt come from those farmers in North Otago and lower South Canterbury, on light land without irrigation, who were brought to their knees by drought and who overwhelmingly voted for irrigation when they were given the opportunity to do so.

In discussing the use of water and how far it will go, one must not overlook certain essential factors, especially those of a practical nature. This is often an area in which those discussing irrigation with little knowledge of it, show their

weakness. Agricultural production is a gross consumer of water and must be treated as such. The three cases presented are all essentially different. Mr Morrow has to complete critical irrigation of some 370 acres of crops and needs all his available capacity of $3\frac{1}{2}$ cusecs to do this. Mr Cameron, referred to in Mr Frengley's paper, avoids a peak demand by a different spread of requirements and in doing so opens up the question of how much more valuable more water would be.

Mr Wright, on the other hand, uses more water during his peak demand periods than will be available when irrigators on his scheme are fully developed. Two things can happen—both logical, both tenable—one can devise a system to maximize the water available, or one can provide water for a maximized system for irrigating an area. The first is the development and short-term phase, the latter the long-term objective for the total irrigation of a region. (It envisages storage, it envisages the transfer of water between areas and uses, it requires a roster, irrigating for a 24-hour day, it emphasizes the need for automation, efficiency, co-operation between irrigators and others, willingness to create something worth while, and social awareness—points embodied in J. R. Cocks' paper).

Mr Wright makes a strong case for wild flooding to make use of the initial water available on a scheme such as his. There is no doubt that this is good business. He also recognizes that it is wasteful of water and labour and that he must progress to the controlled automated use in the long run. Despite this, however, he has been correctly advised by the Ministry of Works that should other farmers proceed with irrigation he will not be able to have adequate water for full irrigation. This information is timely and is relevant to irrigators in the Ashburton/Lyndhurst and Valetta areas where there is already a demand for water in excess of availability during even moderately dry periods.

A comment may be appropriate here with regard to the question of the amount of water required for irrigation. Working from principles of evapotranspiration, available soil moisture held in the root zone, rainfall data, soil temperature, soil structure, etc., it would be found that, for the majority of the areas, soils and climates in which Canterbury farmers are interested, the actual deficit in terms of rainfall would be no more than 8 to 12 in. Remembering that few farms can find their own water, and that for the vast majority of farmers requiring irrigation it is necessary to develop a large water resource and that the economics are in favour of large continuous flows, the availability of water from free flow systems would provide something like 5 ft of water if it were all used. There is therefore a very big difference between theory and practice and it is the practical considerations that will be the more important for a very long time.

Drought must be the greatest fear and the greatest retarding factor faced by the non-irrigator. In the *Christchurch Press*

of May 12, in a review of progress on the Glenavy-Morven scheme, R. G. Richards, Chairman of the local farmers' irrigation committee had this to say: "In the last five or six years I have spent more money on buying hay and grazing stock away from my property than would have been required to develop the whole of my farm for irrigation and I believe quite a fair percentage of farmers on light land would be in a similar position." Furthermore such spending was non-productive—it was non-additive—whereas had irrigation been provided it would have increased production and added value. This applies to quite a few of the means used to assist farming; they add nothing to the system; they are expediciencies but they are not creative or socially progressive.

Another illustration of the cost of drought was contained in the information sheet distributed at the Ashley Dene 1971 Field Day. The difference in production between drought and non-drought years was shown to be \$20 per acre. Furthermore, the cost of supporting excessively high stocking rates negated any advantages during periods of economic stress. Interestingly enough, a comparison of the Ashley Dene figures with those from Winchmore indicates that the increased margin to be obtained from irrigation is between \$20 and \$25 per acre, which confirms that irrigation about doubles economic production.

From a social viewpoint, economic considerations may be less important than is thought. However the cold hand of Treasury is not likely to be impressed with that argument. What Treasury should be made aware of, however, is that assistance to farming in one area is not necessarily or even likely to be the same as in another. This is where Canterbury farmers and Canterbury people as a whole have let irrigation and themselves down badly. Government has proposed grandiose schemes for afforestation, for soil conservation, subsidized topdressing, subsidized drenches, weedicides etc., and they have been accepted despite the fact that no great benefit can come from them. None of these measures has been subjected to the investigations imposed upon those requesting irrigation schemes.

It is surprising at a conference with a theme of low-cost farming that there is not a paper from an irrigation farmer dedicated to taking advantage of one of the truly great benefits of irrigation for light land—low-cost pastoral farming. For high stock production irrigated pastures are permanent—they do not require renewal. Winchmore has adequately demonstrated the productive capacity of truly permanent pastures for lamb, wool and beef production. It has shown that pesticides, weedicides, vaccines, drenches, footrot control, high fertilizer rates, nitrogen, lime and such adjuncts that might be expedient in other cases are certainly not necessary on a well-managed irrigation farm. The potential to carry up to 9 ewes or 2½ weaner beasts for total year-round production is there. Perhaps Canterbury farmers do not appreciate what

little equipment and finance are needed to run such a farm—an old tractor and a mower, a truck for the convenience of feeding out a very limited amount of hay and for lambing—and that is about all. (Half-a-dozen clocks and irrigation gates costing about \$150 do the work of thousands of dollars worth of equipment common on many Canterbury farms.) However if one wishes to farm in the typical Canterbury fashion, irrigation is no hindrance as is well illustrated by Mr Wright and Mr Morrow.

Both these farmers, as does Mr Cocks, point out the major advantages of irrigation, the predictability of production, the increases in production, the means for diversification and the freedom from the worry of droughts.

I do not intend to make an issue of the problem of grass grub introduced by Mr Wright but I would like to correct a wrong impression. Apparently there is a general belief that I claim that irrigation is a control for grass grub (I have reviewed another paper this week claiming the same thing). On the contrary I believe irrigation will support a high grub population. What I have said is that a well-managed, efficiently-irrigated farm with old permanent pastures will support a very high stocking rate—up to 9 ewes per acre—in the presence of high numbers of pasture pests including grass grub, porina, weevils, wheat bug, case bearer, the lot. Quite a lot is known about what is happening to the populations of these insects under such a system and it is because of this that I believe far too many aspects of research lack critical examination in the total system to which they apply.

Establishing any irrigation system has now become a costly business, and those farmers who took the opportunity to develop at the low costs ruling up to two or three years ago have made a significant gain. However, from both Mr Wright's and Mr Morrow's examples, it appears that they consider the investment is justified, even at present costs.

This would be borne out by many other examples. There is no doubt that some of the advantages of irrigation have been lost owing to today's high costs of equipment, on the one hand, and land development on the other. To those who have to borrow money the issue may become debatable. In this respect, the irrigation committee of the Water and Soil Authority is to be commended for its positive thinking in recommending assistance for on-farm irrigation development—this could in fact be the most important single factor in assisting the development of Canterbury in the future.

In reviewing Mr Morrow's paper one cannot but wonder at his illustration of the clearcut economic benefits of an irrigation system that costs so much to operate. When his case is compared with those of irrigators who pay less than 1/20th of this to operate their systems, but cannot make them pay, one wonders about the use to which figures can be put.

Although I think all four speakers intended to convey the message for the furtherance of irrigation, I was a little dis-

appointed that none indicated what should be done. Mr Frengley's paper did not clearly define on which side of the fence he wishes Lincoln to stand, the dry side or the wet one. One shortcoming that Lincoln can help to rectify, however, is in the training of skilled technique and management advisers to go with the sound economic planning of future irrigation schemes. No one in the past has "sold" irrigation to farmers. I do not blame the Ministry of Works for this; it was surely a Department of Agriculture responsibility to do so. In fact within their schemes today, they are not in a position to do so because there are no terms on which they can.

Table 1 in Mr Frengley's paper states what might appear to be the obvious, that no matter what farm practices are adopted there will be considerable differences between the performance of individuals even where conditions and opportunities are similar. Mr Frengley makes the point that with irrigation farming this will still be so. Secondly, the table shows that larger farms are less inclined to produce maximum per-acre efficiencies, and this again is what one would expect. The introduction of irrigation to such an area will decrease the need to exploit the full potential of the area still further, because in effect it has doubled the actual potential of each acre. This need not be taken as a reason for not proceeding with a costly irrigation scheme. It does mean, however, that development and the exploitation of the potential will be slower and the planners in establishing such a scheme must take this into account. The past history of mid-Canterbury schemes is an excellent example of what will happen where insufficient thought is given to this aspect. Despite this, a long-sighted approach based on an equitable charge, extension of services to provide information on all efficiency factors, and a government policy to assist rehabilitation and development (and to resist unnecessary amalgamation) could make a scheme very worth while in such circumstances. The third point is that the table establishes a much more reliable estimate of what dryland actually does produce. It is much more realistic than the figures generally quoted.

I feel, however, that the whole paper is an indication that the Rakaia area is used by too many too much as the cornerstone for determining the future of irrigation in New Zealand, and that it is time some other areas were given consideration. Consider, for instance, the great difference inflated land values have made to the economics of farming dry areas around Christchurch and Lincoln. How can one farm these small units at \$500 to \$800 per acre without a means to increase their productive capacity?

The social implication of extending large irrigation schemes in New Zealand are considerable. J. R. Cocks has provided a first-rate assessment of the conflict between water users, the provisions of water rights, the need for individual and national planning where the establishment of a water source is beyond

the capabilities of an individual, which is usually the case, and has gone to some length to establish the value of water to the agricultural producer.

Perhaps one of the social aspects that needs more emphasis than was given is the relationship between irrigation and the opportunities it opens up for more young people both on the land and in the industry. As a case in point, one could examine the progress in the area served by the Ashburton/Lyndhurst scheme compared with that of similar areas without irrigation. It seems certain that future generations will benefit from, and contribute more, to irrigation that has been the case with present and past generations. It is rare, for instance, to hear today's generation speak in downright opposition to irrigation, citing social and economic disaster as a consequence of it, as was so frequently done in the past. There is considerable satisfaction in taking visitors, particularly visitors from overseas irrigation areas, through the Ashburton/Lyndhurst irrigation area. They are generally amazed at the progress that has been made. And yet a statement of this nature made in 1970 referred directly to that area.

It is becoming increasingly apparent that many areas want and must ultimately have irrigation. We need a responsible government body that is prepared to accept this. We want a panel of far-sighted, practical men with strong industry support that is prepared to give impartial judgements on the vital questions of where and how irrigation development should proceed. We want acceptance of a charging system for irrigation services that will provide the means of operating and maintaining irrigation, and of obtaining what other contributions are required, by an *informed* Treasury, and we need to provide an incentive to encourage development and the effective use of irrigation. We should have the long-term interest of the industry and its people in view. The setting up of such a system should not be beyond our capabilities especially in view of the examples presented in the papers reviewed here.

It is encouraging that some positive steps are being taken and the policies for dealing with water as a national resource are at last being given consideration. I am sure improvements will arise from experience, and that Government, catchment authorities and local authorities will respond to wise counsel and leadership dedicated to providing worthwhile opportunities for our future wellbeing.

SOIL TESTING AND INTERPRETATION OF RESULTS*

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Soil testing involves the chemical testing or analysis of soils, by simple, rapid means, and the interpretation of the results. It provides information for farmers on possible reasons for poor productivity of plants and/or animals (*i.e.*, it has a diagnostic role), and the amounts of lime and fertilizers needed.

Different people expect very different things from soil testing. Someone once said that the values attributed to it ranged from "a psychological boost to extension workers" to "a unifying management cure-all", which allows a fair amount of scope. Actually, its value lies somewhere in between. *Competent* soil testing can make a valuable contribution to greater productivity and the efficient use of fertilizers.

DIFFICULTIES IN SOIL TESTING

Phosphate is a nutrient deficient in soils the world over and the one most commonly tested for. Many years ago a survey of 54 principal soil-testing agencies in the United States showed that between them they used 27 different solutions to extract the soil. This may be interpreted in various ways but perhaps the most logical is that the scientists involved, working in their own areas, on different soils, perhaps with different crops, honestly considered that their particular method was best for their own conditions; and they may have been right. This example is used to emphasize the point that a soil test may perform admirably on one group of similarly constituted soils but fail on another. In New Zealand it has been known for several years to soil scientists—and longer to some farmers—that the standard phosphate test (Truog) does not work on some soils; it gives fictitiously high tests. Incidentally the soils involved are largely those farmed in Canter-

*Paper presented at the Dairy Farmers' Field Day, held in association with the N.Z. Dairy Board, during the Conference.

bury by dairy farmers. A different test has been in use for these soils for some time now and has given better results. It is perhaps of interest that research work on soil phosphorus, not originally prompted by any thoughts of soil testing, has led to an understanding of the reasons for the failure of the earlier test procedure on these soils.

Recently, researchers at Ruakura Agricultural Research Centre have found that available phosphate in their soils is appreciably higher in spring than in summer and autumn. The time of year at which samples are taken should therefore be considered in the interpretation of soil tests.

It is well known that different management systems or different stocking rates may greatly influence the productivity from a soil at the same input of fertilizer. In general, this should not alter the optimal fertilizer recommendation, because the extra productivity is really a reflection of the efficiency of use of the extra feed grown, but it does show that there are factors involved other than faulty soil-test recommendations that may explain the different results achieved by different farmers.

On the same soil type but at two different sites Ruakura workers found that the optimal rate in one season was 0 lb phosphorus per acre, while in another season it was 40 lb/acre ($\approx$ 4 cwt/acre superphosphate). Both sites had "high" phosphorus status. This difference was due to climatic and management differences, not to errors in soil tests. What it means, however, is that all the adviser can do is to aim for an "average optimal rate"—in this case, 20 lb phosphorus—knowing that if this is applied there should be no serious loss in production through shortage of phosphate.

It may be possible to improve phosphate testing by using two tests in conjunction. The first is the ordinary type test, the other is designed to measure the phosphate fixation or retention of a soil. The way that these tests could be used is shown in Table 1.

TABLE 1: FERTILIZER NEEDED (lb P/ac)* FOR NEAR MAXIMUM PRODUCTION

<i>P. Retention %</i>		<i>Soil Phosphate Test (P Status)</i>		
		<i>Low (0-4)</i>	<i>Med. (5-8)</i>	<i>High (9-16)</i>
Low	0-30	Variable	10-15	<10
Medium	31-60	40 (44)†	20 (22)	10 (11)
High	61-85	60 (67)	30 (34)	15 (17)
Very High	86-100	80 (90)	40 (45)	25 (28)

*1 cwt superphosphate supplies 10 lb phosphorus.

†Figures in parentheses, kg/ha.

This idea recognizes that the property of phosphorus retention is important in affecting the availability of applied phosphate. It also accepts the fact that once the phosphorus

status of the soil has been built up (by previous applications of fertilizer) it takes less phosphate than before to maintain a good supply to plants.

Looked at another way, it also means that the drop in production will be less serious on soils of good phosphorus status than on soils of low status, if for any reason fertilizer application is missed for a season. The concept is somewhat like a water supply system—the bigger the back-up tank the easier it is to maintain a constant head in the supply pipe.

SOME POINTS OF INTERPRETATION

What does a Truog soil test of 3 phosphate units mean? It means that the soil has low phosphate status and that production will suffer considerably if phosphate is not applied.

For a Paparua sandy loam on the Canterbury plains testing 3 units of phosphate, the amount to be applied for optimal production will be about 2 cwt/acre superphosphate. Once this amount has been applied, it is often thought that the phosphorus test the following year will be distinctly higher, but normally it is not. After several years of regular application, however, it will gradually build up, as was the case at Winchmore Irrigation Research Station in a trial carried out from 1952 to 1957. After applying $1\frac{1}{2}$ cwt/acre superphosphate for 6 years, the phosphorus test rose from 3 to 5; where 3 cwt/acre was used, it rose to 8. Eventually a point may be reached where the soil test is 12. There are then two alternatives. Since the soil phosphorus status is now "high", the complete omission of fertilizer will not be serious, and round 90% of optimum yield can be expected on Paparua soil. Alternatively, the use of not more than 1 cwt/acre superphosphate will ensure adequate phosphate for optimal production.

Work is proceeding on alternative phosphate tests and a new test is imminent. This should enable better assessment of phosphorus status of a wider range of soils. Various phosphate tests have also been evaluated for specific crops such as ryegrass and potatoes and this may eventually lead to more specific recommendations for these and other crops.

A common approach in the conduct of fertilizer rate field trials is to standardize the conditions of the trial, *e.g.*, nutrients under test, rates of application, over a range of soils of similar constitution. This is very sound and will eventually lead to a very sound basis upon which to base recommendations.

The greatest lack in advice on phosphate (or any other) fertilizer concerns the maintenance requirement under grazing conditions. This is a very difficult problem, but it is being investigated at least on a range of about 10 important and widely-occurring soils. Trials embodying different rates of fertilizer, coupled with different stocking rates, are being carried out and again will lead to basic information for the soils concerned. Moreover, thanks to Soil Bureau and soil

researchers generally, our understanding of how and to what extent one soil is related to another will enable the information to be extended to other soils not actually tested. It should be realized that trials of this kind are very costly of time, men and money and this precludes their being carried out on many soils. The connection between soil test values and pasture yield relative to maximum yield, based on average results over 15 years from a Winchmore trial on Lismore soil, is shown in Fig. 1. It will be seen that 90% of maximum yield can be obtained at a soil test value of about 6. It requires $1\frac{1}{2}$ cwt/acre superphosphate to maintain the soil test at this level.

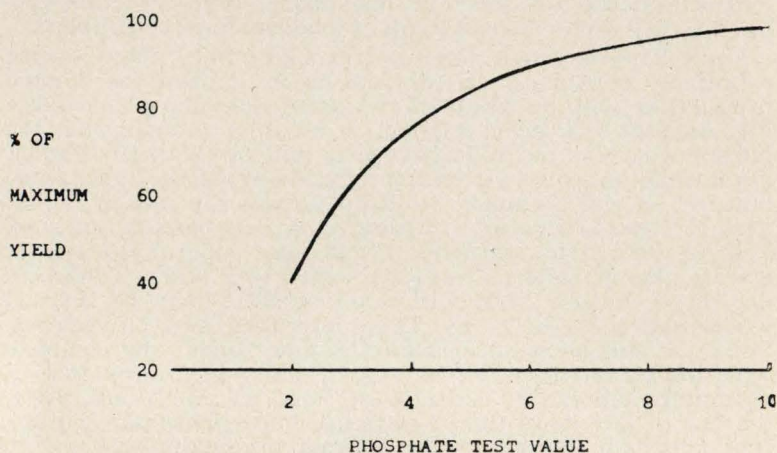


FIG. 1: Phosphate test value and pasture yield relative to maximum yield (based on average results over 15 years from a Winchmore trial on Lismore soil).

For some years there has been a persistent search for a soil test for sulphur. A reasonable test may not be far away, but its interpretation will probably need background information on the sulphate-retention power of the soil and the amount of sulphur derived from the atmosphere arriving in rain.

Work is also proceeding on a soil test for nitrogen, more particularly for use with crops such as wheat and maize. Not enough research has been done in New Zealand on the ability of soils to supply nitrogen to plants. Work by T. E. Ludecke, Soil Science Department, Lincoln College, reported in these *Proceedings*, aims at filling in some of the gaps in our knowledge, especially in regard to wheat.

Space does not permit discussion of the other elements tested for on a regular basis, namely calcium, magnesium and potassium. In my view there are still insufficient basic data to

be happy about testing for trace elements, although there are tests available that could almost certainly sort out grossly deficient soils from well-supplied ones; for example for boron, and possibly copper, for plants. Unfortunately it is the soils in between that cause the problems. It is no accident that so few official soil-testing agencies throughout the world test soils for a range of trace elements on a regular basis. While in most cases there are other, usually better, ways of diagnosing trace element deficiencies, such as plant analysis, analysis of animal organs and clinical symptoms, it would be very useful to have a soil test for the more significant trace elements, since only soil testing offers hope of anticipating deficiencies, and prevention is surely preferable to cure.

SOIL TESTING IN NEW ZEALAND

Currently the Department of Agriculture tests about 30,000 soil samples annually on a fee-paying, advisory basis. Another 22,000 come from research projects, many concerned with fertilizer trials. There has been a slow increase each year in numbers tested. An unknown number is tested by other agencies. Allowing another 30,000 from these sources, the total of 60,000 advisory samples, from 60,000 farmers in the country, *i.e.*, one per farm per year, hardly qualifies as intensive use of soil-testing services (3,600 of the 30,000 tested by Department of Agriculture came from horticultural properties).

The fact that private or commercial soil testing is so active suggests that there is a considerable demand for testing. One wonders, then, at the attitude of the Department of Agriculture which seems not to want to actively promote interest and participation in soil testing. In New Zealand something like \$50 million is spent annually on about 2 million tons of fertilizers.

If, instead of being granted a fertilizer subsidy of \$7.50 a ton, a farmer received \$7.25, there could be $\frac{1}{2}$ million, or about 1% of the fertilizer bill, available for fairly direct application to the problems of ensuring that the \$50 million worth of fertilizer is being efficiently used. This could go to support research on problems associated with soil testing and fertilizer use, more field trials, more staff, and to ensure that data from the very substantial research at present being undertaken are available, *and used*, to establish basic relationships between soil tests and fertilizer responses, measured more in terms of animal production than in terms of pasture growth.

While I believe that the results from soil testing are capable of more precise interpretation under simple cropping systems than under pastoral systems, and while I know that a soil test alone should never be the sole piece of information upon which to base a fertilizer recommendation, I feel sure that if more money, effort and enthusiasm were injected into the system they would eventually pay off in terms of wider cover-

age, more efficient use of fertilizer and a more contented clientele.

SUMMARY

Competent soil testing can make a valuable contribution to greater productivity. There appears to be a need for an extension of the official soil-testing services, and for those that exist to be better publicized.

To satisfy this need would require more staff and experimentation. The possibility of approved, supervised, private soil-testing organizations, as used in some American states, might be considered.

HOW IMPORTANT IS THE QUALITY OF HAY FED TO LACTATING COWS? *

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FEEDING FOR MAXIMUM MILK YIELD

Experienced and knowledgeable cowmen know there are no mysterious or secret formulae for obtaining maximum yields from dairy cows by good feeding practice. Provided the animal has the capacity to produce, the principles are to keep the bulk of the ration down to about 40% of the dry matter (DM) intake, maintain an edge on appetite by feeding 80 to 90% of *ad libitum* intake, ensure the protein content of the ration is about 16% of the DM (not too greatly in excess of this), and that 60% of the ration consists of milking feeds. Thus we hear of North American rations based on corn silage, meadow and legume hays, with concentrate supplements (corn, oats or barley, bran, mollasses, soya bean or linseed meal) making up the milking portion of the diet. A Scandinavian ration might include a break of pasture, meadow hay, fodder sugarbeet, and a grain-based concentrate supplement. However, in a total ration of 45 lb DM per head per day, pasture and hay would make up only 18 lb DM.

The economics of dairying in New Zealand, together with the fact that it is a long, narrow island(s) and has a temperate climate, necessitates the utilization of grass pastures and hay made from such pastures, for milk production. This means that cows are fed on bulky rations in this country. Only in the few herds where large quantities of crushed barley supplement are fed would New Zealand farmers approach the intensive feeding practices of many of their colleagues in the northern hemisphere.

COMPOSITION OF PASTURE

The DM, protein, and fibre content of ryegrass-white clover and lucerne pastures are given in Tables 1 and 2, respectively, according to stage of growth. Pasture quality decreases as the plants mature and it can be seen that this is related to in-

*Paper presented at a Dairy Farmers' Field Day, held in association with the N.Z. Dairy Board, during the Conference.

creasing quantities of DM and fibre (the stiffening structural material in plants) and decreasing amounts of protein. On the basis of protein and fibre content, lucerne is superior in quality to ryegrass-white clover pasture particularly at the haying stage of growth.

TABLE 1: COMPOSITION OF RYEGRASS-WHITE CLOVER PASTURE

<i>Stage of Growth</i>	<i>DM (%)</i>	<i>Protein (% of DM)</i>	<i>Fibre (% of DM)</i>
Short leafy	16	27	17
Long leafy	18	21	20
Pre-flowering	20	16	26
Flowering	22	11	30
Post-flowering	24	8	34

TABLE 2: COMPOSITION OF LUCERNE PASTURE

<i>Stage of Growth</i>	<i>DM (%)</i>	<i>Protein (% of DM)</i>	<i>Fibre (% of DM)</i>
Short leafy	14	28	13
Long leafy	15	25	19
Pre-flowering	16	20	24
Flowering	20	18	27
Post-flowering	25	16	31

SUBJECTIVE ASSESSMENT OF QUALITY IN HAY

Subjective assessments of hay quality are based on such things as colour, smell, texture (feel), sappiness at cutting, leafiness, preference by cows (palatability), time of baling, mood of the farmer, etc. However these parameters may not be consistently related to the performance of milking cows and have some relevance only when comparing lines of hay that are equal in nearly all respects but one (perhaps two). They have become part of the mumbo-jumbo concerning hay and haymaking in many of the conversations conducted by members of the rural sector (including those servicing the industry).

In the long run, subjective assessment must relate to the chemical composition, digestibility, and voluntary intake of hay by cows and hence to its nutritive value. It can be seen from Tables 1 and 2 that stage of growth of pasture plants can readily be indexed by the protein and fibre content of the DM. In addition the fibre content of roughages is inversely related to voluntary intake, although, at a given quantity of fibre, voluntary intake increases the better the protein status of the ration because of increases in digestibility. Therefore the question becomes—what subjective parameters relate to nutritive value?

RESULTS FROM A SURVEY OF HAY FED TO LACTATING COWS

A survey of hay being fed to lactating dairy cows in mid-winter by Christchurch town milk supply farmers was conducted over the period June 25 to July 5, 1971. The survey took the form of a questionnaire, sent to all suppliers of Canterbury Dairy Farmers Ltd., concerning hay-making procedures adopted and the type and quality of the hay ready for winter feeding. Fifty-seven per cent of suppliers (95 farmers) replied to the questionnaire, and 31 farmers were subsequently visited to have their various lines of hay sampled for chemical analysis. The results of the survey are as follows:

(1) Farmers had on hand an average of 65% meadow hay, 28% lucerne hay, 7% other hay (red clover, oaten, subterranean clover, 'Grasslands Tama' ryegrass) for winter feeding. The proportion of lucerne hay in the total hay crop increased as one moved from north of Christchurch to the south. Two per cent of farmers had all lucerne hay compared with 18% who had all meadow hay.

(2) Meadow hay was cut at all stages of growth, but particularly the flowering stage, while lucerne was almost invariably cut at the pre-flowering stage of growth. The effect of this on the protein and fibre content of the hay is shown in Table 3.

TABLE 3: COMPOSITION OF HAY ACCORDING TO STAGE OF GROWTH AT CUTTING

Stage of Growth	Meadow		Lucerne	
	Protein (%)	Fibre (%)	Protein (%)	Fibre (%)
Pre-flowering	9.4	36.2	18.2	33.6
Flowering	9.3	41.1	—	—
Post-flowering	7.7	40.9	—	—

(3) Thirty-five per cent of farmers north of Christchurch and 55% of those south of Christchurch used a conditioner after cutting. Since conditioning was closely related to the quantity of lucerne hay harvested, and as it did not appear to affect the composition of a given type of hay (Table 4), it was concluded that the differential drying rates of lucerne leaves and stems were uppermost in the minds of producers.

TABLE 4: EFFECT OF CONDITIONER ON COMPOSITION OF HAY

Treatment	Meadow		Lucerne	
	Protein	Fibre	Protein	Fibre
Conditioned	9.0	38.4	18.1	32.9
Not conditioned	9.5	40.9	18.1	34.1

(4) Eighty-five per cent of farmers raked their hay, as distinct from tedding, wuffling, or using the centipede, and 31% both used the rake and one other of these implements.

(5) All but 2% of farmers provided some cover for their hay, 71% using the open barn and up to 30% a closed-in barn for storage.

(6) The average protein and fibre content of the various hay samples is given in Table 5. It should be noted from Table 5 that even the poorest quality lucerne hay is still equal in protein content to the best meadow hay samples. There are also tremendous improvements in quality as the content of legume in grass pasture hay (*e.g.*, red clover and subterranean clover hay) increases.

TABLE 5: COMPOSITION OF VARIOUS TYPES OF HAY

<i>Hay</i>	<i>Protein (%)</i>	<i>Fibre (%)</i>
Meadow	8 (4-13)	39 (32-52)
Lucerne	18 (13-21)	34 (26-42)
Red clover	15 (12-16)	34 (33-35)
Sub. clover	15 (one sample)	26 (one sample)
Oaten	8 (one sample)	34 (one sample)
Tama	7 (one sample)	31 (one sample)

FEEDING TRIALS WITH LUCERNE AND MEADOW HAY

The value of lucerne hay as a basal ration for milking cows, compared with that of meadow hay, was tested in a feeding trial with mixed-age autumn-calved cows during the winter of 1971. In all, three experiments were conducted:

- (1) Lucerne compared with meadow hay alone;
- (2) Lucerne hay plus 10 lb low-protein meal compared with meadow hay plus 10 lb low-protein meal;
- (3) Lucerne hay plus 10 lb high-protein meal compared with meadow hay plus 10 lb high-protein meal. The cows had access to limited pasture pickings besides hay or hay plus meal.

Twenty-four cows were used, randomized into groups according to yield, but to some extent they were also grouped according to whether they would consume meal. For example, 6 of the cows in the first experiment (hay alone) would not eat meal and several of the cows in the second comparison would eat low-protein meal but not high-protein meal. Therefore it is invalid to compare results between each experiment because there is certain bias in each experiment according to whether cows liked meal or not.

In the pre-experimental period, after calving, cows were fed autumn-saved pasture, some lucerne and meadow hay, and they were offered limited quantities of meal at milking. In the experimental periods of 12 weeks, groups of cows were fed either lucerne or meadow hay for the first 6 weeks of

winter and during the last 6 weeks the basal rations were changed over. Those fed lucerne were then given meadow hay and the meadow hay-fed cows were given lucerne. This change-over design has the effect of doubling the number of cows given a specified ration during the experiment.

The average protein content of the hay and meal fed during the experiment is given in Table 6. This means that the percentage protein content of the total rations fed to the cows (all with the addition of some grass) would be approximately: Lucerne hay, 18; meadow hay, 8; lucerne hay plus high-protein meal, 20; lucerne hay plus low-protein meal, 16; meadow hay plus high-protein meal, 14; meadow hay plus low-protein meal, 10.

TABLE 6: PROTEIN CONTENT OF HAY AND MEAL

	%
Lucerne hay	18
Meadow hay	8
High-protein meal ...	22
Low-protein meal	13

Table 7 shows the mean values for the milk yields obtained in each experiment where the comparison is made between lucerne and meadow hays. At the start of the experimental feeding period the mean yield for various groups of cows was 40 lb/head/day. Responses of the order of 3 lb/head/day to lucerne hay were obtained in experiments 1 and 2 but the mean milk yields differed little in experiment 3 when the high protein supplement was fed.

TABLE 7: MILK YIELD (lb/head/day)

	<i>Lucerne Hay</i>	<i>Meadow Hay</i>
Experiment 1		
(No supplement)	41	38
Experiment 2		
(plus 10 lb low-protein meal)	40	37
Experiment 3		
(plus 10 lb high-protein meal)	37	36

CONCLUSIONS

(1) Concerning the subjective assessment of the quality of well-made hay, the results of the present experiments indicate that the important parameters indicative of nutritive value are, in order, (a) Quantity of leafy legume present; (b) Proportion of leaf to stem (leafiness); (c) Colour (green, yellow, brown); (d) Texture.

The quantity of leafy legume is placed first because it sets the ceiling as to the potential chemical composition of the

hay and, particularly in the case of lucerne hay, the degree of leaf fracture during haymaking operations. If differences between lines of hay can be assessed on this basis, then there is no real need to go further. On the other hand, lines of hay equal in terms of leafy legume present can be distinguished by the proportion of leaf to stem. This will give an indication of the stage of growth when the hay was cut.

After cutting hay, respiration of the plant tissues continues until the material is dry. The slower the drying process the longer will respiration continue and greater losses of soluble constituents will occur. This causes the greenish colour, indicative of good quality hay, to change to that of yellow or brown. Bleaching, due to overdrying and also mild curing in the stack, causes hay to lose its greenish colour. This is associated with losses of nutrients, including protein, and the proportion of fibre in the dry matter increases. Leaching by rain with subsequent redrying also affects the colour of hay. Therefore colour is the next indicator of quality in the above hierarchy.

All things being equal to this stage, then texture can give some indication of relative fibre contents of different lines of hay and thereby voluntary intake.

Spoilage of hay, by storing when not completely dry, can result in overheating of the bales in the stack and the development of black patches and mustiness. Under these conditions a subjective assessment could be made on palatability or preference by stock that would override all of the stated parameters. However such hay would be classified as poorly-made hay, even though it was beyond the farmer's control. Indeed, if such hay does not become musty it is quite palatable, in spite of nutrient losses and a reduction in digestibility brought about by continued respiration.

(2) Legume hays, and in particular lucerne, contained adequate protein for the requirements of lactating dairy cows. Meadow, oaten and Tama hay were found to be wanting in protein and could be considered dry stock feed, or fed to lactating cows when their protein requirement is satisfied by another source (*e.g.*, grass pasture). In the absence of adequate protein intake, the capacity of the cow to produce milk will not be extended. This was indicative of the responses obtained to feeding lucerne hay in the last experiment.

(3) In the absence of significant quantities of pasture or greenfeed for winter milkers, it is suggested that town supply farmers ensure adequate quantities of legume hay be fed to cows as the basal ration if they wish to obtain responses to feeding crushed barley.

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