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THE FARMER AND TRANSPORT IN NEW ZEALAND

A. E. McQueen, Lecturer in Geography, Victoria University of Wellington.

In this paper I plan to look at the demand for rural transport services in two ways
— the nature of the demand for transport from the farm gate
— the demands from the processing plant to export port or to the point of consumption in the domestic market.

The second stage has been discussed in several recent reports devoted to examining the movement of our export goods to overseas markets. The first stage, however, has not to my knowledge been surveyed on a general scale, probably because the pattern of demand and commodity movement is so fragmented that it is difficult to generalise on the matter. However generalisation, rather than detail, can provide a good basis for discussion; the first task is therefore to set the carriage of farm produce into a broad context of the transport of primary produce in general.

THE PRIMARY SECTOR AND TRANSPORT

The very word “primary” indicates that the goods being offered for sale are in their earliest stages of production—even if, as is the case with the farming industry, there is a lot of technology and other investment behind the bale of wool or bushel of grain.

To those who produce from the land, from mines, from forests and even from the sea, transport costs assume special significance because the primary producer’s output, in a raw form, is usually of low value in relation to manufactured items to which value has been added in processing. In some circumstances, particularly where the producer is remote from his market or processing centre, transport costs can exceed the production site value of the commodity. Transport efficiency and freight and handling costs are therefore of quite critical importance to the primary producer, particularly where he is selling on a market in which there is little price difference between a “traditional” product and a more recently discovered substitute—for example coal compared to oil, wool to synthetics, butter to margarine, timber to concrete or aluminium.

In spite of their common features as primary producers, the farmer, the forester and the miner place rather different sets of demands upon transport services, quite apart from the obvious differences in the commodities which need to be carried. These varying demands, and the differing solutions to the problems they create, are in large part a result of the different characteristics and structures of the respective industries—a point quite fundamental to an understanding of transport demand in the primary sector and, indeed, in any part of the economy. To take two somewhat disparate examples: a large coal mine supplying only one industrial customer will have a highly concentrated and generally predictable demand for transport services. The intensity and regularity of the coal movement between single points of loading and unloading can lead to investment in
specialised equipment which will enable an efficient service to be offered for that particular commodity on that particular route, probably at a set rate for the job. The investment of capital in handling facilities and special rolling stock pays because of the economies achieved in a large scale movement—that is, economies of scale.

On the other hand a small scale contract logger, supplying a number of mills at various times within a region from a variety of logging sites, has a dispersed and unpredictable pattern of transport demand. He has vehicles which of are medium size, so that expected roading factors such as axle weight limits can be complied with; he has a small portable winch to be easily moved between logging sites; if he makes use of railway facilities it is unlikely that there will be special loading equipment, or that a special high capacity wagon could be supplied; and while his rate for a particular contract will be set for that job, his rate for casual log cartage could well be set “by the book”—a rate set to cover costs for a “typical” consignment.

Both these transport operations are very likely to be carried out with maximum efficiency in relation to the particular task; but they make the point that transport, as a service, can be only as efficient as the customers’ demands will let it be. Specific needs will be met by specific solutions, tailored to the job; general needs will call for only a general service catering for the majority with varying degrees of suitability but rarely with any precise matching of needs to a particular customer. It is the difference between large scale operation and specialisation, and small scale operation and a general purpose service.

FARMING AND TRANSPORT

By now you may well be wondering about the relevance of this lesson in transport economics to the farmer and his transport costs. The answer is this: farming in New Zealand, as in most countries, is, in industrial terms, small scale and structurally very fragmented. The farms are owned by many different people of diverse abilities and attitudes who produce a variety of commodities. The farms are geographically dispersed; production schedules are governed by the vagaries of seasons and climate, as well as by variations in international market demand or the dictates of government policy. Most farmers, in structural terms, are the equivalent of the fishermen, the logger or perhaps the smallest-scale forest owner, or the smallest scale of quarry or mine owner. The big difference, in the case of the farmer, is that he is usually producing a number of commodities, and demanding a variety of stores at different times of the year—all of which adds up to a very diverse pattern of transport demand. The forester produces only logs, the miner only coal or some other easily handled and sorted product; their produce is available all the year round, and production can be adjusted to meet industrial or consumer demand. Even the fisherman, to a large extent, has his raw material available until he wants it. But fat stock, dairy produce, and many crops, must be shifted for processing or storage when the season demands it. In this respect there is a peculiarly immediate quality about the farmer’s demand for transport services; he is producing something which, if not shifted within a quite short period of time, will often be totally wasted. This factor, coupled with the diversity

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of products calling for transport, puts farm transport services in a
rather different category from those of other parts of the primary
sector; it also explains why the transport operator serving the
farmer, faced with such seasonal and only partially predictable
demands, needs to have maximum flexibility built in his fleet, his
staff, and the management of his resources.

As producers, collectively, farmers are a powerful influence on
transport demand; as individuals on the economic scene, however,
a farmer has little if any influence at all. If one of your number
were to suddenly cease production, the nation's economy would not
shudder; it wouldn't even wince. And this, in broad terms, is the
significance of your impact, as individuals, on transport services in
terms of the custom you provide. Unlike the large mine-owner, or
forest-owner, or large industrialist, your individual transport deci­
sions are of little significance to anyone but yourself. There are very
few farmers whose transference of custom would seriously affect a
single transport operator; as a community, however, you could make
or break him. Rural transport services must therefore be considered
on a community or district basis; for maximum economic benefit,
the majority or community interests must come first.

In summary, the nature of the farmers' demand on transport
from the farm gate is that of a dispersed and very small-scale indus­
try. The pattern of transport demand is predictable only in the
broadest terms; and because a wide range of products must be carried
to and from the farm, the potential for specialisation in transport
facilities is limited. The stock crate, the bulk spreader (from ground
or air), the milk tanker, the petrol or diesel farm supply tanker, all
are now widely accepted examples of specialisation, even if some have
come upon the scene on a large scale only in recent years; but the
flat-deck lorry, often of only medium size so that it can traverse Class
II or III roads and bridges, has been and will remain for a long time
the mainstay of the rural transport fleet. It can be quickly adapted
to carry a stock crate, to handle bagged commodities, fencing mater­
ials, bulk wheat or fertiliser, hay, drums of fuel, a tractor, or farm
stores. It is, in essence, a general purpose vehicle, because it has to
meet a general purpose demand. At the local district level it is not
serving an industry in which there is such a clearly-defined pattern
of demand that it is worth investing in a wide range of special pur­
pose vehicles for special jobs—such as is the case with an operator
providing vehicles used only for carrying industrial commodities such
as flour, tallow, plaster and cement. And because of this general
purpose demand—which contains a built-in seasonal surge of some
intensity—the economies to be gained by specialisation in farm
cartage are limited. There are certainly some opportunities for spe­
cialisation, but the very diversity of farm location, of seasonal
demand and output—of rural transport demand in total—this very
diversity puts certain limits to specialisation and subsequent econo­
mies in transport operations.

A GENERAL PURPOSE TRANSPORT SYSTEM

It is worth looking back in time to see the effects of this "small
scale" demand on transport on the national level, as well as purely
on the farming scene. Until the 1950s there was relatively little large
scale production in New Zealand industry; apart from some concentration at Auckland productive capacity was widely dispersed in various regional cities which had grown up around particular ports. The transport system was geared to handle farm produce, farm supplies, and a wide range of imported and locally produced industrial and—particularly—consumer goods. The population, itself small in number, was scattered widely outside the main and regional centres; the demands for transport services were, with few exceptions, only broadly predictable in quantity and extremely varied in origin and destination. Within a few weeks one railway wagon might contain such diverse commodities as coal, fertiliser, steel, seed, timber, tallow (in casks), a motor vehicle, wool, and a mixture of manufactured goods—in each case bound for a different destination from a different starting point. Road transport had similar characteristics, though with a rather more local emphasis and a more clearcut division between rural and urban operations. Perhaps in years to come we may look back and see this diversity and lack of specialisation in internal transport as a result of restriction on competition, or inept management, limited research, or other factors; but I would suggest that fundamentally it arose because the nature and scale of transport demand in New Zealand was such that there was little encouragement for economies of specialisation. Coupled with these points was the fact that the economics of the road transport industry encouraged the operation of small general-purpose fleets rather than larger fleets in which there was scope for specialisation.

This is the national setting, in economic, geographic, and historical terms. The theme is diversity, both in production patterns and therefore in transport demand. The next step is to look more closely at the response of transport services, in recent years, to farmers' needs—again, in the first stage of the journey to eventual markets, from farm to processor. By definition this involves a look at road and rail transport, both as separate entities and as complementary or competitive media. But it also involves, before road and rail come into the picture, a very brief comment on farmers' attitudes to transport services—a subject on which I generalise at some risk.

ATTITUDES TO TRANSPORT

To almost everyone, transport is but a means to an end. It is often an expensive item in the total production process; expensive not only in terms of the direct outlay on freight rates, but expensive in terms of the time involved in dispatching or receiving, in packing or unpacking, in having goods idle or unsaleable while they are in transit. There is no intrinsic advantage in having goods transported; it does not add to their value in any way except in the sense that it puts the buyer and his goods together. For these reasons, no one particularly likes transport, or likes to think very much about it—except when some part of the system does not work. For those who do make the mental effort, the results are at times unrewarding, because the complexities of running all but the most simple transport service are considerable. Thus there exists a considerable fund of ignorance about transport, and therefore about the nature of the problems which an operator, whether it be road or rail, may have to meet in fulfilling an apparently quite simple request. Ignorance is
never a sound basis for sympathy, and the reaction of the man who is thwarted in a request for a lorry or a wagon is very predictable and often unprintable. Farmers, as an occupational group, and for reasons which I have already outlined, are very good at making unusual demands on transport services—demands which seem eminently reasonable to the individual farmer or stock agent or buyer, but which can pose very real problems for the transport operator—who may be torn between the conflicts of factors such as hay in the paddock with rain forecast, drivers tired and almost over their regulation hours of work, a lorry sorely in need of routine maintenance, and the desire to keep a farmer—very likely personally known to the operator—as a satisfied customer. To talk to an occasional buyer and a few farmers, one has the impression that by some sudden divine ordinance a particular draft of sheep must be in to the works within an almost impossible time; nothing, but nothing else on this earth matters but that this holy mission should be fulfilled. The instances of this sort of behaviour are hopefully becoming rare; but the poor relationship which it can engender between farmer or buyer and transport operator are not conducive to maximum efficiency in either case.

The fragmented structure of the farming industry means that there will be little co-ordination of transport demand from a district's farmers until that demand reaches the transport operator, or unless the demand is channelled through a co-ordinating organisation such as is the case with wheat movement. This puts the transport operator in the position of being co-ordinator of transport, of assessing the relative priority of demands between many people wanting service at the same time. Most decisions are reached by negotiation; a few are forced upon him by weather, or other factors beyond either the farmers' or the operators' control. In general, however, most decisions have to be assessed at the local level and this places a considerable onus upon the skill and knowledge of the local transport operator, or his manager, in terms of weighing up the priorities of competing demands for limited transport resources.

Now to look briefly at the relative merits of road and rail on the rural scene, a subject of conflicting attitudes and ideas in recent decades.

**ROAD AND RAIL IN RURAL TRANSPORT**

To read early reports about the growth of New Zealand's railway system is to read about the geographic extent of land settlement. The purpose of our railway system, it was acknowledged by Sir Joseph Ward in the 1905 Railways Statement, was:-

"... to regard the railways as adjuncts to the settlement of the country, and to look upon the earning of a large profit as of minor importance compared with the incalculable benefits that accrue to the State by giving the settlers a convenient and cheap means of transporting the produce of their farms to the markets ..."

You will be familiar with the result; a railway system which reached into most productive areas of the country to give a service of moderate efficiency to most settlers, even if in terms of transport economics some of the lines were of very doubtful worth.
An export-oriented economy, such as New Zealand's, dictated a peculiarly local pattern of commodity movement, with the regional centres as the focus. This centre—a city such as Christchurch, Timaru, or Invercargill—was and still is the place where most of the farm produce of a region is sold or processed; freezing works, flour mills, wool sales, cool stores, weekly stock sales—most, if not all, are found in the regional centre. And from the regional centre the rural dwellers' basic personal needs are consigned to the local market centres' stores and stock and station agencies—the food, clothing, and household needs not obtainable on the farm, as well as farm machinery and stores. If these items are not made in the regional centre, they are imported through the associated port, or purchased from elsewhere in the country, to be held in the warehouses and stores awaiting eventual distribution to residents of the hinterland—distribution which sometimes took place via agents in a smaller town.

This is still, to a large extent, the pattern of goods movement to and from the farm gate—with a partial change being that a much wider range of manufactured goods is made within New Zealand and may therefore be despatched from outside the regional centre direct to a farmer. But the big additions to the transport scene since the turn of the century have been vastly improved roads and very efficient motor vehicles; the lorry for the large loads, the car or light truck for personal use and for smaller items. And as the motor-vehicle has the enormous advantage over rail of providing a direct link from the paddock, drafting yards or farm gate directly to the regional centre, it is not surprising that the local function of the railway has now largely disappeared. The result has been not only the closure of many rural branch lines, but a less-noticed but steady diminution in the number of rural stations on main lines—for example, between Rolleston and Palmerston, in 1940, there were 54 stations; in 1968 there were 38, and I would not be too sure about the future of some of those remaining.

The motor-vehicle as a means of transport in rural areas has a further advantage, too—its movements, and the provision of its service to farmers, is locally administered. A local transport operator knows his district, and his customers; he is, in effect, part of the rural community. He has the added advantage of being able to provide a service at short notice—a flexibility which rail is structurally hard put to match. The railway service, on the other hand, is a bit impersonal; it is part of a national transport organisation, with loyalties and priorities far beyond the ken of a particular farming district or an individual farmer. Certainly there have been railway staff who have offered a service to their district which has, in effect, held customers to rail; and it would be interesting to explore the extent to which some farmers continued to use their district's branch line until closure from a sense of loyalty to something peculiarly a part of their district as much as from any rational argument about the choice of transport services.

In the years after World War II, the railways were run down, a result of reduced capital investment in the depression years as well as during the war. Wagon shortages, coal shortages (and reduced or curtailed train services), staff shortages (no local stationmaster or agent), and increasing competition from road services . . . the factors
weighing against railway services to rural areas just kept adding up. Indeed, speaking in such general terms, one begins to wonder if rail services have any long term future in serving rural areas. I would submit they have, on a number of grounds.

RAILWAYS AND THE FARMER

The railway operates most efficiently where traffic densities are high, where long hauls are the practice, and where loading and unloading points are relatively few; these are the circumstances in which rail can compete with road for almost any commodity. This points to a railway system which comprises primarily main lines, or secondary main lines (such as the Palmerston North-Gisborne line); the branch line has a place only where traffic is steady, and where the feeder value to the main line is considerable.

The trend today is toward concentration of loading points to a relatively few stations. (Grain traffic, significant in Canterbury, is one of the few commodities which will keep smaller stations open.) These points of concentration are, in essence, transhipment points between road and rail; even now I suspect that a majority of Canterbury’s rail traffic (outside Christchurch and its environs) is handled at relatively few stations. If the traffic throughput is high enough to warrant investment in handling equipment which sharply reduces the expensive transhipment costs, if the traffic is predictable enough, if it can be organised well enough in the sense of co-ordinating its movement between road and rail, I see a continuing and important function for the railway over medium and longer distances in the larger scale movements from rural areas to regional centres or other points of concentration. This would include livestock; I have for long found it an anomaly that road can successfully compete with rail over long hauls (150 miles plus) for quite large consignments when the economies implicit in rail haulage should clearly favour rail. I suspect that the detachable and transferable stock crate on a flat top wagon will provide an answer in this case.

The implications in this continuing trend to concentration are considerable. The ability to co-ordinate traffic being transhipped to or from rail at a single centre suggests a need for some general co-ordinating supervision over much of a district’s road transport services; this might be done by a special agency, it might be done through increasing concentration of control and ownership of rural transport fleets, a trend which is already well under way in New Zealand. It would involve a high degree of co-operation between management in road and rail, and a discarding of the prejudice toward the other medium which is still at times apparent. It would make the present 40 mile limit to a large extent superfluous, because in many cases the type of facilities available and the ease of transhipment would leave little choice, in terms of freight rates and service available, to the prospective consignor. For those who wished to pay for the load individually handled the road service, or the rail wagon at the smaller station, would still be available—at a price appropriate for such an individual movement.

What I have outlined is, in effect, a model situation. I predict that within twenty years we will be working at least partially within the terms of that model; in fact bulk superphosphate depots are a
first and significant stage, and there are other examples. I doubt if we will ever go all the way, because there will be the demands of both transport and democracy to call for exceptions to the general rule. But to forecast increasing concentration and specialisation in function between road and rail is, I feel, reasonable, with rail being predominant in the line-haul work. This means that, in the long term, the decision about which form of transport carries a farmer's goods to market may be made by the road transport operator, or a representative of some type of forwarding agency, rather than by the farmer himself.

Three qualifications; these arguments are predicated on the assumptions that transport decisions will be taken on the basis of total transport and handling costs—that is, the total distribution concept, involving packing, handling, transhipment and other costs as well as just movement costs. This implies a much more detailed store of knowledge about such costs than I suspect exists at the moment. Secondly it is possible that in the future some apparently arbitrary decisions may be taken about priorities in the use of roads, particularly concerning the role of the heavy motor-vehicle.

Finally there will always be the farmer who can produce convincing reasons—at least convincing to himself—that the use of his own vehicle is cheaper than the use of public transport.

FROM PROCESSING TO PORT

The movement of commodities such as wool, meat, and dairy produce from store to port is, in theory, much more easily controlled than the very fragmented distribution pattern evident in rural areas. Unfortunately such factors as shipping delays, labour disputes, and odd demands from consignees leave such theory largely with the beautiful thoughts division of mankind and introduces unwelcome and often uncontrollable elements of reality into the exercise. The evidence for this reality lies in such documents as the then Transport Department's publication "Movement Costs of New Zealand's External Trade, 1966," published in 1968, the Waterfront Industry Commission's annual reports, and various papers published by the Transport Commission in recent years.

Briefly, the problems of goods movement to the wharf can be classified into a number of categories:

Commodities
A variety of commodities, some requiring refrigerated cargo space, need to be assembled at one point (the ship's side) from a number of different places.

Distance
The distance between the point of manufacture and the port or wharf store may vary from a mile to several hundred miles.

Handling
Under existing manufacturing and handling techniques, some of these commodities may be handled many times between the factory door and the ship's side; and as some stores are not suited to the mechanical handling of certain items, or the items themselves are not easily handled by mechanical means, expensive manual labour is involved.
Shipping

The nature and size of the package in which the commodity is exported may be governed by factors such as limits on crane weight capacity (in New Zealand or elsewhere), the consignee's capacity to handle the goods, or some technical aspect of cargo-stowage.

Tradition and Investment

If a company has been handling its goods for a long time by one method, and new handling techniques call for new investment and a change from existing and well-tried methods, a major decision is called for. Some companies initiate change, others try to avoid it; much therefore depends on management and particularly the quality of the research which they can call upon.

The introduction of containers has put all these matters to test, and many more as well. New technology, new investment, and new methods of organisation and management have all been required, and all within a relatively short space of time; because containers are the symbol of concentrated and specialised transport movement. Cargo movement to ports for despatch in conventional ships has certainly been co-ordinated and controlled in times past, but to a large extent the marshalling of the goods and their packing has taken place on the wharf or in the ship's hold. What containers mean, along with comparable unit loading techniques, is that the assembly and packing of cargo is to take place further back along the transport production line. The new organisation and demands on management which this involves are the reasons for the upheaval at present being experienced in the means of moving our export goods. Upheaval is rarely a noiseless process; hence the many words on the subject, words of examination, exhortation, research, intent . . . and just words.

CONCLUSION

Now to pull the strands together.

Transport is a capital intensive activity, in which economies of scale can be very real. The ability to achieve economies of scale, however, implies bigness in size; size of organisation, size of operations, even size of vehicle or wagon. Size, in turn, implies a certain remoteness in management, a rather impersonal quality so far as the farmer is concerned—because the farmer lies at the other end of the organisational scale; he is small-scale. Size also implies the ability to support research staff, who will be the source of new ideas, and change.

Farmers, as I have pointed out, operate on a local or community level so far as transport is concerned; already they are, as an occupational group, getting used to dealing with bigger firms or combines in the road transport industry. The local flavour of rural transport is diminishing—not without protest—but I doubt if it will ever completely disappear, however strong the economic arguments against it.

So the trend is in the broadest sense towards specialisation and concentration of transport facilities—and I think the way farmers can do most to keep their transport costs down is to be aware of the advantages of this process, to be informed about it, to watch it for signs of over-centralisation. The benefits to be gained are already apparent, such as the reduction of rural road freight rates in Southland.
If there is one basic theme to this paper it is that transport, as a service industry, can be only as economic and as efficient as the demands of its customers will allow. As customers, farmers are collectively a powerful group; as informed customers, they are not only powerful but influential. My answer to a specific question about ways of keeping rates down would be to encourage the maximum interchange of information both formally and informally between the two sectors, farmers and transport. At a local, regional, and national level I suspect that appreciation of each other's problems and points of view can do as much to improve efficiency—and therefore hold farmers' transport costs—as the expensive and time-consuming research which is going to accompany the rapid changes at present being experienced in the transport industry.
"CHANGES WHICH COULD REDUCE SHIPPING COST INCREASES"


RECENT MOVEMENTS IN FREIGHT RATES

Shipping freight rates New Zealand to United Kingdom for lamb, butter and apples have risen by approximately 20 per cent since 1962. Over the same period the rate for wool (which was low in 1962 because of competition) has increased by just under 60 per cent.

Over the same period the road transport haulage rates for fat lambs and bulk fertiliser for a haul of over 60 miles decreased by just under 20 per cent and 10 per cent respectively.

On the railways haulage rates for frozen lambs for a 50-mile haul increased by 4 per cent and for wool for 110-mile haul 6 per cent.

Just what further increase in freight rates our external trade could bear is a matter for speculation. On the shorter hauls the freight rate does not assume such significance as on the longer ones. Declining price levels for our exports also increase their significance, as also do the movements in the rates for our competitors.

Although it is clear that the level of freight rates has not reached the damaging level, it is also clear that it would be folly to wait until it does.

ORGANISED ACTION TO COUNTER THE FREIGHT SPIRAL

Before 1962 there were mutterings about the freight “creep” and some sporadic attempts were made to do something about it. But generally it was a case of “When the sands are dry he’s as gay as a lark, and speaks in contemptuous tones of the shark.”

In 1962 it was agreed by the contracting parties to the Freight contracts (i.e. Meat, Dairy, and Apple and Pear Boards, and the British Shipping Lines) that organised action be taken to control the escalation in freight rates.

The Producer Boards felt that there were limits to what New Zealand exports could stand, while the shipping lines were concerned at uncontrollable inflationary trends in the costs of operating their cargo liner services.

They agreed to set up two independent committees to report on ways and means of increasing efficiency and making economies in the ports, transport and shipping. The committees jointly reported on the services, both in the United Kingdom and in New Zealand.

EXPORTS AND SHIPPING COUNCIL

Arising out of this report the Producer Boards and the Shipping Lines combined with the Wool Board, Railways, Road Transport, Harbour Boards, Freezing Companies, Chambers of Commerce and Federation of Labour and set up in 1964 the Exports and Shipping Council. The aim of this Council was first to implement as far as possible the recommendations of the “Streamlining” Committees. When this was done the Council would carry on as a general co-ordinating body for transport, ports and shipping services, with the idea
of adopting the whole system to meet the new environment already referred to.

Instead of a costly staff of experts the Council set up a number of working committees comprising some of the best managerial brains in our exporting, ports, transport and shipping services. Separate working parties were organised under the headings of Port Facilities and Transport, Packages and Cargo Handling, Peak Shipping Requirements, Shipping Allotment Procedure, Clearance and Distribution of Imports. Monthly meetings are held, and where agreement is reached as to new methods and procedures, they are put into operation.

It is essential in the organisation of a shipping service to have such a close liaison between shippers and shipowners, and the machinery to implement it, as to ensure that enough ships, but not too many, are available at the right time, in the right port, to carry all the cargo that has been sold to the full range of discharge ports. A basic requirement is to have reliable estimates of production as far ahead as possible, because ships have to be programmed months ahead. About April or May each year one of the Working Committees of the Council starts collecting all available information relating to the next exporting year, and preparing preliminary estimates of production. These estimates are reconsidered from month to month in the light of new information that may become available. Reliable statistics relating to the sheep population are very important here. Formerly these statistics relating to June were not available until December, but the Agriculture Department has helped by taking sample counts and releasing the results some time in August. Experience has shown that these sample counts are liable to a comparatively small margin of error.

The next step is the preparation of what is known as the annual survey of port capacity. This takes into account the loading out capacity, say at freezing works, cool stores, wool stores, etc., the transport services available, the labour available, the berths available, etc. This exercise shows up possible "bottlenecks" in advance, and enables corrective action to be taken.

TRANSPORT COMMISSION

The Council agreed with a recommendation made in the Streamlining Report on the need for a national plan for the future development of New Zealand transport and port facilities in the interests of the country as a whole. But it recognised that the formulation of such a plan was a matter for government action. Representations were accordingly made to the Government, as a result of which the Transport Commission was set up early in 1965, with a very wide order of reference.

This Commission did valuable work which was set out in a number of reports. These reports made valuable contribution to the general body of knowledge on the whole matter of transport, ports and shipping. They also dealt with some current problems referred to the Commission by Government.

The reports covered:
Aug. 1966—Wharf Handling Charges.
1967—New Zealand Ports.


Sept. 1967—Permanent Authority on Port Development and Transport.


The Commission was the first authoritative organisation to recognise that container ships were an economic proposition for New Zealand. In the report of Sept. 1966 the Commission recommended “that no further pocket elevator all-weather loaders of the type at Bluff should be installed at New Zealand ports,” and expressed the view that “New Zealand’s overseas trade may have to be geared to container techniques within a comparatively short period of years.”

The Report on Container and Cargo Handling by a Committee set up by the British Conference Lines reported in May 1967 that a service comprising four container ships could be planned for about 1971.

It is interesting to note that in 1964 the Streamlining Report by the original committee said “we think containers are unsuitable for the New Zealand trade at present, or in the foreseeable future.”

The conclusion reached by the Commission spelt the death knell of any additional meat loader systems and turned our thoughts to the container ships. They were subsequently confirmed by the recent Shipping Lines report on container ships and the independent Metra Report.

FURTHER CHANGES SOUGHT

In July 1967 the Exports and Shipping Council met the Prime Minister and other Ministers. The main points made were:

“After three years’ experience with New Zealand’s transport, ports and shipping problems, the Council is concerned about the future.

“In spite of the Council’s efforts, which have resulted in savings of approximately £1,000,000 per annum, our overseas freight rates have increased by 30 per cent since 1959. This escalation, we fear, will continue unless some bold unified action on the part of all concerned, including the Government, is taken to contain it.”

“There are definite limits to what our export industries can carry by way of freight rates and still hold their place in the competitive markets of the world.”

“Bold and urgent plans are being made (in other parts of the world) to take advantage of the container revolution that holds out promise of reducing both time and cost on the main trade routes of the world. How long can we afford to stand aloof?”

“We are convinced that the existing state machinery relating to transport is too fragmented to deal adequately and expeditiously with the problems that now confront New Zealand. There must be a determined unified attack. We submit the best way to achieve this is by the creation of a co-ordinated overall policy for the future, backed with the necessary thrust and power to carry it expeditiously into effect.”
Action was sought on the following points to increase the turn-round of ships:

(a) Organise more effective and efficient use of labour and facilities on the waterfront.
(b) Reduce the unproductive time, i.e. time when discharging and loading are held up.
(c) Increase throughput at those berths where mechanical loaders are installed.
(d) Improve the presentation of cargo at ship's side by increased use of unit loads.

Following on these representations the Government set up the Waterfront Industry Conference which is still in session, the Ministry of Transport, which came into existence on 1/12/68, and the New Zealand Ports Authority as from 1st April 1969.

A corollary to these changes was to be the phasing out of the Transport Commission after it had reported on the Metra Report.

IMPROVEMENTS IN SHIPPING TURN-ROUND

Independent records kept by the Waterfront Industry Commission indicate that over the last five years the activities of the Exports and Shipping Council have resulted in

(a) Substantial improvement in the turn-round of refrigerated ships on the New Zealand coast.
(b) Valuable additions to the general body of knowledge relating to ports, transport and shipping, and
(c) Improvements in State administrative machinery associated with ports, transport and shipping.

The improvement to the turn-round of shipping has been due principally to the following:

1. Improved programming of ships, which is reflected in fewer ports of call (average per ship is now two less than in 1963), and more cargo being worked at each port of call (average loadings per port of call are now 3,040 tons compared with only 1,350 tons in 1963; average unloadings have increased by less than this—2,200 tons to 2,400 tons).

2. The flow of cargo on and off ships per day worked has increased substantially in volume—for ships loading and discharging the average tonnage per day is now 473 tons, or 126 tons more than in 1963—while the rate for ships loading only has risen from 300 to 396 tons.

3. Improvements in presenting and clearing cargoes from the ships, which has resulted in more men being employed per ship and substantially increased throughput per man. Round about a dozen extra men are now employed on the average per ship at work output rates per gang that are 13 per cent higher for ships loading only and 19 per cent higher for ships loading and discharging.

By comparing the average gross days on the coast for each year since streamlining was started with the corresponding figure for 1963 (50.1 days) it is possible to make an estimate of the savings in ship operating costs that have been made.

Expressed in dollars, savings of approximately $10,500,000 have been made on the New Zealand coast since the Exports and Shipping Council was started. Had these savings not been made it is certain that the level of freight rates would have risen higher than it has.
What of the future? Is it possible that further rationalisation could hold the situation? Present indications are that further savings on a reduced scale are possible, but that they could not be on a sufficient scale to halt the spiral.

This conclusion has arisen out of our own efforts in New Zealand. It coincides with the following views expressed by the heads of the Shipping Lines when they were recently in New Zealand:

"The introduction of container ships is the best possible means of retarding the freight spiral, which, owing to inflation, would continue to apply to a fully conventional service."

"The Lines would not be prepared to continue building conventional ships because of rising costs and the limited return on capital."

The independent Metra Report also found "that the containerisation of New Zealand's trade with the United Kingdom and Western Europe will have an economic advantage over conventional and palletised systems."

Further confirmation is available in the rapidity with which container ships are being planned for the principal shipping lanes of the world, the nearest being, of course, our neighbours across the Tasman, whose services have already started.

MARITIME POLICY FOR NEW ZEALAND

During the course of the Export and Shipping Council’s activities, the question frequently arose as to whether New Zealand should have a definite maritime policy and just what such a policy should be. The matter was also one of considerable public interest.

The Council therefore decided that it should endeavour to ascertain and make public as much knowledge as possible on the matter. A paper posing three possibilities with the advantages and disadvantages of each was circulated to interested organisations:

Should New Zealand invest capital in the British Conference Lines?
Should New Zealand drop the present contract system and charter our requirements on the world market?
Should New Zealand form its own Shipping Line?

A summary of the views received indicated that while there was some support for each proposition, the general consensus of opinion was against each one. Just prior to these comments being made the Transport Commission published a report on “Movement Costs of New Zealand’s External Trade 1966.” This report showed that of the estimated total costs ($252,740,000) of movement from the point at which the goods were in an exportable condition in the country of origin to the destination overseas, no less than 45 per cent was incurred in New Zealand and only 17 per cent on ocean movement. Of $165,000,000 spent on ship freight some $65,000,000 were incurred within New Zealand on stevedoring, etc., coastwise movement and time in port. This report, I think, was responsible for the general opinion among the organisations making comments, that New Zealand should concentrate on reducing these costs, “irrespective of who has invested capital in the Lines, or who owns the ships or has them on charter.”

The next step was a Forum on 6 December 1968. The chief speakers were Sir Donald Anderson, chairman of the P. and O. Ship-

Mr F. W. Holmes, one of the country's leading economists, summed up the papers presented at the Forum. Here are some of his conclusions:

"If there is a case for a New Zealand Shipping Line operating in overseas trade in one way or another, it has not been proven by today's proceedings."

"There is no doubt at all . . . that the New Zealand Government must have a positive maritime policy and that it must, on behalf of all New Zealand's trading interests, take a very positive interest in overseas shipping and attempt to influence its operations to our advantage, both directly and in support of private shippers and negotiators."

As farmers represent the biggest body of users of overseas shipping, this question of maritime policy is a matter of considerable interest to them. Inadequate, inefficient or too costly shipping services could damage our export trades, and affect the prosperity of the farmers. Time does not allow me at this stage to go into more detail, but I hope I am in a position to give more information in response to any questions that may be asked.

THE FUTURE

Ports
The original Streamlining Report, 1964, recommended that "representations should be made to Government to prepare as a matter of urgency a national plan for the future development of transport and ports."

It also recommended that before the plan was evolved, an independent enquiry should be made into ports, transport and shipping to collect and consider the necessary information on which the national plan could be defined. This role was filled by the Transport Commission that has already been referred to.

The next step was to be a single Government Department (such as a Ministry of Transport) or, as regards harbours alone a Harbours Commission, to define the proposed plan and with the responsibility of seeing that it was implemented.

We now come to the New Zealand Ports Authority which recently came into operation with the Hon. J. K. McAlpine as chairman and four other members.

The main function of the new authority is "to foster an efficient and integrated ports system for New Zealand" and for that purpose to prepare a National Ports Plan, which is to be reviewed from time to time.

Another important function is the control of capital expenditure by harbour boards: Auckland and Wellington (over $250,000), Northland, Tauranga, Taranaki, Gisborne, Napier, Nelson, Lyttelton, Timaru, Otago and Southland (over $150,000); other ports (over $50,000).

All decisions made by the Authority relating to these matters is subject to a right of appeal to the Minister of Marine, whose decision is final. Ultimate power therefore resides in the Minister.
Other functions include ways of achieving a quicker turn-round of ships and the promotion of efficiency in the operation of ports.

This new Authority has a very important role to play, because the demand for the services provided by Harbour Boards could change dramatically in the "seventies." On the shipping side the advent of containers, plus the further rationalisation of the supporting conventional ships will probably require fewer ports and fewer berths. On the land side there will be far-reaching changes as the railways meet the demand for containerisation, not only for the external but also for the internal trade. Quicker loading and discharging of wagons will enable them to exploit to the full their inherent advantages of speedy haulage of bulk loads. Distances will be of lesser significance as liner trains are developed, and they should be able to meet the full requirements of greater aggregation of cargoes for shipping at attractive rates.

It is axiomatic in transport economics that goods tend to flow along the channels that suit the shippers best, the principal criteria being cheapness, speed, regularity, less liability to damage, etc. This law of business is always there. It accounts for the extinction of many ports in New Zealand down the years as the roads and railways have provided attractive alternatives to shipping services. A port can exercise a certain amount of persuasion in attracting business, but generally it is in between the inter port transport services and the shipping services. If shippers decide on more attractive alternatives which may involve using other services or ports, there is very little the port that suffers can do about it.

The battle of the ports is about to be joined. It will be fought out in the "seventies."

It will in my opinion have a profound effect on the administration and management of ports. The new Ports Authority is the first indication of this. The National Ports Plan will no doubt indicate some changes, but more important, it shows the emergence for the first time in our history of some sort of national direction in port policy. Specialist ports could be a development.

As some ports wax and others wane the question as to whether changes in Harbour Districts will be necessary to meet the new era will arise. There will certainly be a tendency for closer collaboration between neighbouring ports, maybe eventually leading to amalgamation and joint management arrangements, with the idea of reducing costs and maybe meeting the costs of redundant capital works.

The role to be played by coastal shipping is not conclusively shown in the Metra Report. There is, however, this significant statement: "It is concluded, therefore, that whilst on some routes coastal container ships of about 200 container capacity can give rise to savings over rail, there does not appear to be a sufficient volume of trades on enough routes to justify their use. If a large part of New Zealand's internal (or possibly Australian) trade was handled in containers by coastal ships, then the enhanced load factor could make coastal shipping desirable for centralisation to deep sea container ports of the European trade."

It is a pity that this point was not covered in the report. It will certainly have to be determined before a National Port Plan can be drafted.
Enough has been said to indicate that coastal shipping may have a very important role to play in "feeding" the big overseas container liners over the longer distances. The important points are regularity, speedy turn-round, and cost, given, of course, adequate traffic volumes. The inter-island ferries (Cook Strait and Wellington-Lyttelton) show that ships can maintain a measure of regularity that compares more than favourably with the other forms of transport, while the growth of trade (internal and external) must bring many traffic routes up to the level where the low unit costs of sea transport become very attractive.

The role of the coastal "feeder" container ship in the new era has of course, a big bearing on the prosperity of the ports concerned.

Harbour Boards occupy a traditionally important role in our transport system. They are autonomous, democratic organisations that enjoy a high reputation for efficiency in their main function of providing safe berthage for the ships to load and unload. In 1967 the aggregate of shipping (coastal and overseas) arriving at ports in New Zealand amounted to over 12,000 "ship calls," with a registered net tonnage of 24,412,000 tons. Total manifest cargoes (coastal and overseas) passing through the ports amounted to 20,431,000 tons. In the same period the railways handled 11,500,000 tons. I do not suggest that these figures (in which coastal cargoes are counted twice—inwards and outwards) are comparable as indicators of the roles played by ports and railways, but they offer some evidence of the important part ports and shipping play in our trade and commerce. A fair basis of competition between these two forms of transport is essential if the users are to get the full benefits of the inherent advantages of each.

Shipping

References have already been made to container ships. In March 1969 the four British Shipping Conference Lines published a report setting forth a proposition for a container ship service between the United Kingdom and New Zealand.

Here is a summary:

"1. Four container ships each carrying approximately 1,400 containers (1,100 refrigerated and 300 general cargo) at a speed of about 23 knots should be ordered by mid-1969 in order to commence service in the United Kingdom-New Zealand trade in late 1972.

"2. Southbound, this fleet will cater for virtually all the containerable cargo with the exception of seasonal upsurges which will be covered by conventional ships. Northbound, the container ships would expect to lift rather less than 50 per cent of the total annual exports from New Zealand to the United Kingdom. The remainder of New Zealand's exports will be carried in conventional ships.

"3. Either Tilbury or Southampton will probably be the container terminal for the United Kingdom; Wellington and Auckland will be the two terminals in New Zealand. Some South Island cargoes may be containerised and shipped via Wellington but the majority of South Island exports will continue to be carried by conventional ships (e.g. from the Timaru and Bluff loaders).

"4. The freight structure assumes that costs in shipping by the new service will be no greater than under the present system. The Lines certainly do not foresee any reduction in freight as a result of
containerisation but they believe that the new service is the best possible means of retarding the freight rate spiral.

"5. Further development of the initial container service may be possible during the 1970s and some advantage might be obtained, in the future, by the integration of the New Zealand service with Australia.

"6. The investment involved in the service, as outlined, is approximately $50 million (NZ$107 million)."

These conclusions were arrived at after considering

(i) The large imbalances in total volume and seasonal variation of the outward and homeward trades between the United Kingdom and New Zealand. The following figures, which are an estimate of the cargo for 1972, illustrate the problem expressed in millions of cubic feet:

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<td>January/December</td>
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"(ii) A container service, even if augmented with conventional ships, must itself be of sufficient frequency and regularity to satisfy shippers without carrying a lot of surplus space.

"(iii) The physical limitations imposed by the Panama Canal and the terminal ports which are selected.

"(iv) Both New Zealand and the Lines have a large present investment in the trade as it is currently served. New Zealand has, for instance, only recently spent money in installing the meat conveyors at Timaru and Bluff, and we believe that these will continue to have a most useful role to play in the future. Equally, the Lines have a large combined fleet of refrigerated ships with an average age of only 12½ years at present; the majority of these ships were built specially for the New Zealand trade.

"(v) It is uncertain whether the United Kingdom will eventually join the European Common Market or indeed, if she does, the exact effect such entry would have upon the New Zealand/United Kingdom trade. It will be readily admitted, however, that if the Lines are to make a major decision involving the building of container ships which may last until 1990 it would be imprudent to ignore the contracting effects that the E.E.C. could have on future trade."

Consideration was also given to various alternatives:

"The unit-load system, involving intensive palletisation in ships of special design is a less radical departure from conventional methods than containerisation. The capital investment called for may well be less than for containerisation but the system involves more handling of the cargo. Further, this system does not offer the same overall economies in reducing weather delays and ship turn-round time, quite apart from the physical problem of unitising carcase meat under refrigeration, for example.

"The roll-on roll-off ship, which is designed to carry the cargo on trailers on vehicle decks, achieves rapidity of turn-round but is wasteful of ship's space, particularly so far as refrigeration is concerned. It is better suited to voyages far shorter than the New Zealand/United Kingdom trade.
"The barge carrier, of which LASH (Lighter Aboard Ship) is the best-known example, may be considered as a variation of the container principle. The barges are in effect large floating containers, but the possibilities for through transport by barge are limited so most goods are loaded and discharged at the dockside in the conventional fashion.

"There are points in favour of each of these ship types. In the Lines' view, however, the paramount consideration is the highly specialised requirements of refrigerated cargo which leads inevitably to the conclusion that a container operation is the right choice for New Zealand, bearing in mind its capability for door-to-door transport."

**Metra Report**

While the Shipping Lines were preparing their report, the New Zealand Government engaged the Metra Consulting Group of London to report on the economics of containerising New Zealand's trade with the United Kingdom and Western Europe. This study evaluated a large number of alternative transport systems and compared their economic advantages. The results showed that containerisation would lower the costs of shipping goods between New Zealand and Europe.

The following detailed conclusions were arrived at:—

1. The containerisation of New Zealand's trade with the U.K. and Western Europe will have an economic advantage over conventional and palletised systems.

2. The economic advantage to be gained is less if the U.K. trade only is containerised.

3. The container service should be provided from either Wellington or Wellington and Auckland together in New Zealand and London in the U.K. Containers destined for or proceeding from Europe should be trans-shipped for or proceeding from Europe should be trans-shipped at London.

4. The largest container ship able to use the Panama Canal should be employed in this service. It would have a capacity of 1,400 to 1,500 containers of which about 300 would be carried on deck.

5. The container ship should have a service speed of 22 to 23 knots.

6. The number of such ships which would give the most economic service is five if the present carryings of British ships are considered potential container traffic. This number would be increased to six if the European trade not currently carried in British ships was included in the service.

7. Uncertainties about the development of New Zealand's trade with the U.K. could lead to an uneconomic service in future if five or six ships are put into service. Four ships in service would be a satisfactory solution since it does not incur a heavy cost penalty in any of the trade situations envisaged.

8. The number of ships should be increased to five if trade with the U.K. remains at its current level.

9. Four ships of a capacity of 1,400 containers and a speed of 23 knots plying between Auckland, Wellington and London for the trade currently carried in British ships (this corresponds to all
of the U.K. trade plus approximately 45 per cent of exports to Europe and 50 per cent of imports) could provide a maximum of 32 round voyages per year. They would be able to carry 66 per cent of the northbound traffic and 81 per cent of the southbound. Thirty-one conventional ships would be required for the balance of non-containerised traffic.

“10. If the service with four ships was scheduled so as to provide regular fortnightly sailings, the number of voyages per year would be 25, allowing for surveys, etc. This service would take 60 per cent of the northbound traffic and 81 per cent of the southbound. Thirty-seven conventional ships would be required for the balance of non-containerised traffic.

“11. The faster service based on four ships calling at two New Zealand ports would require a total new investment in ships, containers, and New Zealand port facilities of about $NZ80,000,000.”

Broadly speaking the Metra Report confirmed the principal conclusions arrived at by the Shipping Lines.

It is, I think, now clearly established that the introduction of container ships offers the best way of halting, or even reversing the freight “creep.”

This “creep” on exports alone has cost New Zealand something between $10m and $20m since 1962 and if it continued (and there is every indication that it will if we continue with the existing conventional fleet) it could well cost us double that over the next decade.

The Metra Report is at present being examined by the Government and unless there is some last-minute “turn-up” I would think that we will have the container service on the U.K. run by the latest towards the end of 1972.

In the meantime the Australian-New Zealand-East Coast North America container service is scheduled to start in 1971.

Difficult Period before Container Service Starts

Difficulties could arise between now and the commencement of the container service. On the shipping side there is a strong possibility that our conventional ships will lose the back-loads they have carried for many years to Australia on their way to New Zealand to the new U.K./Australia container service. Gross revenue from this traffic varies but it is substantial and could run as high as $10m per year. From it the costs involved in loading and discharging must be deducted to arrive at the net loss of revenue involved. Unless this loss can be offset by further “streamlining” economies, or by filling the empty space with other cargoes, the question of freight increases on the export traffic to bridge the gap could arise.

There could be difficulties in making some existing equipment and facilities last out until the container services take over, but I think the new Ports Authority could see us over this one.
CONCLUSION

In my opinion all the evidence indicates that New Zealand is about to escape from the clutches of freight escalation that has been threatening us for a generation.

On the one hand we have the offer of the British Shipping Lines to invest a huge capital outlay in the new container system. On the other we have the new machinery being provided by the Government to ensure that the new system is smoothly and efficiently introduced. Then we have our local transport services, the railways, road transport and the harbour authorities concerned who can all be counted on to show the enterprise, enthusiasm and foresight to make for success.

But we must not let the bright hopes of the future blind us to the fact that we have a big job ahead in holding the situation over the next three years.

I am reminded of some lines from Kipling—

“Our England is a garden and such gardens are not made,
By singing, Oh, How Beautiful, and sitting in the shade.”
VAR IE TIES OF SUBTERR EAN CLOVER

M. L. Smetham, Lecturer in Agronomy, Lincoln College.

The Subterranean clovers are winter-growing annual plants originally found in countries bordering the Mediterranean Sea. As such they are adapted to areas of cool moist winters and hot dry summers. With man's unintentional help they spread to Australia and New Zealand and are now sown by farmers in both countries, and in similar areas of Mediterranean climate in South America, the U.S.A. and South Africa.

In New Zealand it was not until the mid-1930s that farmers began to realise the value of Subterranean clover as the dominant legume for pastures in Canterbury. By 1945 most properties on the shallow free-draining soils of the Canterbury Plains were using Subterranean clover-based swards and were carrying about 2½ ewe equivalents per acre on these. Use of Subterranean clover had, by 1955, extended to the sandy soils of the Manawatu; the shallow stony soils of the Wairarapa, and to the dry east coast North Island hill country.

STRAIN DIFFERENCES

The number of quite different and true breeding varieties or strains of Subterranean clover is large; 89 having been identified in Western Australia alone, and it is probable that there are about 150 strains known in Australia as a whole.

These can be conveniently grouped according to time of flowering.

The early flowering group includes such strains as Dwalganup, Geraldton and Carnamah. This group is adapted to areas in which drought occurs from early spring onwards. The period needed for growth between germination in autumn and flowering in spring is about five and a half months. In situations where this group thrives the winter period is mild, and rainfall is almost non-existent over the summer. The absence of frosts allows very early flowering and a good seed set. The absence of summer rains means that seed does not germinate until autumn rains, adequate to support subsequent growth, occur.

The mid-season flowering group, including Nangeela, Mt Barker, Woogenellup and Clare, need about seven and a half months of good conditions for growth between germination and flowering in late spring. This group is therefore suited to areas which do not dry up until late spring. These plants require cold conditions over the winter to stimulate flowering.

The late flowering group, which includes the strains Tallarook and Bena, need a period of about eight and a half months between germination and flowering over which conditions are favourable for growth. This restricts these varieties therefore to parts which do not experience drought until mid-summer. They also require a period of winter cold to stimulate flowering.

The mid and late flowering groups then are limited to areas of higher rainfall than that required by the early types. Associated with the higher rainfall is the increased likelihood of spasmodic
summer showers after the seed is set. To guard against premature germination and death of seedlings in subsequent dry periods, the ripe seed of the mid-season and late flowering groups exhibits a temporary inability to germinate for two or three months. This dormancy gradually wears off as autumn approaches. Early-flowering strains show little seed dormancy.

Since Subterranean clover is an annual, its success greatly depends on good regeneration from year to year. As will be realised from the description of flowering requirements the amount of regeneration depends, for any one flowering group, on the climate in which it is growing.

Early flowering types flower so early in New Zealand that the flowers are liable to be killed by late winter and or out-of-season spring frost. In addition the lack of dormancy may allow seeds to germinate before substantial autumn rains fall and so they die.

On the other hand the late flowering group may, particularly in a wet season, flower so late that dormancy prevents germination until late in the autumn and seedlings run the risk of being killed by frost and frost heave.

NEW ZEALAND VARIETY TRIALS

In the limited number of strain evaluations conducted in New Zealand, the mid-season flowering group have been the most successful and productive, mainly because of superior regeneration.

The first strain trials in New Zealand were conducted by Levy and Gorman (1936) at Palmerston North. Using a wide range of strains they found that the early mid-season Burnerang and Myall (Syn. Bacchus Marsh), and Nangeela (late mid-season) were the most winter active and most productive at all seasons. Mr Barker, of the mid-season group, gave only fair production. Tallarook, a late flowering strain, produced well but too late in the spring to be of value.

In spite of these findings the only strains to be widely used in this country have been Mt Barker and Tallarook; the only reason being it seems that seed of these has been readily available.

Trials conducted by the Department of Agriculture in the 1960s over a wide range of conditions with more than 70 strains adequately fertilised and inoculated showed that Woogenellup, Bacchus Marsh, and Nangeela all nearly always outproduced the standard Mt Barker.

More recent trials by research workers in the Department of Agriculture Research Division and Grasslands Division, D.S.I.R., have also shown these three strains as being more productive than Mt Barker, in places as far apart as Winchmore and northern Southland.

CENTRAL OTAGO TRIALS

Over the period 1965-67 the author conducted a strain trial in Central Otago using representatives of all three flowering groups at three locations—Cromwell, Tarraas and Wanaka, having respectively 20-year rainfall averages of 16.5, 17.5 and 25.1 inches per year. The varieties were observed and scored for density and production at least four times a year for three years.
RESULTS

Since sward density has a big effect on seed set depending on the flowering group concerned and soil moisture levels, only second and third season results are quoted. Seeds were sown in single rows but by the second season plants were well spread over each plot.

The most outstanding result of these strain trials was that in all seasons at all sites several, and sometimes as many as six strains out-produced Mt Barker by 20 per cent or more.

ANNUAL PRODUCTION

The average annual measurements for all sites showed that two strains, Woogenellup and Nangeela, outproduced Mr Barker very substantially.

| TABLE 1 |
| Mean Annual Production 1966 and 1967 all sites combined | |
| (Relative to Mt Barker 100) | |
| Woogenellup | 151 |
| Nangeela | 141 |
| Mt Barker | 100 |

The results for each site individually showed that in addition to Woogenellup and Nangeela, Bacchus Marsh and Wenigup performed well at Tarras; Bena and Tallarook outproduced Mt Barker by a large margin at Wanaka.

| TABLE 2 |
| Mean Annual Production for each Site 1966 and 1967 (Relative to Mt Barker 100) | |
| Cromwell | Tarras | Wanaka | |
| Woogenellup | 124 | Bacchus Marsh | 162 | Woogenellup | 226 |
| Eden Hope | 113 | Wenigup | 155 | Nangeela | 222 |
| Nangeela | 107 | Portugal 294 | 105 | Bena | 159 |
| Mt Barker | 100 | Woogenellup | 104 | Tallarook | 144 |
| | | Mt Barker | 100 | Derrinal | 114 |
| | | Nangeela | 93 | Mt Barker | 100 |

SEASONAL PRODUCTION

At all three sites Woogenellup was the only strain which was higher producing than Mt Barker in each of the four seasons. Nangeela proved to be the best strain in winter and summer, with Wenigup best in autumn.

| TABLE 3 |
| Mean Seasonal Production 1966 and 1967. All sites combined (Relative to Mt Barker 100) | |
| Autumn | Spring | Winter | Summer |
| Wenigup | 167 | Woogenellup | 169 |
| Woogenellup | 145 | Tallarook | 110 |
| Nangeela | 128 | Eden Hope | 109 |
| Clare | 117 | Mt Barker | 100 |
| Portugal 294 | 111 | Nangeela | 90 |
| Bacchus Marsh | 105 | | |
| Mt Barker | 100 | | |
| Nangeela | 173 | Nangeela | 171 |
| Woogenellup | 166 | Woogenellup | 125 |
| Mt Barker | 100 | Mt Barker | 100 |
AUTUMN ESTABLISHMENT

There were big differences between strains in the numbers of plants which established in the autumn.

TABLE 4
Mean Density Ranking February or March 1966 and 1967

<table>
<thead>
<tr>
<th>Strain</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nangeela</td>
<td>5.9</td>
</tr>
<tr>
<td>Woogenellup</td>
<td>5.8</td>
</tr>
<tr>
<td>Bena and Bacchus Marsh</td>
<td>4.7</td>
</tr>
<tr>
<td>Mt Barker</td>
<td>4.4</td>
</tr>
<tr>
<td>Dwalganup</td>
<td>0.7</td>
</tr>
</tbody>
</table>

By comparison with Mt Barker, both Woogenellup and Nangeela had approximately 30 per cent higher seedling density. This is one of the factors which has contributed to the overall superiority of these two strains in this evaluation.

The early flowering group of Subterraneae clovers regenerated very poorly. False breaks leading to germination and death of seedlings may have been the reason, or more probably, seed set was poor due to frosting of flowers by the inevitable late spring frosts experienced in Central Otago.

Mid and late-flowering strains re-established best at the site with the highest annual rainfall—Wanaka. This was especially so with Bena and Tallarook, both late flowering types, and reflects the need of this group for a long growth period for adequate flowering and seed set.

EFFECT OF CLIMATE ON STRAIN PERFORMANCE

Apart from the climate effect on regeneration, there were no sharp differences in the suitability of strains to the annual rainfall of the three sites. Nevertheless a trend (Table 2) is evident. At the driest site an early mid-season variety Woogenellup was most productive. At the slightly wetter Tarras site a mid-season (Bacchus Marsh) and a late mid-season strain (Wenigup) were superior. At the wettest site, in addition to early-mid and late-mid season strains, two from the late flowering group were also high producing.

Considerable frosting was recorded in only one season at one site. This effect was severe only on certain strains: Geraldton, Dwalganup, Nangeela, Wenigup, Tallarook x Wenigup and Rutherglen, but no plants were killed. Two weeks of ground frosts greater than 18 degrees caused this damage in September. It seems unlikely then that lack of frost tolerance of any new strains will be important in the usual winter conditions experienced over most of New Zealand.

DISCUSSION

In summary the most productive strains at all sites were two in the mid-season flowering group Woogenellup and Nangeela, and these were higher producing than Mt Barker.

The late flowering group performed well only at the wettest site with 25 inches annual rainfall. Strains in the early flowering group were the lowest producers of any varieties.

No grazing or cutting for yield determination was practised during the evaluation. In spite of this the results agree broadly with those of the recent Subterraneae clover trials where cutting and or grazing was a measure of yield. In Australia, too, Mt Barker has
lately been almost completely superseded by the more productive Woogenellup.

On the weight of evidence available farmers should in future use Woogenellup instead of Mt Barker or Tallarook. Woogenellup seed must be inoculated with a special strain of root nodule bacteria. It appears to be the only strain of Subterranean clover which does not nodulate satisfactorily with the normal commercial clover inoculum available in New Zealand. Australian work, as well as very recent experiments conducted by Plant Diseases Division, D.S.I.R., shows that it is essential to inoculate Woogenellup seed with one of the special strains WA 290, WA 67 or WA 95. These are now available commercially on request. A mixture of 3lbs Woogenellup and 3lbs Nangeela per acre is advocated since the different flowering periods of these two strains will give some insurance against adverse seasonal effects.

A note of warning should be sounded here, since we know little as yet of the oestrogenic potency of strains other than Mt Barker and Tallarook. The ability of strains to adversely affect the breeding performance of ewes by their differing oestrogen content is an important aspect of Subterranean clover testing which, although well catalogued in Australia, has not been studied here. Professor Calder working at Lincoln College with Mt Barker found no adverse effect with this strain. Future varietal testing of Subterranean clovers already under way at Lincoln College will have to include a measurement of oestrogenic potency. Meanwhile although Woogenellup has been sown by farmers in increasing quantity over the last two seasons there have been no reports of serious breeding upsets on this strain.

The disappointing performance of Mt Barker in the Central Otago trials is probably due in part to its susceptibility to the aphid-borne virus diseases "stunt" virus and "red leaf" virus.

THE FUTURE

On shallow free-draining soils under low effective rainfall, rotationally grazed lucerne produces almost double the dry matter of Mt Barker-based swards. The trend on these soils will, or should be therefore, an increase of lucerne and a corresponding decrease of Subterranean clover-based swards.

However there is an estimated half-million acres of steep dry sunny-face hill-country in the South Island alone, as well as large areas of North Island hill-country, on which the use of Subterranean clover would result in higher production of herbage. This country is at present largely clothed with native species and is low producing even when oversown with white clover. Lucerne introduction in these areas is desirable but not as yet technically feasible. Little use has been made of Subterranean clover and it is here that a big increase of sowing should occur.

The very good growth of some strains of Subterranean clover in the cool seasons is an important aspect of these plants which may lead to increased use especially to provide feed at these times.

Future sowings of Subterranean clover should be made with the varieties Woogenellup and Nangeela, both of which have proved in a number of experiments to be considerably more productive than Mt Barker.
FLAMEPROOFING OF WOOL

Dr W. S. Simpson, Section Head, Fibre Modification, Wool Research Organisation of N.Z. (Inc.)

As short a time as two years ago it would have been difficult to arouse any great interest among textile manufacturers in the problem of flammability of clothing and other textiles. A small segment of the cotton industry was and still is producing flannel and winceyette in flameproof form mainly for use in children's night-wear. In high fire hazard places in industry special clothing, e.g. asbestos suits have been used, but nearly all textile goods are inflammable to varying degrees. From time to time public or official concern has been expressed about these fire hazards, but these outbursts produced little practical effect. Until very recently, no one in wool research was working on the problem of finding new or better processes, and synthetic fibre producers may have been privately concerned about it, but seemed to me to give a public impression of playing down the issue of fire safety.

The main reason for the recent upsurge of interest in research laboratories and in industry in flameproofing derives largely from legal developments. In the U.K. it is now illegal to market children's nightwear which will not pass a flameproof test even after fifty launderings. More far-reaching implications are embodied in U.S. legislation passed in December 1967 which strengthened the earlier Flammable Fabrics Act of 1964. The present law gives the U.S. Secretary of Commerce authority to promulgate standards wherever necessary to protect the public interest, and extends the Act to cover all fabrics and related products. It seems very likely that further developments such as the principle of liability for damages will evolve from these legal powers as particular areas where "public interest" is concerned are defined in the courts.

This legal activity is partly a consequence of case histories of death and injury resulting from burning clothing, and partly from special hazards posed by various kinds of fire risk, e.g. the furnishings and fittings of jet aircraft. In 1966 in New Zealand there were eight deaths and 107 hospital cases for severe burns directly attributable to clothing fires, and the toll tends to increase, even though open fires and unprotected heaters are less commonly used forms of home heating. Public buildings are particularly susceptible to fires, and when they occur they can be aggravated by the presence of flammable drapes, furnishings and carpets. The hazards of aircraft fires are already sufficiently obvious so that strict flameproof standards are applied to their furnishings.

The volume of wool or other fibres used in public buildings and transport is not a large proportion of textile consumption, but it has a high public visibility and prestige factor, on which a lot of publicity mileage may be based. For instance there is already fierce competition for the contracts to supply seat covers, etc., for the new fleets of Jumbo jets soon to be flying, and at this moment wool cloth probably could not be offered in an acceptable form to win this prestige market.

Most people tend to regard wool as a relatively safe textile fibre with respect to fire. It is certainly better than cotton, the rayons, and most of the synthetics, but it is only slightly better than the nylons, and not in the same class as some of the blended or modified synthetics.
FLAMEPROOFING METHODS

The present knowledge of what sorts of compounds will act as suitable flameproof additives for textiles has a number of gaps and anomalies, but it is established that certain elements such as boron, phosphorus, nitrogen, antimony and chlorine are often successful if combined in the right way with the fibres. One of the additives which has been traditionally applied to wool for many years, whenever a fire hazard is obvious is a solution of borate salts. These will form a thin transparent layer on cloth soaked in an appropriate solution. Unfortunately this layer, and the flameproofing action, disappears if the cloth becomes wet or if it is drycleaned. However this process is the only one until perhaps a mere few weeks or months ago, which could be carried out for wool, here or elsewhere. For example the wool fabric seat covers used in Boeing aircraft operated by N.A.C. are treated with borate salts, and the treatment must be repeated each time these covers are drycleaned. Obviously this practice is expensive and therefore unsatisfactory.

During the last few years the Proban process is one of the more successful of several treatments devised especially for cotton. It is based on a very complex polymer formed by reacting a phosphorus compound with urea or ammonia. The treatment approximately doubles the cost of cotton cloth, and also makes it stiffer, but it is permanent to washing and drycleaning. Both the Australian wool research laboratories and my research group have devised similar processes based on the same chemicals, and these are presently being evaluated. The Australian workers have just filed a provisional patent for their version.

My group have also investigated processes based on rather cheaper antimony compounds, and there are good prospects for one of these proving to be permanent to washing and cleaning. We also have a very simple process based on inorganic salts which we hope might be a practical alternative when only fastness to drycleaning is required. The advantage of this process would be that it is very cheap, but might be quite effective for drapes, furnishings, etc., that are normally only drycleaned and not washed.

My overall impression of developments up to now is that it should not prove too difficult to devise good flameproofing treatments for wool, but the commercial success of these is likely to depend on whether they may be easily applied in industry without costly outlays for special equipment. The fact that wool is less flammable to begin with, than many competing textile fibres will always be some advantage. In order to adequately proof cotton, about 20 to 20 per cent by weight of the Proban additive must be incorporated in the fabric, whereas for wool 10 to 15 per cent is apparently ample. Most successful treatments for flame-proofing synthetic fibres also appear to be rather costly or involve blending which results in a less attractive fabric.

It may prove in the long term to be of advantage to wool for high standards to be set for flame resistance because it should prove cheaper for wool to meet the standards than it would be for other fibres. This assumes of course that wool research can present to industry the cheap and preferable permanent processes I have suggested are likely to develop from our present experiments.
PEPPERMINT AS A NEW CROP

J. Lammerink, Crop Research Division, Department of Scientific and Industrial Research, Lincoln.

The rather uncertain future for some of our traditional pastoral exports has created an increasing interest in cash cropping. For instance the production of wheat, which is protected by an internal guaranteed price, has expanded to such an extent that we now have a surplus. Farmers are genuinely keen to try new, unconventional crops from sugar beet to soya beans. In this context the question is asked: Is there a place for peppermint as a new crop? Peppermint is grown for the extraction of peppermint oil, one of the most widely used essential oils. It is used in pharmaceutical preparations, flavourings, confections, beverages, toothpaste and chewing gum. It is estimated that in 1968 New Zealand had an annual consumption of 8000lbs of peppermint oil.

The first New Zealand field trial of peppermint was conducted in the early nineteen-fifties at the Rukuhia Soil Research Station, Hamilton and described by Elliott and Adams in the 1952 New Zealand Journal of Agriculture, Volume 85: 240. However, with the high prices for wool, meat and dairy produce at that time, there was little incentive to develop a new crop, and research work on peppermint was discontinued.

Over the last few years the position has changed considerably. Professor M. D. Dawson of the Oregon State University, who was Visiting Professor at Lincoln College last year drew our attention to the tremendous development of the process crop industry in Oregon. He pointed out that New Zealand has an ecological and sociological environment remarkably similar to that of Oregon, and should have a great potential for process crops. Peppermint was one crop he thought we could grow as well as Oregon. According to Professor Dawson, peppermint grosses in excess of $5 millon to Oregon farmers. Peppermint oil is exported from Oregon to many parts of the world including New Zealand, Australia and South East Asia. Growing peppermint in New Zealand seemed a proposition well worth investigating.

Peppermint, botanically known as Mentha piperita should not be confused with other species of mint such as spearmint (M. spicata) and winter mint (M. cordifolia) which grow in virtually every New Zealand home garden. Both also occur in the wild as escapes from cultivation. Peppermint was first recorded growing wild in New Zealand near Auckland by Kirk in 1870. It is also found growing along streams in many parts of the country including Canterbury, often together with the so-called bergamot or lemon mint (M. citrata) which it closely resembles.

There are two main types of peppermint. One type has dark-green to purple stems with dark-green leaves and is called black mint. The other type has stems and leaves of a lighter green. Black mint is the more desirable type. Oil is present in numerous minute glands, mainly on the underside of the leaves.
Although peppermint probably originates from the Mediter­ranean region, the first commercial crops were grown in the 18th century in the Mitcham district, now a London suburb. Black Mitcham mint was introduced to many other European countries where it replaced local strains. In 1812 Black Mitcham mint was introduced to the United States where it spread from east to west. Since 1835 the crop has been grown in the Midwest, but the first commercial plantings in Oregon and Washington were established in 1919.

Because peppermint does not set seed normally, it must be propagated vegetatively from runners (rhizomes and stolons). Runners are usually planted in early spring in furrows, four to six inches deep and about three feet apart. Peppermint does well on deep, alluvial, well drained soils of a rather loose texture, provided sufficient soil moisture is available and irrigation is essential. However, warm dry weather is required in late summer before the crop is harvested. Weeds are a serious problem, because they can affect the quality of the oil considerably. Fields with perennial weeds, such as twitch (Agropyron repens), and Californian thistle (Cirsium arvense) should be avoided. Annual grasses and broad-leaved weeds can be controlled with terbacil weedkiller applied after planting, but before the crop emerges. However, some hand weeding may still be necessary. Just before, or at full flowering, the crop is mown and the partially dried material is picked up with a forage harvester after one or two days drying and carted to the steam distillation plant, where the peppermint oil is extracted. In Oregon the crops are usually maintained for two or three years only for maximum production.

Crop Research Division in 1968 decided to investigate the possibility of growing peppermint in New Zealand and imported disease-free material of a high yielding, good quality strain from Oregon. Through the courtesy of Dr C. E. Horner, a plant pathologist of the United States Department of Agriculture, in charge of mint research, 400 rhizomes of Black Mitcham mint arrived by air from Oregon State University on 29 March, 1968. The rhizomes were propagated in the glasshouse by taking tip cuttings of new shoots. The rhizomes were then destroyed as a further precaution against introducing mint diseases and nematodes. On 30 September a nucleus block of over 3800 plants was planted at Lincoln on Paparua Sandy Loam and a similar number of plants were sent to Winchmore Irrigation Research Station for planting on Lismore Stony Silt Loam. At Lincoln the plants were placed in rows three feet apart with one foot between plants in the row. A mixture of equal parts of superphosphate and nitrolime at the rate of about 2cwt per acre, was placed in the rows before planting. Despite two spray irrigations on 29 October and 28 November, there was very little growth before mid-December. After growing vigorously in the glasshouse during our winter, which coincides with Oregon's summer, the plants seemed to go through a period of semi-dormancy, perhaps caused by their transfer from the Northern to the Southern Hemisphere. Another two irrigations were applied on 19 December and 7 February. There was vigorous growth only from mid-December to late February when the crop was coming into flower. During that period the crop spread within and between the rows. Trial distillations at weekly intervals from 10 February
to 17 March were carried out by Chemistry Division, D.S.I.R., Petone, and at Crop Research Division, Lincoln. The oil content expressed on a dry matter basis was high. It varied from 1.30 per cent before flowering to 0.96 per cent at full bloom, the recommended stage of harvesting for good quality. The composition of the peppermint oil samples analysed by Dr Terry Manning of Chemistry Division was well within the acceptability range reported from Oregon. The estimated yield of 18lb per acre was low, but this was not unexpected considering the initial lack of adaptation of the recently introduced plants. A big increase in yield is expected next year.

According to Dr Horner, a good grower in Oregon should get 70 to 80 pounds of peppermint oil per acre which he can sell at the current price of $US5 per pound. However, there is a large investment involved for labour, root stock, irrigation, fertilisers and weed killers and for a steam-distillation plant, which may cost as much as $US20,000 for a plant which could handle about 100 acres. However, I visualize that in New Zealand the crop would be grown by a number of growers under contract to a processing firm, able to integrate the steam distillation and rectification of peppermint oil with other operations thereby spreading overhead costs.

At a yield of 80lbs per acre, 100 acres would supply New Zealand's present consumption of peppermint oil, but our target should be to sell New Zealand peppermint oil on the world market, where it will have to compete with oils from other sources, including Oregon.

Before a local peppermint industry can be established, trial plantings need to be made in some selected districts with a favourable soil, irrigation potential and plenty of sunshine. Furthermore, samples of peppermint oil must be evaluated for quality, not only locally, but also by international flavour houses.

Crop Research Division can assist by supplying planting stock and advise on crop management and steam distillation.
Much publicity has recently been given to some of the defects of conventional methods of insect control which involve the widespread application of insecticides. You will be aware of the mounting suspicion with which residues of organochlorine insecticides such as DDT and Dieldrin in animal fats are coming to be regarded. You will also be aware of the problems sometimes created by the evolution of insecticide-resistant strains of insects. Yet in many cases satisfactory alternatives to the application of conventional insecticides still do not exist. One way of dealing with this situation is to institute a search for new insecticides, for new formulations or new methods of application which might avoid the present difficulties. I understand that work along these lines is currently being carried out in the laboratories of the insecticide manufacturers. On the other hand research into alternative methods of insect control has also been intensified in the last ten years—much of this seems to be going on outside the laboratories of the insecticide manufacturers.

The major alternative methods available at present fall into three categories. These are:

(a) Biological Methods of Control. Examples include the use of predators or parasites of pest species or of insect pathogens.

(b) Methods involving the sterilisation of insects rather than their immediate destruction.

(c) Methods involving the use of insect attractant chemicals.

It is with this last approach that I shall be concerned today.

Insects may be attracted by many agencies. Heat is attractive to some species. Light, both visible and ultraviolet may also be attractive—many insects are attracted to colours. But at the outset it is apparent that the best prospects for evolving large scale control methods with an attractant seem to depend on the development of suitable chemical attractants. This is possible because insects are known to use chemical odours to locate a source of food, a site where eggs may be laid, a mate or a fellow although all insects do not use chemical agencies alone in these activities. In the case of some species, factors such as sight may be highly important. With some insect-attracting flowers the attractant effect is sometimes due to a combination of sight plus chemicals such as sugars which display a contact effect only. Compounds of this latter class, although they may be responsible for the assembly of large numbers of insects, are really arrestants not chemical attractants.

The scientific search for chemical attractants has been carried out in several different ways. One method is to make a random selection of organic chemicals and to expose these to a limited selection of insect pest species. This can be done quite simply:

Screening is continued until a compound is found which displays attractant activity. Related compounds are then obtained or synthe-
sised and again screened. Any relationship between structure and activity may be noted and used in further synthesis and screening. The results of such tests indicate that a large number of compounds may have some attractant effect. In many cases the effect is very weak. Even relatively strong effects are liable to be reduced greatly when attractant tests are carried out subsequently under field conditions.

Of course such tests can only involve a limited range of pest species. Most of the work of this type has been carried out by the United States Department of Agriculture and consequently most of the data concerns insect pests of importance in the U.S.A. Despite the effort put into this work and the fact that many thousands of compounds have been screened it is fair to say that for one reason or another none of the attractive materials discovered during the course of this work has yet been employed in insect control work in the field. However, several materials have been used in conjunction with insect traps, in surveys to determine the extent of pest infestation in a particular area.

Another approach to search for chemical attractants involves the chemical examination of natural products which are known to be attractive to insects. An elementary precaution here is to ensure that the basis of attraction really is chemical. This has been neglected on occasions and may be one of the reasons why this field is far less productive of results than might have been supposed. There is, of course, no shortage of fermenting bait type attractants for insects, e.g. stale beer or port wine. Some of these mixtures have for long been in use in field surveys. However, the mixtures themselves are short-lived and unsatisfactory in many ways, and no chemical identification of the active constituents of these mixtures has yet been published.

A third approach and one which has received more publicity than the other two has involved the characterisation and isolation of the so-called insect sex attractants. There are two reasons for the publicity which this approach has received. One is that from a scientific point of view enormous physiological potency was exhibited by some of the first compounds to be investigated. The second reason for the publicity associated with this field is less scientific and more obvious! It had long been known that newly emerged female insects, particularly moths, are highly attractive to males. Caged females have for many years been used in insect traps in survey work aimed at determining the distribution of certain pest species, such as the gypsy moth which is a pest of woodlands in the U.S.A. That the basis of the attraction was chemical was beyond doubt and work on the isolation and identification of the sex attractants of two moth species, including the gypsy moth was commenced in the 1930s. Progress was very slow for the active materials were present in minute quantity. However, in the late 1950s the advent of new physiochemical techniques enabled work to proceed more quickly and the chemical structures of the first two compounds was released in 1961. In the isolation of the gypsy moth sex attractant a total of twenty milligrams (twenty thousandths of a gram) was obtained by extracting some half a million adult female moths. The material was subsequently synthesised
on a very small scale by an involved chemical procedure and in this way the previously assigned structure was verified. Despite the potency of the compound the difficulties involved in its preparation clearly ruled out any attempts at field trials. It was found possible to synthesise a related compound which in the lab showed activity of the same order. However, the chemical synthesis of this material on a large scale is apparently still not entirely satisfactory. Activity varies widely with batches and interpretation of the field trials which have been held is made difficult by this fact. This material, "gyplure," is still a comparatively expensive compound.

Since 1961, the structures of several more insect sex attractants have been worked out. Most of the insects concerned are moths. Although accurate data is not available concerning the effective range of most of these new compounds, there are indications that it is likely to be less than the mile or so recorded for the gypsy moth. This is important when one considers possible practical applications of these compounds.

At this stage I should like to discuss recent developments at Lincoln College.

In October 1967, following a decision to expand research against the grass grub within Lincoln College, a team consisting of Dr C. P. Hoyt, a biologist, and myself, an organic chemist, commenced work in the then very recently completed Hilgendorf Wing. Dr Hoyt's scientific interests were, inter alia, the field of chemical attractants. Mine were in the general area of organophosphorus chemistry and insecticides chemistry. However, in the beginning, little scientific apparatus was available so we decided to collaborate on a project in the chemical attractants field. This seemed to be the area where there was the greatest chance of producing some results reasonably quickly with the means available. Naturally we decided to make the grass grub our principal target. We decided to look for an attractant for the adult stage of the insect—the brown beetle. One approach would have been to start evaluating some of the chemical compounds already known to attract beetles. However, few of these compounds were available or could be synthesised in time. So we turned to look at some of the host plants of the beetle. You will know that beetles emerge from the pupal stage in late October. On favourable evenings they fly from the ground at dusk to the foliage of various trees where they rest, mate and feed on the leaves. A wide range of host species has been recorded. However, we were interested to note that in this area the common elder (Sambucus nigra) seems to be particularly attractive to beetles. At the time of beetle flights this plant is in flower and both the flowers and the leaves possess strong aromas.

We carried out some very simple tests to determine whether the material present in the leaves or the flowers was, in fact, acting as a chemical attractant. We merely took three containers, filled one with fresh leaves, another with fresh flowers and the third was kept empty as a control. All three containers were covered with white muslin to conceal the contents. They were then placed in a paddock on a still, warm evening just before the commencement of beetle flights. The results of this exceedingly simple experiment were interesting. The bucket containing flowers was surrounded by a cloud of beetles while the other buckets were unvisited. This seemed
to indicate that a chemical attractant was present in the aroma of elder flowers.

We now took a few kilograms of fresh flowers and steam distilled them in the lab. Field tests for attractancy, carried out with insect traps, indicated that the attractant activity was concentrated in the first few drops of distillate. A number of beetles were trapped in this way during the middle of November, 1967. On examination it was discovered, surprisingly, that they were nearly all females.

In 1967 we soon ran into trouble. The grass grub beetle is, of course, an exceedingly difficult species with which to work. Major flights occur for about six weeks in the period from the end of October to the end of December. There are many nights during this period when flights may not take place at all. Yet all of our bioassay experiments must be carried on in the field. In December 1967 we suddenly began to run out of beetles and elder flowers quite simultaneously and this project had to be stopped and other work embarked upon.

It was anticipated that in 1968 our main preoccupation would be with the above project although we had now acquired a fair selection of chemicals which had been reported in the scientific literature to show general attractant activity against other beetles. We intended to test these compounds and had proceeded to do so systematically—and quite unsuccessfully—when a chance happening completely re-orientated our research programme.

In October last year when beetle flights commenced it was certainly not possible to state that the species utilise a sex attractant chemical. There was some evidence for this but there was also opposing evidence. We thought that it might be of interest to carry out some very simple, basic experiments which would indicate whether, in this case, sight was important in the attraction of males to females.

Several newly emerged female beetles were thoroughly extracted with organic solvents to remove all odiferous chemicals. They were then exposed on the leaves of an elder tree just before beetle flights occurred. The night was slightly windy so the dead beetles were secured in place with a small amount of one particular synthetic chemical adhesive. To our intense astonishment the dead beetles were highly attractive. However, on the following evening beetles which had been deodourised in the above way but which were fixed on with a variety of other brands of adhesive or glue, or were exposed without being fixed were quite unattractive. But small particles of the original adhesive put out on their own were quite attractive.

Using the original preparation we were subsequently able to trap considerable numbers of beetles. On examination they were found to be all males. This, together with their behaviour indicated that the adhesive did contain a compound functioning as a sex attractant although, of course, it is not necessarily the actual chemical used by the beetle in nature.

Although fractions containing the active ingredient can readily be isolated our work on the chemical characterisation of the material had to stop—as we again ran out of beetles.
The big question now is whether this new material can be put to practical use to control the grass grub. We anticipate that development work will fall into three phases.

1. Chemical characterisation of the material must be completed. It may also be desirable to try to increase the concentration of active material in the product. The adhesive used in our tests contained the active ingredient as a minor product, only.

2. More biological work is necessary. We must determine the age and condition of the male beetles attracted. We must carry out more accurate determinations of the range and persistence of the material.

3. Only when the above preliminaries are substantially complete—and the chemical and biological work will be carried out concurrently—can field trials commence.

The question arises, of course, "How could a chemical attractant be used in grass grub control?"

Although the ways in which insect attractants might be usable in insect control has been discussed in the scientific literature there have been very few attempts to translate theory into practice. Very few field trials have been carried out. This is due largely to the fact that attractant chemicals which can be used conveniently against major pest species have simply not been discovered.

However, although relatively little field work has been carried out, successes have been registered in the following instances:

1. Annihilation of the oriental fruit fly on the island of Rota in the Marianas in 1963 by the use of the chemical attractant methyl eugenol (discovered in 1912) combined with an organophosphorus insecticide.

2. Attractant/chemisterilant mixtures have been used successfully although of course no chemisterilant work has yet been done on the grass grub beetle.

3. In small scale trials a chemical attractant has been used successfully to mask the odour of newly emerged female insects so that they could not be detected by the males.

Of course, when we discuss the practical application of this latest discovery in New Zealand we are moving into quite uncharted territory. From a scientific point of view it is impossible to make any prediction concerning the practical application of the new material until some field trials have been carried out. There are obvious difficulties. However, the fact remains that this material possesses some extremely desirable attributes—cheapness and persistence. Field trials will commence as soon as possible. The issues at stake are considerable and we shall carry the matter forward at the utmost pace.
EARLY WEANING OF DAIRY CALVES

R. H. Khouri, Ruakura Animal Research Station, Hamilton.

Rising costs, increasing herd sizes and greater use of surplus dairy calves for beef production have taxed the New Zealand dairy farmers' labour resources in recent years. These trends have highlighted the need for earlier weaning systems of calf feeding than the eight to nine weeks minimum commonly advocated for pasture reared animals (McMeekan 1955). Two years of Ruakura research on early weaning are best introduced by brief descriptions of the stomach in adult cattle and in newly born calves.

THE STOMACH IN ADULT CATTLE

Cattle have a four-chambered stomach, the rumen, reticulum, omasum and abomasum (Fig. 1). The rumen has a capacity of
20-60 gallons, occupies most of the body cavity on the left and lower sides and accounts for 80 per cent of the total stomach volume.

Solid feeds enter the rumen and are fermented to a fine consistency by a mixed population of bacteria and protozoa. Unfermented feed residues and micro-organisms then pass through the reticulum and omasum to the abomasum or true stomach where enzymic digestion begins. Most of the nutrients produced by fermentation are absorbed through the highly papillated wall of the rumen and those arising from enzymic digestion are assimilated in the intestines.

THE STOMACH IN CALVES AT BIRTH

Calves are born with an incompletely developed stomach (Fig. 1). The rumen is small, has a thin smooth wall and is tucked under the rib cage in the upper part of the body cavity. Ruminal capacities range from one to three pints and account for only 30 per cent of the total stomach volume.

Like all other mammals calves are almost entirely dependent on milk for a supply of essential nutrients during early life. Ingested milk does not enter the rumen but is diverted by the oesophageal groove to the abomasum and from there passes into the intestines. Enzymic digestion begins in the abomasum and continues in the intestines as in simple-stomached animals.

RUMEN DEVELOPMENT

Chemical compounds known as steam volatile fatty acids stimulate rumen development. These acids are produced in the rumen by microbial fermentation of solid feeds. The rumen of calves with free access to solid feeds attains maturity at the age of about three months.

SOLID FEEDS

Solid livestock feeds are divided into two main categories, roughages and concentrates. Roughages are fibrous and bulky and include pasture, hay and silage. Concentrates are low in fibre and dense and include cereal grains, protein meals and formulated mixtures of the two.

Ground meals are fermented more rapidly and pass through the rumen more quickly than course roughages. Meals can therefore supply calves with a greater amount of nutrients than roughages during the transitional period of rumen development.

EARLY WEANING

Years of research and experience have shown that indoor reared calves can be weaned at the age of three to five weeks if whole milk is fed at low maintenance levels and concentrate meal mixtures and good quality hay are offered free choice from the first week of life (Table 1). The feeding system promotes early consumption of solid feeds, accelerates rumen development and is known as "the restricted whole milk and early weaning concentrate mixture method" (Preston 1956, 1967, Roy 1959). Calves are ensured an adequate supply of nutrients during the post-weaning period by continued feeding of meal. This is usually withdrawn at the age of 10-12 weeks when the rumen approaches maturity and calves can derive their nutrient requirements from good quality roughage. The main advantages of the system are reduced labour inputs, decreased consumption of whole milk and lowered incidence of scours.
TABLE 1
Feeding Programme

<table>
<thead>
<tr>
<th>Quantity and Duration</th>
<th>Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3 pts/calf/day for 5 weeks</td>
<td>Whole Jersey Milk*</td>
</tr>
<tr>
<td>To appetite for 9 weeks and gradually withdrawn during subsequent 3 weeks</td>
<td>Concentrate mixture**</td>
</tr>
<tr>
<td>To appetite throughout</td>
<td>Hay**</td>
</tr>
<tr>
<td>From 6 weeks onwards</td>
<td>Pasture</td>
</tr>
</tbody>
</table>

*Calves brought onto full ration of milk in three days.
**Concentrate and hay offered from the first week.

EARLY WEANING MEAL MIXTURES

Early weaning meal mixtures are based on cereal grains (Table 2). These are coarsely ground or rolled and are included at levels of 60-70 per cent. Protein supplements such as vegetable oil meals, buttermilk powder, meat meal and fish meal are incorporated, either singly or in combination, to raise the crude protein content of the mixture to the generally recommended level of 20 per cent. Taste and smell are improved by the addition of 7.5-15 per cent molasses or "molassine meal." Minerals and fat soluble vitamins are added to avoid micro-nutrient deficiencies.

TABLE 2
Formulation, Mean Chemical Composition and Estimated Cost of Concentrated Mixture

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent</th>
<th>Amount (lb)</th>
<th>Price ($/ton)</th>
<th>Cost ($)</th>
<th>Mean Chemical Composition ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolled barley</td>
<td>65</td>
<td>1300</td>
<td>61.02</td>
<td>39.66</td>
<td>Dry matter 85.81</td>
</tr>
<tr>
<td>Meat meal</td>
<td></td>
<td>280</td>
<td>82.14</td>
<td>11.50</td>
<td>Protein 19.26</td>
</tr>
<tr>
<td>(60% protein)</td>
<td>14</td>
<td>200</td>
<td>80.46</td>
<td>8.05</td>
<td>Ether extract 3.56</td>
</tr>
<tr>
<td>Linseed meal</td>
<td>10</td>
<td>16</td>
<td>44.64</td>
<td>0.36</td>
<td>Crude fibre 5.34</td>
</tr>
<tr>
<td>(36% protein)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ash 6.20</td>
</tr>
<tr>
<td>Liquid molasses</td>
<td>10</td>
<td>200</td>
<td>62.50</td>
<td>6.25</td>
<td>Nitrogen free extract 65.64</td>
</tr>
<tr>
<td>Salt</td>
<td>0.8</td>
<td>4</td>
<td>3.20</td>
<td></td>
<td>Calcium 1.03</td>
</tr>
<tr>
<td>Trace minerals and vitamins**</td>
<td>0.2</td>
<td>4</td>
<td></td>
<td></td>
<td>Phosphorus 0.74</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>2000</td>
<td></td>
<td>69.02</td>
<td></td>
</tr>
</tbody>
</table>

*Whole prices.
**Each tone was supplemented with: Vit. A 16 m.i.u., Vit. D 4 m.i.u. Vit. E 40,000 i.u. Ferrous sulphate 1000 gm, copper sulphate 80 gm, cobalt sulphate 50 gm, potassium iodate 1 gm, manganese sulphate 100 gm, zinc sulphate 40 gm and selenium 0.15 p.p.m.
RUAKURA RESEARCH

A pilot trial conducted in early 1967 showed that dairy calves could be economically reared on pasture by the "restricted whole milk and early weaning concentrate mixture" method of feeding (Khouri, Stronach and Steele, 1967). This was followed by a series of experiments aimed at improved calf performance and at reducing costs and labour still further.

New Zealand manufactured protein supplements were investigated first, because the protein of buttermilk powder was twice as expensive as that of meat meal. Results indicated that calves would, contrary to commonly held belief, consume concentrate mixtures containing high levels of good quality meat meal (up to 24 per cent of the mixture, Khouri, 1968) and that the three supplements were nutritionally similar (Khouri, unpublished data).

Other experiments were aimed at reducing the labour and time associated with the hand feeding of milk which either entails the herding of calves to the dairy or the hauling of milk to pasture. Animals in these experiments were restricted to sheltered lean-tos adjacent to the dairy during the initial five weeks of milk feeding and were reared on pasture from weaning onwards. The lean-tos opened onto loafing yards and provided the animals with shelter in bad weather. Both areas were bedded, either with untreated wood shavings or with barley straw. A six-inch layer was first spread out. This was raked daily during the first two weeks and was thereafter topped once or twice weekly as required. Calves reared under these conditions grew more rapidly and did not scour as badly as those on pasture. Odd cases of scours were noted during or after rainy weather and were invariably cured by fasting animals off milk for a day and by gradually returning them onto their full allowance.

The latest study (Khouri, in press) showed that Friesian calves could be fed milk once instead of twice daily from the outset at no sacrifice in performance or increase in meal consumption (Table 3). In this study overall growth rates during the first 15 weeks of life averaged 1.4lb/calf/day at a total investment of $9.47/animal in milk and concentrate. These figures compared favourably with those previously noted in conventionally reared Friesian calves fed for nine weeks on a gallon of milk/day, namely a growth rate of 1.2lbs/calf/day at a feed cost of $9.25/animal (Khouri et al. 1967).

Reductions in the feed costs of early weaning could be achieved if barley were home grown and not purchased. Substitution of whole milk with proprietary high fat milk replacers and shorter post-weaning periods of concentrate feeding could further reduce costs but then only at a possible sacrifice in calf performance.

PRACTICAL IMPLICATIONS

The New Zealand dairy farmer could save himself a considerable amount of time and labour by adopting the "restricted whole milk and early weaning concentrate mixture" method of calf rearing. He could reduce and spread out his work load even more if he resorted to once a day feeding of milk from the outset, fed his calves during late morning or early afternoon and confined them to sheltered yards near the dairy during the pre-weaning period. Sheep farmers could
also adopt this method for the rearing of dairy beef by feeding reconstituted proprietary high fat milk replacers instead of whole milk.

**TABLE 3**

<table>
<thead>
<tr>
<th>Period (weeks)</th>
<th>Calf Performance and Concentrate Consumption</th>
<th>(Milk twice daily)</th>
<th>(Milk once daily)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival to 5</td>
<td>Mean initial live weight, lb</td>
<td>86.6</td>
<td>86.4</td>
</tr>
<tr>
<td></td>
<td>Mean liveweight at 5 wks lb</td>
<td>125.0</td>
<td>121.5</td>
</tr>
<tr>
<td></td>
<td>Mean liveweight gain lb</td>
<td>38.4</td>
<td>35.1</td>
</tr>
<tr>
<td></td>
<td>Mean growth rate, lb/calf/day</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Mean concentrate consumption</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>5 to 9</td>
<td>Mean liveweight at 9 wks, lb</td>
<td>175.9</td>
<td>172.8</td>
</tr>
<tr>
<td></td>
<td>Mean liveweight gain, lb</td>
<td>50.8</td>
<td>51.1</td>
</tr>
<tr>
<td></td>
<td>Mean growth rate, lb/calf/day</td>
<td>1.7</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Mean concentrate consumption</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>9 to 12</td>
<td>Mean liveweight at 12 wks, lb</td>
<td>203.7</td>
<td>201.1</td>
</tr>
<tr>
<td></td>
<td>Mean liveweight gain, lb</td>
<td>27.8</td>
<td>28.4</td>
</tr>
<tr>
<td></td>
<td>Mean growth rate, lb/calf/day</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Mean concentrate consumption</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>12 to 15</td>
<td>Mean liveweight at 15 wks, lb</td>
<td>231.3</td>
<td>229.7</td>
</tr>
<tr>
<td></td>
<td>Mean liveweight gain, lb</td>
<td>27.3</td>
<td>28.7</td>
</tr>
<tr>
<td></td>
<td>Mean growth rate, lb/calf/day</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Arrival to 15</td>
<td>Mean liveweight gain, lb</td>
<td>144.6</td>
<td>143.1</td>
</tr>
<tr>
<td></td>
<td>Mean growth rate, lb/calf/day</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Mean concentrate consumption</td>
<td>1.6</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Total concentrate consumption</td>
<td>169.5</td>
<td>173.1</td>
</tr>
</tbody>
</table>

**REFERENCES**


STOCK BREEDING RESEARCH AT THE WHATAWHATA HILL-COUNTRY RESEARCH STATION

G. K. Hight, Whatawahata Hill-Country Research Station, Department of Agriculture, Hamilton.

The Whatawahata Hill-Country Research Station is situated one mile west of Hamilton, and now consists of 2000 acres of land, of which 1750 acres are partly developed. Within this area, land varying in altitude up to 1300ft above sea level and a variety of soil types occurs, but it is fairly typical of much of the North Island hill country, or in fact about two-thirds of the North Island. Experimental flocks of breeding ewes, replacement hoggets, rams, wethers, breeding cows, replacement heifers and bulls are carried. All but a small proportion of the sheep are used in detailed experiments. Increased topdressing, subdivision, oversowing of burnt fern and scrub areas, gorse eradication, higher stocking rates and improved management have contributed to increasing the carrying capacity from 3 to 5 ewe equivalents per acre over the 1962-67 period. An increasing proportion of the farm is already carrying 7 ewe equivalents per acre. Further increments to over 12,000 ewe equivalents are planned. The sheep and beef cattle research programme is therefore being conducted within an integrated developing hill-country unit, and all staff members actively participate. The staff at present consists of four scientific officers, seven field technicians, and two records assistants, together with supporting services. In addition to the station livestock projects collaborative work is being undertaken at Kaikohe, South Auckland, Mangakino, Tangoio near Napier and Havelock North, and on soil fertility, pastures, forestry and fencing. While the station is essentially orientated to animal production research considered relevant to the farming industry, the participation of scientists interested in any aspect of hill country is encouraged, and joint projects are undertaken with Ruakura staff. There is limited factual information available to hill-country farmers, and we are convinced that large increases in efficiency are feasible. There have been few attempts to test the maximum productivity of hill country in New Zealand with the most efficient sheep or beef cattle available when grazed together on high-producing adequately fertilised pastures. The approach at Whatawahata is to examine how and why different breeds or classes of stock differ in productivity, in order that a more rational basis for hill-country farming can be achieved.

Previous sheep experiments have been concerned with the effects of Border Leicester-Romney crossbreeding, wool efficiency, effects of shearing on appetite and two-tooth fertility, different pasture treatments on intake and gains of hoggets, and the long-term effects of contrasting planes of nutrition. The Aberdeen Angus beef breeding herd has been used to describe the effects of various nutritional levels over the late pregnancy and suckling periods, for early weaning studies, and developing a new bull mating harness.
At present two main flocks of sheep are being studied. One flock consists of four selection and two control lines, each of 200 breeding ewes and their replacements. A Romney flock is being selected for a high October hogget fleece weight, another Romney flock for a high post-shearing hogget body weight, a Border Leicester x Romney flock is being interbred and selected for a high body weight and these are being compared with a randomly bred Romney control flock so that genetic changes can be studied. A further Romney flock has been established by screening a large population of sheep for those with a high lambing performance. Some 200 ewes which have reared twin lambs at each of their two-tooth and four-tooth lambings are to be further selected for a high number of lambs weaned. The weight of hoggets after shearing in October is highly heritable and positively related genetically with the number of lambs born, earliness of sexual maturity, weaning weight and post-weaning liveweight gains and is easily measured. Use of this criteria enables sheep to be quickly ranked in order of their likely future productivity at an early age and without detailed recording. It should therefore be possible to select hill-country sheep indirectly for higher productivity without actually recording individual animal performance of the whole flock. It is for these reasons that the effects of selection for this trait in genetically different flocks is being studied. The high fertility Romney flock formed by screening a large population enables a very high initial level of fertility to be attained, and the results from this work will be particularly relevant to the ram breeding industry. It seems likely that sufficient Romney rams for the industries’ requirements could be bred from ewes which rear unassisted to weaning a minimum of 200 per cent of lambs, if we continuously screened both commercial and registered flocks for animals capable of this performance, and this is what we should be aiming for. These sheep were made available by a large breeding scheme, and this will be discussed later in this paper.

A second group of sheep consisting of representative flocks each of 200 ewes and their replacements of the Perendale, Border-Romney, Romney, fine-woolled Merino, Corriedale and some Cheviot sheep was formed in 1969. These sheep have been purchased from several breeders in both the North and South Islands. Romney and Merino x Romney sheep are also being compared. Interest in purebred fine-woolled Merinos and Merino x Romney sheep has been revived by overseas reports that Tasmanian sheep produced well under high rainfall conditions, and the consistently stronger demand for fine than crossbreed wool. If a permanent change to finer wool is required then crossbreeding with Tasmanian Merinos offers perhaps the only way of doing this rapidly. These sheep are to be compared with representative flocks of other breeds since surprisingly, no previous comparisons of all these breeds have been conducted on North Island hill country. Considerable interest, too, is being shown in the importation of exotic sheep and cattle breeds. Before these animals are widely used it is vital that they are compared with the range of genetic material already available in New Zealand. We must be careful not to assume that because exotic breeds are high priced they are automatically superior, and if any of these animals are proven to have useful traits then we must also evaluate the effects of crossbreeding with our existing breeds. These genetically different animals
will therefore further test the assumption that the Romney breed is the most suitable for developed North Island hill country and present markets, and enable an evaluation of other existing and exotic sheep.

In all flocks detailed records of fertility, lamb mortality, weaning weights, hogget growth rates, oestrous behaviour and ovulation rates, fleece weight and quality are being collected. All sheep are individually identified from birth.

Field trials are also being conducted on the mating behaviour of ewe hoggets and its relationship to subsequent fertility at Kaikohe, South Auckland and Havelock North, and a collaborative breed comparison project involving Romney, Perendale and Border x Romney sheep has been initiated on the Tangoio Soil Conservation Station at Napier.

It is of interest to us that two large scale private sheep breeding schemes, one with 40,000 Romney ewes and another with 12,000 have been established. A further large sheep breeding scheme involving the screening of 60,000 Romney ewes was started in 1968. In the first year of this scheme some 2700 Romney ewes each of which had reared twin lambs, together with the best 2500 ewe hoggets from among the 16,500 available were transferred to a central flock for more detailed recording and subsequent selection. The purchase of high fertility sheep from these schemes has enabled the high fertility flock to be established at Whatawhata.

A wool metrology unit is being established at Whatawhata which in collaboration with Massey University and other laboratories, will provide objective information on wool growth and quality of the different breeds and classes of sheep.

The main cattle projects at present centre around the comparison of purebred Friesian and Angus cattle as beef producing hill-cows, the development and testing of a new bull mating harness for observing the mating behaviour of cattle, artificial insemination and systems of double or triple-suckling Friesians. Information is also being collected on the effects of nutrition and early weaning with or without concentrates on the growth of Angus calves. Dr Dalton, with the co-operation of the Dairy Board and the Department of Lands and Survey, has commenced studies on the growth rate, carcass composition and relationships with the genetic capacity for milk production in 75 Friesian bull calves. This is to be extended to include about 200 Friesian plus Angus bull calves during the 1969 season. Future plans at the Hill-Station are to compare purebred Friesian, and Angus with Friesian x Angus, and Friesian x Jersey cattle as beef hill-cows, with the Friesian or crossbred females being mated to Friesian bulls.

These studies will provide performance data on different breeds or types of sheep and cattle, and the extent to which various characters are related within and between breeds. By studying in detail the growth rate, liveweight, fertility, food efficiency, carcass composition, lamb mortality, etc., on genetically different animals a more detailed understanding of hill sheep and cattle can be provided. This knowledge is essential before the effects of using other methods of selecting animals can be predicted.
In selecting topics to discuss in greater detail I would like to restrict comment to:

(1) Results from the Border x Romney crossbreeding experiment and factors associated with lamb mortality.
(2) The large scale sheep breeding schemes, and
(3) The comparison between Friesian and Angus cattle as beef producing hill cows.

**Border Leicester and Crossbreeding and Lamb Mortality**

It is widely appreciated that the inherent capacity of Romney flocks to wean a high percentage of lambs with the minimum of assistance is a major inefficiency of sheep farming. There are two ways of changing this. We can select from within the Romney for high fertility or Romney sheep can be crossbred with another breed of higher fertility. The effects of crossing the Romney ewe with Border Leicester rams and interbreeding the crossbred ewes to first-cross or F1 rams was therefore studied at Whatawhata. Romney sheep have been compared with first (F1), second (F2), and third (F3) cross Border Leicester x Romney ewes. All females except those with obvious defects were retained until after the four-year-old lambing on hill country and were grazed together from birth, except over the mating period. A fifth flock of Romney ewes with the same background as the Romney control flock, was used as the source of crossbred ewes, and is referred to as the Remainder flock. The lambs from the first-, second-, and third-cross ewes are referred to as F2, F3 and F4 respectively.

The overall fertility analysis of these flocks for the years 1959-67 are given in Table 1. Data in this table shows that the number of ewes lambing as a percentage of the number of ewes present at lambing was higher for the F1 ewes than in the other five flocks. The percentage of ewes lambing with multiple births was higher in the crossbred ewe flocks (F1, F2, F3), than in the Romney ewe flocks (RCR, RER)). The number of lambs born per 100 ewes present at lambing increased to the F1 ewes, and then tended to decline with interbreeding without selection in the F2 and F3 ewes. Similar trends were evident for the number of lambs weaned per 100 ewes present at lambing. The overall lamb survival rate was highest for

---

**TABLE 1**

<table>
<thead>
<tr>
<th>Sire</th>
<th>Romney</th>
<th>Romney</th>
<th>Leicester</th>
<th>F1</th>
<th>F1</th>
<th>F1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewe</td>
<td>Romney</td>
<td>Romney</td>
<td>Romney</td>
<td>F1</td>
<td>F2</td>
<td>F3</td>
</tr>
<tr>
<td>Lambs</td>
<td>Remainder</td>
<td>Control</td>
<td>F1</td>
<td>F2</td>
<td>F3</td>
<td>F4</td>
</tr>
<tr>
<td>No. years records</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>No. ewes at lambing</td>
<td>1158</td>
<td>1396</td>
<td>1344</td>
<td>1401</td>
<td>1234</td>
<td>558</td>
</tr>
<tr>
<td>% ewes lambing</td>
<td>87</td>
<td>88</td>
<td>84</td>
<td>93</td>
<td>88</td>
<td>87</td>
</tr>
<tr>
<td>% multiple births</td>
<td>17</td>
<td>17</td>
<td>14</td>
<td>35</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Lambs born per 100</td>
<td>100</td>
<td>103</td>
<td>96</td>
<td>126</td>
<td>115</td>
<td>118</td>
</tr>
<tr>
<td>ewes at lambing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lambs weaned per 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ewes at lambing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamb survival rate %</td>
<td>80</td>
<td>82</td>
<td>83</td>
<td>86</td>
<td>81</td>
<td>78</td>
</tr>
</tbody>
</table>
F2 lambs from F1 ewes, but declined in the F3 and F4 lambs. No selection was practised to offset this decline. Analyses to date show that lambs from first- and second-cross ewes had a similar and higher weaning weight than Romney lambs. The F1 ewe hoggets had the highest post-weaning growth rates and liveweight with the F2 and F3 hoggets being intermediate between the F1 and Romneys. More crossbred, and particularly the F1 hoggets, exhibit oestrus (heat) as hoggets than Romneys and they have a higher ovulation rate. The first cross sheep have heavier hogget fleeces, and the older ewes produce fleeces of similar weight, quality, and of the same value per pound of wool to the Romneys, despite their higher fertility. The crossbred ewes transferred to easier country and mated to Southdown rams have produced up to 145 per cent of live lambs to weaning or on average, about 29 per cent more lambs than the Romneys. These results have been obtained at a high stocking rate. The lambs have been heavier and killable at an earlier age. Carcass studies on the lambs indicate that they are of similar “quality” in terms of bone, muscle and fat at the same carcass weight as S.D. x Romney lambs and of equal consumer acceptance as judged by taste panels. Despite their higher liveweight and decline in productivity with interbreeding it is considered that the higher over-all productivity of the first-cross ewes throughout their lifetime offers real advantages to both hill-country and export lamb producers. Interbreeding the first-cross ewe and their progeny to highly selected first-cross or crossbred rams bred from high-producing sheep, and use of the greater scope for selection among the more numerous progeny could offset all or part of the decline in productivity observed in this unselected flock. In practice, the decision to change from Romneys to Border Leicester crossbreds or Coopworths, to Perendales or another breed must be based on an economic evaluation on a particular farm. In general terms, the formation of interbred Coopworth flocks on North Island hill country, and as export lamb dams, offers advantages to traditional practices, but not necessarily to the best Romney or other breeds that could be bred.

The detailed records of factors associated with lamb mortality in the 7727 lambs born to 7091 two-tooth to four-year-old ewes over the nine years of the crossbreeding study have been analyzed. Comparisons were possible between Romney, F1, F2, F3 and F4 lambs. These flocks have been intensively shepherded during lambing and detailed records of birth weight, dam age, lamb sex, birth and rearing rank together with the age and cause of death obtained. The results of these analyses will now be briefly described.

Over all flocks the survival rate of single-born lambs increased from the two-tooth to the six-tooth lambing, and then declined slightly in the four-year-olds. The survival rate was calculated as the proportion of live lambs at weaning of all lambs tagged at birth, whether dead or alive. Multiple born lambs from older ewes had an equal or better chance of survival than single-born lambs from younger ewes. Shepherding is therefore likely to be more profitable if concentrated on the younger sheep. Some 3.3 per cent more of the singles than twin-born lambs survived to weaning. This difference is not great enough to cancel more than a small proportion of the advantages of a high twinning rate in hill country ewes. In both single- and multiple-born lambs females had a higher survival rate
than males. The lamb survival rate increased from Romney (82 per cent) to F2 lambs (86 per cent) and then declined to the F3 (81 per cent) and F4 (78 per cent) lambs. This indicates that first-cross ewes provided a more favourable maternal environment and/or the lambs themselves had a higher ability to survive. In other words, lamb survival rate can be increased by breeding. In my opinion, no rams used for siring future breeding ewes should be selected from ewes unless these have produced a high percentage of heavy lambs at weaning without assistance. In ram breeding flocks lambing should be regarded as the time to identify those ewes and their offspring for subsequent culling which do not meet this rigid standard, and not for fostering or caesarian operations.

Perhaps of greater interest in this lamb mortality study are the factors associated with lamb deaths, and the way these are related to birth weight. Of the 7727 lambs born over the nine years of this project, 6350 or 82.2 per cent were reared by their dams to weaning, and 1377 or 17.8 per cent were dead, missing or fostered before weaning. This emphasises the large economic losses involved. Of the dead lambs, 464 single and 350 multiple born lambs or 60 per cent of all those dying were subjected to a detailed post-mortem examination. These results, together with shepherding notes were used to classify the cause of death into seven broad groups, namely, pre-natal, dystokia or difficult births, starvation, infections, abnormalities, misadventure and undiagnosed deaths. The relative importance of these causes within single and multiple-born lambs is presented in Fig. 1. The data shows clearly that the importance of dystokia and starvation differed between single and twin born lambs. For single born lambs 44.6 per cent died from difficult births and 15.1 per cent from

### Lamb Mortality Characteristics All Flocks 1959-67

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>% of Lambs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-natal</td>
<td></td>
</tr>
<tr>
<td>Dystokia</td>
<td></td>
</tr>
<tr>
<td>Starvation</td>
<td></td>
</tr>
<tr>
<td>Abnormality</td>
<td></td>
</tr>
<tr>
<td>Misadventure</td>
<td></td>
</tr>
<tr>
<td>Undiagnosed</td>
<td></td>
</tr>
</tbody>
</table>

- Singles
- Multiples
starvation, while in multiple born lambs 16.0 per cent of all classified deaths were from dystokia and 41.7 per cent from starvation. The relative importance of post-natal, infectious diseases, abnormalities, misadventure and undiagnosed classes were essentially similar between single and multiple-born lambs. Dystokia and starvation were associated with 59 per cent of all diagnosed deaths, while relatively few lambs died before parturition, from misadventure or abnormalities. As seen in Fig. 2, most of the lamb deaths occurred within three days of birth, with a higher proportion of singles than mult-

Overall Mortality Age Distribution Within Lamb Age & Birth Rank 1959-67

<table>
<thead>
<tr>
<th>AGE AT DEATH</th>
<th>% of all DEAD LAMBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIRTH</td>
<td>30</td>
</tr>
<tr>
<td>1-3 DAYS</td>
<td>20</td>
</tr>
<tr>
<td>4-7 DAYS</td>
<td>10</td>
</tr>
<tr>
<td>8-WEANING</td>
<td>10</td>
</tr>
<tr>
<td>UNKNOWN</td>
<td>10</td>
</tr>
</tbody>
</table>

Embryos actually dying at birth, and a higher proportion of multiples than singles dying within one to three days of age. Efforts to reduce the rate of lamb mortality should therefore be directed to the period up to three days of age since some 57 per cent of multiple born lambs died within this short period. It also suggests that the selection of ewes with the inherent capacity to lamb and mother their lambs is of major importance. Sheep breeders must provide animals which can lamb and mother their offspring without assistance. They should be completely ruthless in culling all ewes and their offspring which cannot achieve this under commercial farming conditions.

Within each flock single- or multiple-born lambs were classified into 1lb birth weight groups. The relationship between the birth weight of single born lambs and survival rate is given in Fig. 3. It is clear that lambs of below or above average birth weight have a decreasing chance of survival, and that within flocks lambs of about average birth weight have the highest survival rate. The lower survival rate of small lambs is probably due to their lower energy reserves and large heat dissipating area, resulting in faster cooling, while large lambs tend to die from dystokia. A similar pattern is
Effects of Birth Weight Within Single Born Lambs & Flocks 1959-67

found for multiple-born lambs. Ideally, a high proportion of all lambs should be of optimum birth weight. Our data suggests that this optimum is about 8½ to 11 lb for singles and 7-10 lb for twins. Since the unborn lamb(s) develop rapidly within the last quarter of pregnancy, this is likely to require differential feeding of pregnant ewes within a flock, and the separation of ewes bearing singles from those with singles prior to lambing. To this end the use of X-rays, ultrasonics and visual techniques are being studied. Clearly the importance of genetic and management factors associated with lamb deaths and particularly those within three days of age from dystokia and starvation in lambs from young sheep deserve further study.

Large Scale Sheep Breeding Schemes

There are good reasons for believing that we are not effectively using the potential for genetic improvement of the flocks that already exist in New Zealand. To ensure the maximum genetic improvement we must fulfil three basic requirements. These are:

(1) Define and measure the character(s) to be improved in a simple and objective manner.

(2) Choose a foundation breeding population with the highest initial inherent productivity, and with sufficient members and scope to be able to make rapid progress.
Apply an effective method of selection and mating system to this base population, using the superior males as widely as possible, and avoid inbreeding closely related animals. We should bring together any animals to be compared to a common environment since direct ranking of animals on different farms is not possible.

To some extent breeders are meeting the requirements of (1) and (3), but generally the potential for more rapid improvement through changing the structure of the basic breeding population has been neglected. For purposes of illustration the application of a large scale breeding approach to Romney ewe flocks will be considered. The rate of genetic improvement depends on three factors, namely:

1. The strength of inheritance of the character(s) and the number being selected for.
2. The degree of superiority of the selected males and females used for breeding compared with the productive level of those from which they were selected. The higher the breeding value of the rams used the greater the potential lift in their offspring’s production.
3. The time interval between the birth of an animal and its subsequent reproduction.

It therefore follows that if rams and ewes are mated first as hoggets and these are being selected for one or more traits of fairly constant inheritance, then the rate of progress must largely depend on the number and degree of superiority of the parent used for breeding. It is commonsense that we should be breeding rams from those ewes in the National Flock which have the highest production, whether they be registered or unregistered sheep.

At present farmers largely rely on the existing ram breeding flocks as a source of rams. Most of these flocks are relatively small in size with few registered flocks of more than 500 ewes, and these animals are registered on pedigree and may or may not have a high performance. They are widely scattered on a large number of farms, and this makes it impossible to compare directly the breeding value of sheep on different units, independent of the effects of feeding and management. Within each of these flocks, as in commercial units, there will be a proportion of genetically superior animals. These are the only sheep that we are interested in from the point of view of ram selection. Furthermore, it seems likely that often the average productivity of the ram breeding flocks does not appear to be superior, and may even be inferior, to at least a small proportion of those sheep of high productivity in non ram-breeding flocks. Yet if we are to rapidly improve the inherent level of performance of the commercial flocks all the rams used must be selected from the top sheep. An important point is that in ram-breeding flocks the small numbers of very high-producing sheep automatically limits the scope for improvement however well the breeder is recording and selecting. This often forces breeders to use outside rams of unknown breeding value.

The limitations of flock size and base population can be illustrated by one example. If we are to improve the inherent capacity for high fertility as quickly as possible, then we should use young rams from ewes which rear 200 per cent or more of lambs to weaning.
at each lambing. Their female offspring will perform at a higher level than if rams from lower fertility ewes are selected. If we assume a ram breeding flock of 200 ewes weans 120 per cent of lambs, with a 30 per cent twinning rate and 10 per cent dry or wet/dry ewes, then what chance has a ram buyer of obtaining rams from ewes which have reared say six lambs in three lambings. Even if 40 per cent of the ewes rearing twins in one year rear twins the next year (and it is usually less than this), then there will be only nine ewes from the original flock which meet the basic fertility standard. Some of these ram lambs could have obvious culling faults and a proportion will be used as home sires. Thus there is very limited scope for obtaining sufficient rams from many of the smaller registered flocks.

While the limitations imposed by the numbers of high fertility sheep can be changed slowly by the application of established breeding principles, the only way this can be rapidly overcome within a breed is to screen a much larger sheep population for those with high performance. If the hypothetical flock of 200 ewes was expanded to 23,000 commercial or stud sheep then we would have a reasonable chance of bringing together 1000 ewes as a ram breeding flock, all of which had reared six lambs in three lambings. Combining these top sheep from several farms enables more effective breeding to be practised. The greater the size of the sheep population being screened the higher the chance of obtaining animals of high productivity, and maintaining high standards for all traits. I suggest therefore, that combining the elite sheep from both registered and unregistered flocks into larger more effective units would enable these to produce immediately at a level that will take many years to attain with the present approach.

Three large breeding schemes collectively screening over 100,000 Romney ewes have recently been established in the North Island. One of these provides an example of the principles and methods of organising these large groups. This group consists of a number of North and South Island farmers collectively owning about 40,000 ewes. Each of these farmers has a common interest and objective in breeding higher producing sheep, and has several years of experience in recording animals for fertility, weight of lamb weaned, fleece weights and quality. Within each flock, all or a proportion of sheep are recorded in detail, and most of the records are analysed by the National Recording Scheme. One unit acts as the central flock. This structure is illustrated in Fig. 4. The objective is to transfer the highest producing animals continuously screened from all farms to the central flock, so that these sheep and their offspring can be recorded and compared. It is then possible to establish the comparative breeding value of all the ewes and their progeny. Rams bred in the central flock are then available for transfer back to participating members. After weaning the selection of ewes from those which have previously reared twins without assistance are considered for transfer. Five ewes are exchanged for one ram from the central flock. The ewes which then become the property of the central flock are selectively mated to central flock rams of the highest breeding value on the basis of the weight of lamb weaned by their dams plus their own hogget fleece weight and quality. All the ewes and their progeny in the central flock are ranked in order of merit in this way.
before any selection is practised. During ram selection participating members have the right of first pick of any ram progeny produced by their ewes, after the central flock, and of course of any other rams available. Ideally, all members should draw their rams each year from the central flock so that all the young and older rams on all members' farms can be compared on the basis of updated central flock records. Frequent meetings are held, often on a member's farm, to discuss breeding methods and ideals. A competent secretary assists in compiling minutes, circulating relevant information and general organisation. The group is completely flexible and no interchange of capital for stock or legal arrangements have been necessary. The selection of both males and females can be made with greater precision, outstanding rams can be used more effectively on more high-producing ewes and the economics of scale operate without members losing control of their animals. Annual ram costs are reduced or eliminated, and the group as a whole has the potential to produce large numbers of rams of high breeding value at competitive prices. There is considerable flexibility in the type of animal produced and specialist services can more easily be applied. It should be noted that the high-performing stud ewes and their progeny are being compared with those elite ewes and their progeny proven on commercial farms, and that the screening and testing of the elite animals is a continuous process. The identification and recording is streamlined and easily undertaken by the normal labour force. I believe that this type of scheme could be expanded and applied with modifications to other breeds and even to beef cattle breeding. It is realistic to assume that the successful breeders of the future will be operating on a large scale with very high-producing purebred or crossbred animals. Breeders with small flocks may not be able to compete unless they too form effectively integrated schemes. If the
size and number of these groups continue to expand then research studies on the high fertility Romney flocks at Whatawhata will be particularly valuable.

Friesians as Beef Hill Cows

Ideally beef breeding cows must be highly fertile, exhibit ease of calving, a docile temperament, have sufficient milk to suckle one or more calves capable of high liveweight gains to weaning, good mothering ability and be free of structural defects and not be susceptible to diseases. They should calve as two-year-olds and regularly produce a high weight of calf per unit of cow liveweight. In the future they could be required either as beef or dairy cows. The steer, excess heifer or bulls grown for beef should have a high and efficient post-weaning growth rate, and produce carcasses with a high proportion of lean, tender, red meat with the desired flavour, juiciness, water content and fat cover. Excess fatness at young ages and light weights is not required. Coat colour is really of no importance and conformation or shape of relatively minor importance from the purely meat production point of view. The main requirements are therefore high fertility, rapid growth rate, high feed conversion efficiency, and relatively late physical maturity to avoid excess fatness.

In breeding cattle towards these ideals we must first establish a base herd of either straightbred or crossbred animals of the highest productivity. In selecting the base population beef, dairy or beef x dairy cattle, or even exotic breeds can be considered. While there is a large unrealised potential for improving the existing beef breeds by selection, if an alternative breed is already capable of producing at a much higher level then this would be preferred.

The higher growth rate of Friesian steers compared with traditional beef breeds, changing commercial grading standards and the fact that Friesians can produce acceptable carcasses in terms of fat, lean and bone content, palatability and tenderness all indicate the potential of Friesian or Friesian x Jersey cattle for dairy-beef production. At the same degree of “finish” Friesians are likely to have a similar dressing-out percentage as traditional steers, but at young ages yield a higher proportion of lean meat and bone with less fat than Angus cattle. Because they grow faster and have a lower fat content they should produce more red meat per unit of feed intake at a higher efficiency than traditional earlier maturing breeds, which tend to fatten more at lighter weights. All these factors indicate that Friesian or Friesian x Jersey steers or heifers can produce beef of similar “quality” as or more efficiently than traditional beef breeds. This knowledge is currently being exploited in dairy-beef production in New Zealand.

Until recently there has been little inclination to move one step further from tradition and test dairy or beef x dairy cattle as beef producers on hill country. Yet it is known that within a calf’s capacity the higher the milk intake the higher the pre-weaning calf gains, that the milk production of Friesians should be higher and more efficient than Angus cattle, and that only a slow rate of improvement of milk production is possible in the beef breeds. Furthermore, it is possible to select for a high growth rate without appreciably
affecting the level of milk production. Further improvement in the beef producing capacity of Friesians is therefore possible without greatly affecting their milk production or capacity to rear one or more calves to high weights. They could provide a base herd providing more flexibility in the age and class of beef produced. The weight of calves at weaning too, is of increasing importance with the change to slaughtering animals at younger and lighter weights and the fact that calf weaning weights can predetermine the feasibility of finishing beef for slaughter before the second winter. The belief that traditional beef breeds have genetically a greater hardness, adaptability to hill country and produce the superior boned-out beef now required for export, or beef for local supermarkets, is therefore open to question. It should be appreciated too, that the rapid development of farming land capable of sustaining high producing pastures means that our cattle systems should be constantly reviewed. Consequently, trials have been carried out at the Whatawahata Hill-Country Research Station to compare straightbred Friesian with Aberdeen Angus cattle as beef-producing cows on hill country. The results from the first three years of this trial will now be briefly described.

In the autumn of 1966, 22 straightbred two-year-old Friesians were purchased from several dairy herds and compared with 26 Angus three-year-olds from the Station herd. The Friesian heifers produced 62lb calves at birth compared to 56lb calves born to the Angus. At weaning on 31 January 1967, the Friesian calves were 66lb heavier.

In the second year, 19 rising two-year-old, and 28 three-year-old Friesians were compared with 18 three- and 25 four-year-old Angus. They were grazed together on hill country throughout, except over the mating period when they were rotationally grazed. Except for short periods of hay feeding before and after calving no supplementary feed was offered, and the herd was used to clean up roughage and for fern control over the autumn and winter. The Friesians gained weight over the period 7 March to post-calving, whereas the older three- and four-year-old Angus lost weight. The 70lb liveweight gain of the Friesians compared with the 50lb loss of the Angus three-year-olds, or a difference of 0.59 lb/day emphasises that once adapted, Friesians can winter better on poor hill country. The Friesians produced 68lb calves at birth, a difference of 17lb. Three calves from each breed died between birth and weaning. Again no calving problems, mastitis or grass staggers were evident. The single-suckled calves on the three-year-old Friesians grew 0.45 lb/day faster than the calves on the three-year-old Angus, or would be 60lb heavier at 134 days of age.

In the 1967-68 mating season 41 straightbreds Friesian three- and four-year-olds were mated to either four Friesians or four Angus bulls, and 43 four- and five-year-old Angus cows also mated to the same Friesian or Angus bulls. These matings produced purebred Friesian, Angus x Friesian, Friesian x Angus and straightbred Angus calves in the 1968-69 season. As in previous years the Friesians gained more or lost less than the Angus over the pre-calving period, and the Friesians suckling Friesian or Angus x Friesian calves gained less between calving and weaning than the Angus suckling the smaller purebred or crossbred calves. A summary
TABLE 2
Comparison of Friesian and Aberdeen Angus 1968-69

<table>
<thead>
<tr>
<th>Sire breed</th>
<th>Friesian</th>
<th>Angus</th>
<th>Friesian</th>
<th>Angus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam breed</td>
<td>Friesian</td>
<td>Friesian</td>
<td>Angus</td>
<td>Angus</td>
</tr>
<tr>
<td>No. cows calving</td>
<td>23</td>
<td>18</td>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td>Mean calving date</td>
<td>14 Sept.</td>
<td>15 Sept.</td>
<td>16 Sept.</td>
<td>8 Sept.</td>
</tr>
<tr>
<td>Cow liveweight (lb):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 April 1968</td>
<td>937</td>
<td>902</td>
<td>937</td>
<td>876</td>
</tr>
<tr>
<td>Post-calving</td>
<td>856</td>
<td>838</td>
<td>795</td>
<td>739</td>
</tr>
<tr>
<td>Weaning (19 Feb. 1969)</td>
<td>957</td>
<td>962</td>
<td>941</td>
<td>902</td>
</tr>
<tr>
<td>No. live calves weaned</td>
<td>22</td>
<td>17</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>No. calf deaths</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Calf birth weight (lb)</td>
<td>69</td>
<td>71</td>
<td>61</td>
<td>48</td>
</tr>
<tr>
<td>Weaning weight (lb)</td>
<td>404</td>
<td>396</td>
<td>347</td>
<td>324</td>
</tr>
<tr>
<td>(corrected)</td>
<td>(407)</td>
<td>(408)</td>
<td>(353)</td>
<td>(313)</td>
</tr>
<tr>
<td>Weight calf weaned/unit cow wintered (%)</td>
<td>40</td>
<td>39</td>
<td>34</td>
<td>29</td>
</tr>
</tbody>
</table>

of the overall production differences for the four groups during the 1968-69 season is given in Table 2. Average calving dates were similar. The Friesian and Angus x Friesian calves were heavier at birth than the Friesian x Angus, and these in turn were heavier by about 13lb than the purebred Angus calves. This illustrates the superior pre-natal maternal environment of the Friesians and the influence of the Friesian sire on the crossbred calves. One purebred Friesian calf was born prematurely due to brucellosis and one Angus x Friesian calf died after falling into a tom. Two Friesian x Angus and seven purebred Angus calves died prior to weaning. This and overseas results show that no increase in calving troubles result from the use of Friesian or Angus bulls on Friesian or Angus cows. At weaning on 19 February, at about 159 days of age, the straightbred Friesian calves were 80lb heavier than the Angus or when corrected for age of dam, sex and age of calf were 94lb heavier. The Angus x Friesian calves were similar in weight to the straightbred Friesians while the Friesian x Angus calves were heavier than the purebred Angus. Overall the Friesians weaned calves 74lb heavier at weaning than the Angus. This is a very large difference produced in a short period. If these results are substantiated, it indicates that it will take many years of intensive selection for the purebred Angus to attain the present level of performance of the Friesians. Using the total weight of calf produced per unit of cow liveweight wintered it is estimated that the single-suckled Friesians could be 40 per cent more efficient as hill-country beef cows than the purebred Angus. Limited data on Friesian heifers born at the Hill Station shows that their liveweight advantage at weaning is maintained or increased up to two years of age, more calve as two-year-olds and their calves are about 60lb heavier at weaning than those produced by Angus heifers. The steer calves transferred to Ruakura for nutrition experiments have increased their liveweight advantage compared to the Angus and produced heavier carcasses at a young age.

The overall efficiency of hill-country cattle could be further increased by the cows suckling two or more calves. In the 1968-69
season 10 Friesian three-year-olds reared two calves averaging 331lb or a total of 662lb of calf, and nine reared three calves and weaned 927lb of their own weight as calves. This represents an increase in “efficiency” of 160 and 250 per cent respectively compared with the single-suckled Angus.

To summarise the results with purebred Friesians as hill beef cows. The Friesians gained more over the post-weaning autumn and winter period than the Angus, but less while suckling their larger calves. Friesian calves have been heavier at birth with lower losses between birth and weaning. The calves suckled by Friesians have been 60-80lb heavier at weaning. The heifer calves retained on hill country have maintained or increased their liveweight advantage and more have calved and weaned heavier calves as two-year-olds. The steer calves transferred to Ruakura have attained a higher liveweight at a given age than the Angus. Friesian suckling one calf, or three-year-olds suckling two calves seem to have a similar level of fertility to the Angus with one calf. Fertility could be reduced if two-year-olds rear two, and three-year-olds suckle three calves. Friesian cows clearly provide a superior maternal environment to Angus dams, and appear to be substantially higher producing and more efficient as hill-country beef cows. Their high potential milk production simply adjusts to the calf’s capacity and to the feed supply.

The results should be regarded as preliminary information since not all cattle have been reared in a common environment and only young cattle have been tested. Nevertheless, the consistency of the results, the large differences produced and the fact that Friesians were transferred abruptly to poorer conditions justify some remarks on how this knowledge might be used. First, the limited but increasing number of Friesians available from the dairy industry could be used to increase the rate of expansion and productivity of beef herds. Secondly traditional beef breeding cows and their cross-bred progeny could be graded up to high growth rate Friesian bulls either through natural mating or artificial insemination. Artificial insemination seems a practical proposition even in hill-country beef herds now that the “Chin-Ball” bull mating harness enables easy identification of the oestrous females. There seems little justification for crossbreeding programmes unless the superior straightbred Friesian cows are in short supply and it seems likely that any cross-bred heifers should be mated to straightbred Friesian bulls. Thirdly, a proportion of the Friesians could rear more than one calf to weaning. Some farmers are already suckling one or two bull calves per cow and producing $80 or more of calves or bull beef within 12 months. The expectation that Friesians could wean calves weighing 500lb or more, at 160 days of age or growing at 2 to 3 lb/day seems a practical proposition on developed hill country.

It is perhaps remarkable that the Friesian breed selected essentially for milk production should be so superior to Angus, the numerically dominant beef breed in New Zealand, and which has apparently been selected for beef production even if on a visual assessment of live animals. Perhaps this provides a lesson for all of us that the selection of cattle must be based on objectively measured heritable traits of real economic importance and not to poorly defined fashionable type points of no relevance to productivity.
REASONS FOR THE RULES GOVERNING THE COOPWORTH

W. N. Dunlop, Farmer, Tai Tapu.

I am deeply honoured to be given the opportunity of addressing this Conference. I am also acutely aware of the calibre of my audience and it is with some diffidence that I speak to you now. I would also at this point apologise for having to quote from the Rule Book for more time than I would like but believe that this is necessary if you are to have some idea of what I am talking about. I might add that I am not here as the representative of the Coopworth Society nor do I speak on their behalf.

To discuss the reasons for the rules governing the Coopworth one must first examine the thinking of the sheep breeders involved and why this quite radical departure from traditional breed society rules has been adopted.

It would be fair to say that the economic conditions which have forced farmers to examine costs and methods whereby profits can be maintained would be the major factor. Following from this would be the realisation that the sheep as an individual stock unit was not increasing its overall efficiency with the rapidity of the poultry, dairy or pig industry and maybe the methods used in these industries could be used or adopted by sheep breeders.

On examination the principles leading to the quite remarkable progress by these three branches of stock breeding show that some of them can be adapted to sheep breeding, in particular:

(a) The rapid recognition and isolation of superior genetic material,
(b) the concentration of this material with the accompanying mandatory recognition of individuals which fail to reproduce these selected factors and
(c) the selection of only a limited number of factors to be measured.

The factors decided on by the Coopworth Society were therefore limited to five, namely,

1. Increased fertility.
2. Long productive life.
3. Increased growth rate.
4. Increased wool, weight, grade and quality number, and
5. Ease of shepherding,

and the rules are framed in an attempt to ensure that these five are, in fact, achieved.

Earlier I said this was a radical departure from breed society rules, but this is not to deny that individual breeders and groups of breeders are now following these methods in flocks of other breeds but these rules governing the Coopworth are mandatory. Selection must be based on a recording system acceptable to the Council and standards of performance must be adhered to if the individual sheep and/or the whole flock is to maintain registration and irrespective of the standard of performance of the flock the culling rate must be maintained at 40 per cent between weaning as ewe lambs, and mating as 4-tooths. This of course, is an attempt to prevent a flock reaching a plateau and not continuing to improve. However high the standard
of the individual flock as compared with other flocks within the breed, the excellence of an individual is only really measured within the flock of which it is a unit as comparisons between flocks are almost impossible unless those flocks are run together.

These thoughts are behind the wording of certain clauses in the definition of the Objects of the Society, in particular clause (b) which reads: “To promote and encourage, through measurement and recording of productive characters, sheep which are the most profitable in terms of both meat and wool” and (c) “To draw up regulations governing the breeding, selection and culling of the sheep such that the objectives of very high lambing percentage, long productive life, high growth rate, good weight and quality of wool and easy shepherding are in fact achieved,” and further in (d): “To promote the continued improvement of the breed.”

The balance of the objectives are machinery clauses with the exception of (i) and (j): (i) “To engage in or subsidise any branch of scientific research to further the productivity and profitability of sheep farming” and (j) “To investigate the use of any further genetic material which may become available and to form an associate Flock Book incorporating this material if in the opinion of the Council of the day this action would be of national benefit.”

These two clauses are designed so that the Society does in fact take advantage of and participate in any desirable new genetic material which would increase the profitability of sheep farming. I would stress this emphasis on profit. This is what we run sheep for.

With this brief introduction I will now discuss some of the various rules and the reasons why they were adopted by the Society. I don’t think we need to examine the Eligibility of Registration of a flock further than to state that there are three main breeding methods which are acceptable and providing that the culling rate and methods are of a high standard and the thought behind this rule is that it is comparatively easy to become registered and comparatively hard to stay registered and provision is made to progressively tighten the requirements of initial registration. Regulation No. 3 which covers Deregistration or the culling of ewes is considered of great importance and I will quote this in full:

“In order to improve the early conception, lambing percentage, lamb growth rate and wool weight and quality, the following sheep shall be deregistered, their ear tags removed and a positive identification applied.

(a) Any ewe (other than hogget) which is barren.
(b) Any ewe which on more than one occasion fails to lamb in the first 38 days.
(c) Any ewe which does not rear a set of her own twins at or before her four-tooth lambing.
(d) Any ewe which does not lamb naturally, has a faulty udder, or has bearing trouble.
(e) Any ewe which prematurely develops poor wool or loses constitution.

Inclusive of the above, the culling at the hogget stage and after the two-tooth lambing shall be such that 40 per cent of any age group must be culled between lambing as ewe lambs and mating as four-tooths” unquote.
Irrespective of the merits of her parents the ewe stands or falls as measured by her own performance.

This regulation is for the express purpose of increasing fertility and ease of lambing. The period of 38 days during which ewes may be mated is a compromise between conditions in various parts of New Zealand and some breeders in favourable areas will certainly mate for a shorter period. The one occasion on which a ewe is allowed greater than 38 days is to cover a situation such as an infertile ram, facial eczema, bad outbreak of staggers or conditions beyond the control of the breeder.

Rule 3 is designed to eliminate the bottom and specifically states which sheep shall be deregistered and Rule 5 then attempts to ensure the identification of the superior ewes within the flock with the purpose in mind that these sheep are potential dams of future registered rams and of top nucleus breeding ewes. It reads as follows:

“A Merit Register shall be kept. To become a merit ewe, a ewe must have reared 6 lambs by the time she is 4½ years but loses her merit registration if subsequently she fails to rear any lambs in any year or fails to rear less than two lambs on more than one occasion”. She can have one single only, subsequent to becoming a Merit ewe.

“The ewes must be in the top 60 per cent of the flock in hogget fleece weight and for adjusted weaning weight of her lambs.”

This brings us to the Eligibility for single Entry of Rams which occasioned considerable discussion before the definition of acceptance was adopted:

“To qualify for single entry a ram must:
1. Pass inspection, be of multiple birth, and born within the first 21 days.

2. Be either out of a merit ewe and have hogget fleece weight and adjusted weaning weight above average, or be from a registered ewe, who, in her lifetime to date, has weaned 160 per cent lambs and is in the top 40 per cent for that fleece weight and adjusted weaning weight. (If lambed as a hogget, this lambing may be disregarded at the discretion of the breeder.)”

This is accompanied by a note on the interpretation of wool weight which applies wherever hogget wool weight is mentioned and would mean that in assessing wool the weight grade and quality number would be assessed as one item as interpreted by the Wool Scheme as adopted by the Department of Agriculture. There has been some criticism that the fertility of the grand dams has not been taken into account in this particular rule but after a breeder has used Registered rams for a number of generations it is apparent that the female ancestors of any particular ram must have been either merit ewes or prospective merit ewes and particulars of performance would be readily available.

The standards laid down for Single Entry Rams may have to be amended at some future date as only time will show whether this standard will allow sufficient rams for stud purposes or too many.

There are two other important matters I feel should be explained regarding ram selection. The clause pertaining to the 160 per cent and the top 40 per cent for wool and growth weight has been adopted to enable breeders to use sires from young potential merit.
The other matter needing some explanation is the clause regarding the owner's discretion as to hogget lambing. It was felt that the lambing of hoggets should be encouraged and no sheep should be penalised because of this practice as there is some evidence to suggest that this may have some effect on her performance as a two-tooth.

At this stage you will be asking how the Society will be able to see that all these requirements may be met and how they are to be policed and enforced. For the explanation we will have to return to Rule 4 on Inspection and Registration and take certain clauses of this in conjunction with the Annual Returns.

It is not my intention to bore you by reading these in full but only to explain what records are required and why.

An efficient recording system is mandatory. Members are recommended to join the National Flock Recording Scheme but may use other recording schemes if first granted permission by the Council. I might add that this permission will not be lightly given. The Council reserves the right to inspect both the flock and the records and to deregister the flock if the Rules are not carried out both in the spirit and the letter.

The flock book will contain the number of ewes mated, the number of ewe and ram lambs weaned, the number of Merit ewes and the name and number of single entry sires. The breeder will further, in confidence, submit to the secretary and president his N.F.R. or equivalent ewe mating list together with a list of ewes deregistered. If not in the N.F.R. he will also supply his hogget fleece grading list witnessed by a responsible person acceptable to the Council. If he wishes to register Merit ewes or single entry rams he will also have to submit evidence that the sheep involved were in fact in the position of excellence demanded for entry.

You can see from this the degree of importance placed upon the records. We believe all these records are necessary for the breeder to make progress within his flock, and will give the buyer knowledge that when he buys a ram there is performance backing and that this is available to him in detail.

These rules will not be perfect. They are based in the main on methods used by individual breeders now. There has been a degree of compromise of different levels of performance in different areas and under different conditions. Some small anomalies have already become apparent and I have no doubt they will be corrected at the next annual meeting. All that we can say at this point is, a start has been made. There is a firm determination to make progress through the measurement and recording of productive characteristics and I would stress through the flexibility of mind by the breed members.

These rules are not the ultimate neither are the methods or the sheep nor will these sheep fit all conditions or circumstances but I believe the formation of this Society is a forward step in the sheep industry and will lead to greater profitability on the country on which they are suitable.
Mr Chairman, Ladies and Gentlemen:

This paper is concerned with aspects of the management of intensively stocked beef weaners. The topic is quite deliberately restricted to intensive management systems using weaners. I believe these restrictions to be fully justified in the context of modern day farming.

Firstly let us consider the reasons for dealing only with intensive management. In what we now look back on as happier days, cattle were of very minor importance on fattening farms. Useful beasts for cleaning up bits and pieces of rough pasture left behind by pampered and cossetted sheep. Sheep that were not quite the "Lords of all creation," but certainly had a lot to do with the creation of healthy bank balances. For they were the carriers of the Golden Fleece and producers of the famous "Canterbury" lamb—even if most of the latter did come from the North Island!

Today the image of the Golden Fleece is somewhat tarnished and markets for expanded lamb production are uncertain. In New Zealand we eat over 100lb of beef each year and less than 20lb of lamb. And the rest of the world tends to follow our example in showing a marked preference for eating beef.

Faced with generally falling prices for lamb and wool, and under continuing pressure from rising costs, the farmer has had to give careful consideration to the possibility of increasing his income from beef. A shift of emphasis from sheep to beef production is not a step to be taken lightly as sheep retain the tremendous asset of producing simultaneously two saleable products—meat and wool. It is true that labour costs should be lower with beef farming, but these need to be balanced against the higher capital requirements of beef farming. It follows that very high outputs of beef per acre are required, if beef fattening is going to be competitive with fat lamb farming, and this will call for high levels of efficiency. You will all be only too well aware of the necessity for high stocking rates, intensive management systems and high levels of managerial efficiency to achieve high outputs per acre from any form of livestock farming. Beef fattening is no exception.

The next point is—why limit the discussion to weaners? What is wrong with two- and three-year-old steers? The difficulty here is that cattle as they grow older become steadily less efficient as converters of pasture into beef. This arises from two causes. One is that the heavier an animal is the more feed it requires for maintenance, or simply staying alive. As far as the animal is concerned this maintenance requirement takes top priority—an assessment of priorities which we are forced to accept as reasonable! But feed used for maintenance is feed wasted as far as the beef fattener is concerned. It is a completely non-productive use of feed, and the amount of feed
used this way should be kept to a minimum. One way of doing this is to market cattle at 18 to 20 months.

Another disadvantage of the older beast is the marked tendency for these cattle to lay down more fat in their carcasses. We believe that the formation of a pound of fat within an animal requires over four times as much feed as is required for the formation of a pound of lean. And who in today's market wants fat anyway?

What are these rather theoretical objections to the heavy animal likely to mean in practice? We estimate that the feed required to grow a 1,000lb liveweight steer at 1lb/day would grow a 600lb steer at 2lb/day. Another calculation shows that a 14-20 month old steer would require about 17lb of pasture dry matter to grow at 1.5lb per day, whereas a 26-32 month old steer would need 25lb of pasture dry matter to achieve the same growth rate. This is an increase of 50 per cent in intake to achieve the same output of beef.

What are the problems of intensive weaner production? The nutritional aspects of these problems are largely concerned with the attempt to balance the highly seasonal pattern of pasture production with the relatively constant requirements of fattening stock. The basic imbalance between the digestible dry matter available from pasture and required by growing weaners is illustrated in Fig. 1. This problem is perhaps more acute in intensive beef farming than in sheep and dairy farming. In the latter calving and lambing dates are usually arranged so that the peak feed requirements of the lactating stock occur at the time when pasture growth is at its maximum.

In beef fattening the severity of the problems of seasonal feed deficits is going to vary with the stocking rate used. Fig 1 depicts the position at about two weaners per acre. At very low stocking rates, say one weaner per acre, no serious feed deficits would occur. There would be an enormous potential feed surplus during spring and summer, and as a consequence a very low output of beef per acre. This is farming with few problems, but at a profit level that few farmers can afford. As stocking rates are raised and outputs of beef per acre increased, so the size and significance of the seasonal feed deficits are also increased.

As can be seen from Fig. 1 these feed deficits occur in both late summer and winter. I believe that the worst effects of the summer feed shortage can be avoided through adopting a flexible slaughter policy. Provided stock have been well managed through the winter and the idea of selling relatively light weight stock has been accepted, it should be possible to start drafting stock for slaughter in December. In a bad season stock numbers would need to be reduced rapidly in order to keep enough feed ahead of the lighter tail end of the mob to keep them growing. In a good season only the tops would need to be taken out in December-January. You will note that the criteria to decide when and how many stock to slaughter are not the size and condition of the animals, but the availability of pasture. There could be poor seasons when boner prices have to be accepted on quite a high proportion of the stock sold, but it is my contention that this would be the cheapest way out of a bad year. The alternatives are to feed out winter feed supplies in the summer, grow expensive summer crops, irrigate pastures, or hold the stock through a second winter. The use of winter feed supplies achieves
relatively little, as the stock will do little more than hold their weights, and it builds up real problems for the future. Next year's weaners will have a poor winter and great difficulty will be experienced in getting them away in the autumn. Summer crops are likely to fail in a bad season, and are of doubtful value in the good years. An important exception here is lucerne which should be a very useful crop for intensive beef production. Irrigation is effective where it can be used and should have an important role to play in intensive beef production in Canterbury. A comprehensive trial has just been initiated at Winchmore Irrigation Research Station to investigate the potential of irrigated Canterbury pastures for beef production. The alternative of holding the stock through a second winter is a costly expedient on an intensively managed farm, as these animals would require so much costly winter feed.

Having conveniently, if not convincingly for a Canterbury audience, disposed of the problems of the summer drought, we have to see if we can successfully talk our way out of the winter feed shortage. The mechanism we hoped to exploit was compensatory growth.
This is the capacity of animals to follow a period of low level feeding and slow growth with a period of abnormally rapid growth when feed conditions improve. Thus it could be expected that cattle held at maintenance levels during the winter would grow so well during spring and early summer, that they would finish up at the same slaughter weights as cattle that had been fed well during the winter. This possibility was investigated over a series of trials at Rua­kura. In the first of these, two groups of cattle were held at about maintenance levels for 88 days in late winter and early spring, while a third group was grown over the same period at 2.2lb/day on liberal quantities of autumn-saved pasture and early spring regrowth. The result was approximately 180lb difference in liveweight at the end of this winter feeding period. Thereafter the cattle were fed indoors on cut pasture and their intakes accurately measured. The well-fed and one of the maintenance level groups were allowed to eat as much grass as they wanted over a 5½-month period. The other maintenance level group had their intakes of pasture restricted to the extent that they were only offered as much feed as was being eaten by the group that had been well fed during the winter. This forced this group to show compensatory growth through more efficient use of their feed, rather than through an increase in appetite.

**TABLE 1**

<table>
<thead>
<tr>
<th>1966 Compensatory Growth Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding</td>
</tr>
<tr>
<td>Winter (field)</td>
</tr>
<tr>
<td>HIGH</td>
</tr>
<tr>
<td>LOW</td>
</tr>
<tr>
<td>LOW</td>
</tr>
</tbody>
</table>

At the end of the trial the unrestricted group had caught up 38 per cent of the potential weight gain they had lost in winter and early spring, while those with the slightly restricted intakes had only managed to compensate for 21 per cent of the weight gain they had lost through poor winter management. The next year another trial was undertaken to see if smaller weight differences at the end of the winter could be eliminated through compensatory growth. In this trial the cattle from the high level of winter management were 55-60lb heavier than those that had been poorly wintered. The compensatory growth phase of the trial started earlier than in the previous year, giving the stock a longer period consuming high quality spring pasture. However, the percentage weight recovery for unrestricted cattle (39 per cent) was almost exactly the same as that recorded for the previous trial (38 per cent), confirming the limitations of compensatory growth as a means of overcoming the harmful effects of low levels of winter feeding. This conclusion was strongly supported by the performance of cattle subjected to mild degrees of feed restriction during
TABLE 2
1967 Compensatory Growth Trial

<table>
<thead>
<tr>
<th>Feeding</th>
<th>Liveweight gain (lb/day)</th>
<th>% Weight Recovery from compensatory growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter (field)</td>
<td>Summer (stalls)</td>
<td>Winter</td>
</tr>
<tr>
<td>HIGH</td>
<td>Ad Lib</td>
<td>0.7</td>
</tr>
<tr>
<td>LOW</td>
<td>Ad Lib</td>
<td>0.1</td>
</tr>
<tr>
<td>LOW</td>
<td>Slightly restricted</td>
<td>0.1</td>
</tr>
<tr>
<td>LOW</td>
<td>Moderately restricted</td>
<td>0.1</td>
</tr>
<tr>
<td>(grazing)</td>
<td>HIGH 1.2 beasts/acre</td>
<td>0.7</td>
</tr>
<tr>
<td>LOW</td>
<td>1.2 ” ”</td>
<td>0.1</td>
</tr>
</tbody>
</table>

spring and summer. The degree of restriction was much less than would be expected with grazing cattle kept at high stocking rates, and was calculated to permit growth rates at least as high as those of the well wintered cattle. In fact the restricted cattle not only failed to show any compensatory growth, but grew more slowly than those that had been well wintered. The weight differences at the end of the winter being increased by 18 per cent and 32 per cent.

As a part of this trial compensatory growth was measured in cattle grazed throughout the spring and summer at the very lenient stocking rate of 1.2 weaners/acre. Under these “luxury grazing” conditions compensatory growth was rather higher than in the stall fed cattle, but still only eliminated a little over half (56 per cent) of the weight differences imposed by high and low levels of winter feeding.

When we accept the limited usefulness of compensatory growth in weaner cattle, the intensive beef fattener is left right in the middle of a winter management problem. A problem which he must solve if he is going to get his cattle away before they become affected by summer feed shortages. The cattle have to be fed to grow through-out the winter, and the feedstuffs have to be cheap enough to keep the system profitable. Twenty cents a pound, if you can get it, is still a relatively low return for carcass meat, considering about 15lb DM of feed is used in its production.

At Ruakura we have conducted three trials on this topic of winter feeding rations. The first of these compared maize silage, grass silage and hay fed to appetite to cattle stocked on autumn-saved pasture at 2½ and 5 beasts per acre. The differences in growth rate due to the fodders were relatively small. An exception was the maize silage fed group at the lower stocking rate on A.S.P. These animals grew particularly well. However, by far the most important effect
was the higher growth rate in all treatments of the animals held on A.S.P. at 2½ beasts/acre, compared with those at 5 beasts/acre. The more lightly stocked beasts showed a 40 per cent improvement in growth rate despite all groups being allowed unlimited quantities of fodder. Fodder intakes were high as shown in Table 4. The growth rates of these animals during the following summer showed that the overall differences between stocking rates on A.S.P. persisted through to slaughter. In this case no compensatory growth occurred at all. Some compensatory growth was shown by the grass silage fed stock, but the hay fed beasts performed relatively poorly.

During the succeeding winter an indoor feeding trial was carried out where the intakes of A.S.P. were rationed to either 2.2 or 6.6lb DM. Hay or maize silage were again offered to appetite. The results were similar to those obtained in the first trial, confirming the response to level of A.S.P. feeding, and the limited effects of the type of fodder offered. The effect of maize silage inducing an exceptionally high growth rate when fed with more liberal quantities of grass, noted in the first trial, was not repeated in this experiment.

Last winter a third trial was undertaken, again under stall feeding conditions. The levels of pasture feeding were reduced to 1.5 and 4.6lb DM with hay and maize silage being offered to appetite, as in the previous year. Again the cattle responded to the higher levels of A.S.P. feeding, although the differences were smaller than in previous years. This was to be expected from the smaller differences in A.S.P. feeding levels employed in this trial. The outstanding feature of this trial was the improved growth rate of the maize silage fed cattle. This year's maize silage crop had a dry matter digestibility of 60 per cent compared with 50 per cent for the crop used in the first trial.

The main conclusion that we can draw from this winter feeding work is that it is important that large areas of the farm should be closed for autumn-saved pasture and used sparingly throughout the winter. This will mean that an early start will need to be made on feeding out conserved fodder so that the available A.S.P. can be tightly rationed. This grass is extremely valuable and should be used for keeping animals growing and not wasted as maintenance feed. The maintenance part of the winter ration can be supplied from the fodders. If wintering pads are being used, serious thought should be given to the possibility of using an “on-off” grazing system to enable the stock to obtain their ration of grass, while keeping pasture damage to a minimum. In support of these general conclusions it has been heartening to note the success of North Island farmers who have used rationed A.S.P. plus fodder wintering systems, reported at the 1969 Hastings Farmers' Conference.

How applicable is this wintering system, based on Waikato work, likely to be in the South Island? We have no direct evidence on this, but we have sufficient faith in the system to be using it in the Winchmore intensive beef production trial mentioned previously. An examination of pasture clipping yields at various centres throughout the country confirms the common observation that very little pasture grows in the South Island over the three winter months of June, July and August. Against this, autumn growth, as a percentage of total production, appears to be somewhat greater in the South Island, com-
pared with the North. Consequently the proportion of total growth taking place between March and August is reasonably comparable in the two islands. This would probably mean that it was desirable to shut up pastures rather earlier in the autumn in the South Island, and this in turn would further increase the pressure for selling slaughter stock early in the season. As has been stated before, this is only possible if stock have been fed well in early life, and as far as the specialised beef fattener is concerned, this necessitates a system of keeping his cattle growing well throughout the winter. Adequate quantities of autumn-saved pasture, fed in conjunction with liberal quantities of fodder, can be expected to give winter liveweight gains in excess of 1 lb/day, but there may be more convenient alternatives for use in the South Island. Swedes and lucerne hay have both shown promise in earlier work at Winchmore. Whatever wintering system is used it is certain to increase costs, through the growing and conserving of winter feed, and through the labour involved in rationing this feed out to the stock during the winter. Although very important, winter feeding is not the only problem in intensive beef management systems. Bloat can be a serious seasonal problem. Similarly, inadequate control of intestinal parasites could, through depressed growth rates and increased mortality, destroy the profitability of the enterprise. It is certain that intensive beef production is going to test farmers' managerial skills to the full, but the rewards in terms of net outputs of 500 to 600 lb of beef per acre could well justify the effort involved.

TABLE 3

Growth Rate During Winter—Trial 1 (1966) (lb/day)

<table>
<thead>
<tr>
<th>Stocking Rate on A.S.P.</th>
<th>Maize silage</th>
<th>Grass silage</th>
<th>Hay</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 beasts/acre</td>
<td>0.83</td>
<td>0.81</td>
<td>0.88</td>
<td>0.84</td>
</tr>
<tr>
<td>2 1/2 beasts/acre</td>
<td>1.37</td>
<td>1.16</td>
<td>1.02</td>
<td>1.18</td>
</tr>
<tr>
<td>Average</td>
<td>1.10</td>
<td>0.98</td>
<td>0.95</td>
<td>1.01</td>
</tr>
</tbody>
</table>

TABLE 4

Consumption of Fodder During Winter—Trial 1 (1966) (lb D.M./day)

<table>
<thead>
<tr>
<th>Stocking Rate on A.S.P.</th>
<th>Maize silage</th>
<th>Grass silage</th>
<th>Hay</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 beasts/acre</td>
<td>10.2</td>
<td>8.6</td>
<td>10.0</td>
<td>9.6</td>
</tr>
<tr>
<td>2 1/2 beasts/acre</td>
<td>9.2</td>
<td>7.8</td>
<td>8.7</td>
<td>8.6</td>
</tr>
<tr>
<td>Average</td>
<td>9.7</td>
<td>8.2</td>
<td>9.3</td>
<td>9.1</td>
</tr>
<tr>
<td>(lb wet matter)</td>
<td>40.3</td>
<td>40.5</td>
<td>11.1</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 5
Growth Rates During Winter—Trial 2 (1967) (lb/day)

<table>
<thead>
<tr>
<th>A.S.P. (lb/day)</th>
<th>Fodder: Maize Silage</th>
<th>Hay</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2 lb</td>
<td>0.87</td>
<td>0.88</td>
<td>0.87</td>
</tr>
<tr>
<td>6.6 lb</td>
<td>1.24</td>
<td>1.17</td>
<td>1.21</td>
</tr>
<tr>
<td>Average</td>
<td>1.06</td>
<td>1.02</td>
<td>1.04</td>
</tr>
</tbody>
</table>

### TABLE 6
Growth Rates During Winter—Trial 3 (1968) (lb/day)

<table>
<thead>
<tr>
<th>A.S.P. (lb/day)</th>
<th>Fodder: Maize Silage</th>
<th>Hay</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 lb</td>
<td>1.26</td>
<td>0.87</td>
<td>1.07</td>
</tr>
<tr>
<td>4.6 lb</td>
<td>1.55</td>
<td>1.07</td>
<td>1.31</td>
</tr>
<tr>
<td>Average</td>
<td>1.41</td>
<td>0.97</td>
<td>1.19</td>
</tr>
</tbody>
</table>
ARTIFICIAL BREEDING FOR TOWN MILK HERDS

J. W. Stichbury, Director of Herd Improvement, N.Z. Dairy Board.

The New Zealand dairy industry is basically devoted to the production of milk to be used for manufacturing dairy products such as butter, cheese and milk powders. The producers of this milk are paid according to the amount of butterfat they supply to their dairy company and although investigations have been made into alternative systems of payment which would also take into account the amount of protein or solids-not-fat supplied it seems very likely that the amount of butterfat supplied will continue to be the major factor determining payments to dairy factory suppliers. Accordingly the Dairy Board's artificial breeding service is designed primarily to improve the butterfat producing ability of dairy cows and the question might well be asked as the town milk supplier is primarily interested in breeding cows which produce a large quantity of milk is such a service of any value to him?

To answer this question it is necessary to look at two different aspects.

First: Is artificial breeding rather than natural mating likely to result in more rapid improvement of dairy cows?

Secondly: If this is so is an artificial breeding scheme based on selection for butterfat production of value to town milk producers or would it be better if they had an artificial breeding scheme of their own?

Improvement through breeding can only take place if two basic requirements are met. There is an accurate means of identifying the best breeding animals and only the best breeding animals are used as parents of the next generation. In dairy cattle breeding this means that selection of cows as dams of replacement heifers, although desirable, is on its own a very slow method of improvement. It is difficult to accurately identify the best breeding cows and even if this were possible in order to provide sufficient replacements, calves must be reared from most of the cows in a herd. Consequently cows of only average or even below average ability must be used for breeding.

On the other hand because far fewer bulls are required one can be much more selective in choosing them. Accordingly, as has long been recognised, the key to improvement of dairy cattle is the selection of the bulls to be used. The right bull will mean that a succession of superior replacement heifers will come into the herd, the wrong bull—a succession of inferior animals.

Finding the right bull

How can we find the right bull?

There are a number of ways in which a bull could be selected. Some people might decide to use a particular bull because they liked the look of him, others because they liked his pedigree, other again because they liked his progeny. Experience has shown us that although selection on pedigree is better than selection on appearance and in turn
selection on progeny better than selection on pedigree none of these methods is infallible. If we are wise we will concentrate as far as possible on selection of bulls on the basis of their progeny but even this method has its problems. Can artificial breeding help to solve them?

To obtain a progeny test for a bull which will enable us to compare the bull’s merits with that of other bulls with a high degree of accuracy there are two basic requirements. The bull must have sufficient daughters for us to be reasonably sure that they are likely to be a fairly typical sample of all his possible daughters and the daughters should be milked under the same conditions as the daughters of the other bulls we want to compare him with.

For obvious reasons this is very difficult to achieve under natural mating and we are usually faced with the task of comparing bulls which in fact have a relatively small number of daughters and the task is further complicated by the fact that the daughters of different bulls are usually in different herds. Through our sire survey system we make the best possible allowance for these factors when calculating a rating for a bull used for natural mating but we also know that we have not removed the basic problem—too few daughters, all in one herd. Consequently such ratings are really only a guide and in individual cases could be a very unreliable indication of how a bull compares with other bulls used in other herds.

On the other hand what is very difficult to achieve under natural mating is quite simple under artificial breeding. We simply take advantage of the fact that through this means we can arrange for a number of bulls to each have a large number of daughters milked at the same time in the same herds. By comparing the performance of their daughters in this way we can then, from a large number of bulls initially selected by a much less reliable means, their pedigrees, accurately select the best bulls for improving the characters we are interested in. Artificial breeding can therefore be a very great aid to dairy cattle breeding by enabling us to fulfil the first of our two requirements for making progress through breeding—accurately identifying the best breeding animals.

Using the best breeding animals

What about the second requirement, using for breeding only the very best breeding animals?

Unfortunately, under natural mating there are again some very considerable difficulties to be faced. Obviously many of the bulls used for natural mating will be equally as good as any used for artificial breeding. If a farmer is fortunate enough to have one of these bulls and to know that he has it then the obvious thing to do is to use the bull as heavily as possible. But what does he do when the bull can no longer be used? Gamble on another bull picked on pedigree or on a relatively unreliable progeny test in one herd? Or should he have taken steps to prove a number of young bulls at the same time as he was using the good proven bull so that the best of them could be selected to follow the good bull? In theory this could be the way to go but consider the practical problems involved.

To prove just one bull a large number of cows must be mated to him and to provide these cows in all but the very largest herds it will be necessary to just about stop using the already proven bull.
To prove more than one bull at the same time is just about impossible. Thus it is also just about impossible to exercise any selection of bulls when they are proven. Consequently all that can be done is to discard the duds as they turn up and hope that the next bull will be better and to retain the good ones for as long as possible and hope that the next bull isn’t a dud.

In practice therefore progeny testing is not very useful under natural mating because a high proportion of the cows must be mated to unproven bulls and very little selection of proven bulls is possible. Similar progress can probably be made by selecting bulls on pedigree, using them for one year and then replacing them and as more bulls are used this does have the advantage of spreading the risk.

Herd s being naturally mated have this problem primarily because they are limited in size and if they increase in size they then have the problem that there is a limit to the number of cows that can be mated to a bull. Consequently even if a number of bulls could be proven simultaneously in a very large herd, because many bulls will be needed little selection can be practised.

But again artificial breeding changes the position dramatically.

To prove a bull under artificial breeding requires the equivalent of three herds per bull. Thus for every 80 herds we use for proving bulls we can prove ten bulls a year but the best of these bulls, when proven, can sire the replacement stock required annually for 400 herds.

Under an artificial breeding scheme therefore, in contrast to natural mating, only a very small proportion of the cows need to be used to prove bulls, and very intensive selection of proven bulls is possible. Accordingly we can satisfy the second requirement, to use for breeding only the best animals.

Artificial breeding therefore provides the opportunity to make faster progress through breeding. It does this by enabling the relative breeding merits of bulls to be more accurately assessed, by enabling the selection of proven bulls to be used for breeding to be much more intensive and by enabling much more extensive use to be made of proven bulls. If an artificial breeding scheme takes advantage of this opportunity then it must lead to faster progress than is possible under natural mating. The use of such an artificial breeding scheme should, therefore be a good bet for any dairy farmer seeking to improve the performance of his cows.

Now let’s turn to the second question. Is an artificial breeding scheme based on selection for butterfat production of any value to town milk producers or should they endeavour to develop an artificial breeding scheme based on the same principles but where selection is for milk production? Obviously, because town milk producers are paid for milk on a gallonage basis and suffer penalties if the milk they supply falls below certain levels of butterfat or solids-not-fat test, an artificial breeding scheme based on selection for milk production with some attention to butterfat and solids-not-fat tests would be the ideal. On the other hand, because it would require the introduction of a solids-not-fat testing service and would serve only a small group of dairy farmers, it would be more costly to operate. Therefore two artificial breeding schemes could only be justified if,
within a breed, the type of cow required by factory suppliers was markedly different from that required by town milk producers.

As already pointed out the factory supplier in New Zealand is basically interested in cows capable of high yields of butterfat and the Board's artificial breeding scheme is designed to find and use bulls able to sire such cows. Are these bulls also likely to sire the sort of cows wanted by town milk producers?

**Milk production versus butterfat production**

Within any herd there is a very considerable variation in the butterfat production of different cows. This difference can only be brought about by two factors—differences in the milk production of the cows and or differences in the butterfat test of their milk. If differences between cows in butterfat production were entirely due to differences between them in milk production then selection on butterfat production would automatically select the highest milk producers and vice versa. On the other hand if differences in butterfat production were entirely due to differences in test then selection on butterfat production would simply raise the test of milk and would make no difference to the quantity of milk produced. In practice of course cows of the same breed in the same herd vary in both milk production and test and the differences in their butterfat production are due to differences in both these factors.

Thus the extent to which bulls selected on the butterfat production of their daughters are likely to improve milk production depends on whether milk production or test is the more important factor in determining butterfat production. This question has been studied at considerable length, both in New Zealand and overseas, and all of the studies have come up with the same answer. Namely, that differences in milk production are far more important than differences in test in causing differences in butterfat production. Consequently selection of bulls on butterfat production will result in very nearly the same bulls being selected as would be the case if they were selected on milk production. The only difference will be the exclusion of a few bulls leaving high milk production and very low test, which might be considered unsatisfactory from a town milk production point of view anyway, and the inclusion of a few bulls leaving high test with only moderate milk production. An artificial breeding service based on selection for butterfat production should therefore be of very considerable value to town milk producers in enabling them to breed higher milk producing cows.

**Butterfat and Solids-not-fat tests**

Because town milk producers are penalised if the butterfat test or solids-not-fat test of their milk falls below certain levels not only is it desirable for them to adopt management practices which will as far as possible keep their milk at or above the minimum level, but any artificial breeding service which they may be using must take these aspects into account in its selection programme. Particularly in so far as the low testing breeds are concerned.

In so far as butterfat test is concerned the position is to some extent safeguarded automatically in an artificial breeding scheme.
based on the improvement of butterfat production in that bulls siring very low testing daughters are not likely to be retained for use as proven bulls. Other steps could also be taken, such as using in town milk herds only those bulls siring the highest testing daughters. But to do this would almost inevitably result in a decrease in the rate of improving milk production. In practice the best procedure is likely to be to use all the available bulls with the exception of those siring the very lowest testing daughters.

In the case of solids-not-fat test however the position is somewhat different. No information is available in New Zealand generally on the solids-not-fat test of individual cows and hence on the solids-not-fat test being transmitted by different bulls. But fortunately this doesn’t mean that nothing can be done to assist town milk producers to raise the solids-not-fat test of their milk. Because butterfat and solids-not-fat tests are genetically correlated—that is selection for one will tend to raise the other—if some attention is given to butterfat test when selecting bulls for use in town milk herds then automatically this will result in some improvement in solids-not-fat test. It will not be a big improvement though. Within a breed, the variation in solids-not-fat test is quite small and, because the correlation between butterfat and solids-not-fat test is not perfect, there will be some bulls which transmit a high butterfat test with a below average solids-not-fat test. However the use of artificial breeding is in itself a safeguard against such bulls. Because the replacement heifers will be by a number of different bulls the risk is spread and no one bull can have an undue effect, as he can under natural mating. Thus even without a solids-not-fat testing service artificial breeding will automatically protect town milk producers against the “bad” S.N.F. bull and at the same time bring about some improvement in the solids-not-fat content of the milk.

There are people however who say that what should be done is to introduce a national solids-not-fat testing service and to use only the very best bulls from an S.N.F. test point of view for artificial breeding. To my mind this is a very unrealistic way of tackling the problem of low S.N.F. levels in town milk herds for the following reasons:

(1) Because the variation within a breed in S.N.F. test is small even if all our selection were to be concentrated on improving S.N.F. test progress would still be relatively slow.

(2) To concentrate all our breeding efforts on improving S.N.F. test by definition means that we take no notice of anything else in our breeding programme. Very few farmers are likely to be satisfied for very long with a breeding programme which completely ignores milk production, udder conformation and temperament for example.

(3) I believe there are far more efficient and less costly ways of dealing with an S.N.F. problem in town milk and if they are unknown to you it must be a long time since you heard Mr Hollard speak at this or any other conference.

So far in this paper I have been dealing with the way in which an artificial breeding scheme designed to improve butterfat production can assist town milk producers. You are doubtless interested
in knowing what is in fact done in the Dairy Board's scheme. Can I conclude therefore by saying that what I have been doing is describing the procedure actually carried out in the Board’s scheme. That in order to concentrate on those aspects of major interest to town milk producers I have not discussed at all many other aspects of the service. In particular the details of the methods used to select bulls both as yearlings and later when proven. Nor have I made any mention of the field side of the service which in this area is controlled by the South Island Herd Improvement Association.

I trust however that what I have said will have persuaded you that although the artificial breeding service in New Zealand is designed primarily for dairy factory suppliers it will nevertheless be of very considerable value to the owners of town milk herds.
A dairy farmer, faced with a bloat problem in his herd, can now choose between four methods of control with anti-foaming materials.

1. Daily drenching of the cows at milking;
2. Spraying of the pastures to be grazed;
3. Treatment of the drinking troughs;
4. Painting of the animals’ flanks.

With drenching or pasture spraying, the cows have no choice but to take the treatment, and one can expect more effective control with these positive methods than with the other two. In fact, no bloat should occur if either method is carried out properly.

PASTURE SPRAYING with medicinal paraffins and tallow has controlled bloat during severe outbreaks in New Zealand dairying districts, and detailed information is available to those interested. (1, 2).

Although self-emulsifying paraffins have made the job easier for farmers, the spraying method does have some disadvantages. It is costly to spray short open pastures, and it is difficult to divide tall, dense pasture in daily breaks for spraying. Also spraying loses some of its effect when done in rain or high winds.

DAILY DRENCHING has none of these disadvantages, and further points in its favour are:

** It is positive. One is sure that all treated cows have received the proper dose.
** No break-grazing is necessary. Cows can safely graze pasture of any length.
** Initial cost is low. The only equipment needed is an “automatic” drenching gun connected to knapsack reservoir such as can be bought for about $25.
** It is less time-consuming. After a breaking-in period of three or four days, many operators can drench 100 cows in 15 minutes.
** No tractor or spraying gear need be tied up for bloat control.
** There is no pugging of wet pastures by tractor.
** Treatment is equally effective in wet or dry weather.
** Cows can be treated on land where it would be hazardous or impossible to take a tractor.

It is easiest to treat the animal in a herringbone shed with front access, either at milking (if they are used to the treatment) or after milking and before they go out to graze.

Alternatively, a sturdy, simple drenching race can be built near the shed. This should be about 8ft 6in wide, with angled ends, and long enough to take 20 cows.

Recommended materials for drenching are BLOATENZ No. 1 or MARLOX, at a rate of ¼ oz (7.5cc) of material twice daily, dissolved in two parts of water. Drenching only once daily might be more convenient, but a whole ounce of material would be needed for the same efficiency, and this, of course, would double the cost of treatment.
The cost of materials is much the same for daily drenching as for spraying, being about $1.30 per day for 50 animals.

**WATER TROUGH TREATMENT** involves no contact with the animals, and should therefore be ideal for controlling bloat in dry herds on large areas with water supplied in troughs. Moreover, it costs only one-fifth as much as drenching, and is a simple method to use.

Although it is effective on some farms, one must not overlook the many failures during moderate and severe bloat conditions, especially during wet and cold weather, when water intake is reduced.

Much work has been done on this method by Mr D. S. M. Phillips of Ruakura (3) who used Pluronic L64 (=Bloatenz No. 2) for control in his herd. He recommends that treatment be started at least three weeks before bloat is expected, by adding 1oz per 20 gallons in the trough, to be increased to 1½oz if bloat is severe, or 2oz during wet and cold weather. The material must be diluted with warm water before being added to the trough. If added in undiluted form, it will not mix readily with water in the trough, and may not be taken in by stock.

Cows must not have access to untreated water, so do not forget to treat the trough at the shed with 1oz per 10 gallons.

Remember that breakdowns can occur. Watch your animals, and be prepared to treat them if necessary.

**FLANK TREATMENT** has been used on many farms since its introduction from Australia in 1964. It is cheap and simple, but it depends on the cows licking themselves at the proper time. Some cows do this, some don't, and a few will go around the herd licking the others.

Starting with "painting" cows and then switching to spraying or drenching after losing some animals is a pattern that is only too common on dairy farms in spring.

Treatment with automatic applicators is easier still, but requires that the cows be of fairly uniform size: otherwise, when the applicator is set at the right height for the larger animals, it will spray material over the backs of the smaller ones.

Cows are often treated in the bails with a 4-inch brush, though handlers and animals sometimes come to grief by slipping on oily concrete floors.

Once again, be prepared to treat animals that do bloat after being "painted."

**TREATMENT OF BLOATED ANIMALS:** This is usually done in the paddock, or in a temporary crush, by drenching with either 3oz of Bloatenz or Marlox or 4oz of medicinal paraffin. After drenching with Bloatenz or Marlox, one can expect a bloat-free period of 24 hours.

Severely bloated animals which lie down in distress may be saved only by cutting a 4-inch slit with a sharp knife in the left flank at a point equidistant from spine, hip bone and last rib. The outflow of contents should be controlled by hand, if practicable, to reduce the risk of death from shock. After veterinary attention, animals treated in this way usually recover quickly.
None of the present bloat-control methods is suitable for dry stock on large tracts of land with natural water supply, and aerial sowing and topdressing have increased the likelihood of bloat on such land. No reliable method has yet been found which does not require daily rounding up of stock for treatment.

Australian experiments with bloat-preventive stock-licks have not been successful. Either the stock liked the licks and ate them immediately or the licks were so unpalatable that they were not touched.

Supplementary feeding with hay and silage, and grazing on hardened-off pasture with palatable roughage can reduce the risk of losses.

Work is in progress in Australia and at Ruakura on the design of capsules which release anti-foaming material over a longer period. If these are successful, daily drenching might be replaced by weekly treatment, but there are still problems to be solved, such as the choice of a suitable carrier and its disposal by the animals after use.

Bloat research at the Plant Chemistry Division is concerned largely with the animal factors connected with the problem. Such factors might be microbial composition in the stomachs of different animals, or the composition and flow rate of saliva.

Holotrich protozoa, thought to contribute to foam stability, were selectively killed by Emtryl (dimetridazole). (4). Some cows responded and did not bloat as long as protozoa concentrations were non-existent or low. Other cows bloated freely after treatment with Emtryl. Further investigations are being carried out to explain this, and studies of changes in flow rate and composition of saliva may well explain why the severity of bloat varies from day to day in a particular animal, or why certain animals bloat and others don't at a given time. These studies may also lead to cheaper and easier forms of positive control.

It has long been recognised that susceptibility to bloat is hereditary, and the action of the Artificial Breeding Centres in rejecting prospective sires with a known bad bloat history, and in collecting semen only from the bulls which bloat least during their stay at the station, may well help to reduce the incidence of bloat in this country's milking herds.

For the present, however, seek the advice of your Farm Advisory Officer when you are in doubt about the most suitable form of control for your farm. For your animals' sake, use only products which are registered with the Animal Remedies Board. Remember that prices of these products can vary greatly in one area, and substantial savings can sometimes be made by shopping around.

Farm Advisory Officers usually have complete lists of available materials, or if not, can obtain them from the Plant Chemistry Division, D.S.I.R., Private Bag, Palmerston North.

REFERENCES
PRINCIPLES OF EFFICIENT PASTURE UTILIZATION

D. M. Johnston, Consulting Officer, N.Z. Dairy Board.

The principles of efficient pasture utilization were being taught at Lincoln College more than 30 years ago. These principles are probably not much different today. In practice we try to utilize as much of the grass available using dairy cows. Leave the paddock in such condition as to encourage yet another nutritious crop of pasture in the shortest possible time.

Pasture utilization is not a simple exercise. Because grass does not grow at the same speed all the year round. Growth of pasture is in the main effected by moisture, light and temperature. Something we have little control of. Utilizing the grass is likewise affected by these vital factors. The combination of these three important environmental factors are the critical ones. Combination of these three things in reasonable proportions is an ideal that we all hope for, i.e.: Not too wet, not too dry—plenty of sunshine, though not a drought. These three things: moisture, light and temperature are always of direct concern to dairy farmers, usually referred to as the B. weather.

Attaining profitable high production is then a combination of firstly growing grass followed by all the management skills available to utilize most to the best advantage. There is much to discuss as to what are the best techniques or combination of techniques to use in farm practice. That is just what we propose to discuss with you today in this joint session.

Massey, Ruakura and Waimate West Demonstration farm in the Manawatu, Waikato and Taranaki, along with practical farmer experience in all regions of the country confirm that high stocking rates give higher output per acre under seasonal dairying.

There is no evidence that more grass is grown under high stocking, in fact, it is suggested that under extremely heavy stocking less grass is grown. High stocking does however give the opportunity to more fully utilize the grass that is grown and return more evenly the dung and urine to stimulate a continuation of the grass-growing cycle.

High stocking does increase risk, so it pays to look at the insurance cover by way of supplementary feeds.

It would be most unwise in this district to increase stocking rate substantially without reasonable reserves. These reserves can be in the form of hay or silage and perhaps crops. We in the north find crops the most expensive of the three.

Factory-supply dairy farmers try to relate calving spread or calving date to the natural pattern of grass growth. Town milk farmers must take a more prudent approach to stocking rate because of daily quota contracts but the same broad principles apply. High per acre stocking rate does give a more complete utilization. Dairy farmers in the North have been exploiting this very much in recent years—with stocking rate increases of 20-30 per cent quite common, three-quarters of a cow to the acre up to one cow to the acre, plus replacement stock. Rainfall of 35-40 inches. In some of the better summer rainfall districts one and a half cows to the acre is a reality.

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There was ample evidence this past poor spring that some farmers had gone too far, too quickly, with their stock increases without adequate supplementary reserves.

There is considerable difference of opinion amongst farmers as to how well to feed cows. There are those men who believe it pays best to have stock completely fed all the time (they are the high per cow men) often pedigree breeders. There are many more however who support much higher stocking rates with more complete utilization of the pasture and supplements. The high per acre boys! They have labour-saving devices such as a well appointed herring-bone type cowshed, round yard and mobile backing gate enabling increased number of animals to be efficiently handled with the same labour. Sub-division of their farm into 30 perhaps 40 paddocks, one or two wire electric fences, avoiding the need for time-consuming labour in shifting electric fences. Metalled farm raceways and some arrangement of a hard-surfaced area or other convenient places for feeding supplementary feeds during very wet periods. A “must” on most if not all heavily stocked farms. This is of course “only” if no natural advantage point such as a sandy nob or old shingle pit does not already exist. They capitalize on any natural advantage while making conditions of work as congenial as possible. High morale and high production seem to go along with good utilization in a well appointed convenient farm set-up; though this is not necessarily an expensive outfit. The principles of efficient pasture utilization in farm practice are: Complete control of stock: essential for efficient utilization of grass for grazing with milking cows or dry stock. Luxury feeding is avoided at all times. A heavy stocking rate on a rotational system.

It has been amply demonstrated experimentally that if we continuously setstock graze (reduce almost to bare earth) we do not get the full interception of light and drastically reduce pasture production. While on the other end of the scale if pasture is allowed to grow too long we get shading and as much rot going on in the bottom of the pasture sward as we do growth. A happy medium is the ideal and nothing therefore is more important on a dairy farm than COMPLETE CONTROL over all the animals on the farm. Milkers and drys alike.

A dairy farmer must have a high stocking rate if he is to exploit and more fully utilize pasture when favourable growth conditions prevail. Conversely when the opposite situation occurs—he must have reserves to cope with cow requirements. Remember always to avoid wasteful use of expensive hay or silage. Supplements are expensive whether bought or made on the farm.

High stocking demands accompanying skill and techniques to minimize the dangers. Avoid overgrazing and pugging. Always in control of grazing-rotation—speeding up or slowing the interval between grazing as dictated by those vital climatic conditions. I settle for a minimum of 30 paddocks but preference given to 40 paddocks otherwise a lot of time break grazing with frequent shifts of an electric fence at some periods of the year. Two hay sheds with one shed—insurance shed—a reserve supply.

High stocking is proving profitable on many farms, in fact it is a necessity on most today. It need not be dangerous if approached in a realistic programme of sound farm planning.
PROCESSING CROPS WITH A FUTURE IN CANTERBURY

W. Brandenburg, Horticultural Advisory Officer, Depart. of Agriculture, Christchurch.

In the Horticulture Division we have dealt for many years with a wide range of vegetable crops. A number are suitable for various forms of factory processing such as canning, deep freezing, drying or making into pickles or prepared meals.

Considerable experience has been built up by those engaged in the horticultural industry and no doubt farmers have something to gain from this experience—particularly for those crops not closely allied to the traditional pattern of farm cropping in Canterbury.

Before going any further, I must sound two earnest warnings: In the first place, the demand for process crops, the areas available for contracts and the prices to be paid by the factories are company policy and as you all know, this is in the process of rapid changes at present. I cannot, therefore, make any predictions in the field of individual economics of these crops to farmers and so must confine myself rather to a study of the technical feasibility of growing these crops.

My second warning concerns marketing of experimental process crops on the fresh vegetable market. Supply and demand on the fresh vegetable market, to say the least, is very finely balanced and for many crops we are constantly within a hair's breadth of glut conditions. It is realised that farmers will want to plant areas of some process crops to get experience in anticipation of gaining a process contract in the future. I owe it to the fresh vegetable growers, upon whose experience you will be drawing to build up your knowledge on process cropping, to ask you to keep experimental areas small. Large areas are not required to gain technical experience with vegetable cropping. Half an acre or less is usually ample and you should wait with the producing of larger areas until such time as you have a contract in your pocket. This policy of caution works both ways: there are a surprising number of snags in growing some of these process vegetable crops and their cost of establishment can be way above the level of cost farmers are used to. Because of this it is quite possible to lose money if you commence growing such a crop on too large an area with inadequate knowledge or equipment.

Now let us go through the various process crops and see what they have to offer for Canterbury.

Asparagus:

This crop is excellently suited for much Canterbury land. There is increasing evidence from areas all over New Zealand that the lighter and better drained the land is, the longer the life of the asparagus bed is likely to be. And this goes all the way to growing the crop on coastal sand dune country. This is the more important, as the establishment cost of the crop is high and it is rather slow to come into full production. Because of this, it can be anything up to five years before a farmer begins to make a profit. If then the
bed begins to deteriorate at 10 years of age, you have not got a very good proposition. However, we know of asparagus beds in Canterbury on very light land that are still producing well after more than 40 years of existence.

There are adequate manurial and weed control programmes available for asparagus and a few years after establishment, growing management becomes quite simple and straightforward. The reasons for the high establishment costs are that the land must be made definitely free from perennial weeds, early cultivations are intense and deep, in the beginning a heavy initial application of fertilisers is required and young plants are expensive to buy or grow. After establishment, harvesting becomes the most important bottleneck. Although research in this direction is going on, no satisfactory mechanical harvesters are available yet, to my knowledge, and therefore casual labour must be available within reach of the growing area. Packing and transport are no problem, at least not if the crop goes to a processing factory.

Beans:

Although bean crops for processing are gradually increasing in area in Canterbury, there is no great cultural advantage in growing them here. We do not quite get the crops that are produced in the North mainly because of our lower rainfall and average temperatures. The lower temperatures here are to some extent the cause of a factory bottleneck due to the fact that the beans must be planted very late in the spring and need almost the entire time available until the first frosts for their development. This means that spread of planting dates is not very well possible, and therefore, neither is spread of harvesting dates.

There are some diseases that do considerable damage to bean crops in the North Island that are rare here. One or two we share on an equal footing and there are at least two bacterial diseases that may be more prevalent here than in the North.

The bacterial diseases of beans are generally seed carried and a system of crop and seed inspection will be needed to keep them at low levels. We have indications that good, tight control of seed production will be quite effective in keeping incidence down.

Some research on fertiliser programmes is needed. Process growers are generally advised not to use nitrogenous fertilisers on bean crops as they do not give an economic return. In horticulture we have traditionally advocated the use of a small initial application of nitrogenous fertiliser as a starter on bean crops, usually in the form of sulphate of ammonia at no more than 1cwt per acre.

One of the problems in mechanical harvesting of process beans is that the plants tend to be too short and the mower cuts through a lot of beans that are hanging too close to the ground. I have a feeling that growers of process beans may need to take a leaf out of the market gardeners’ book and apply a little nitrogen to stretch the plants somewhat. This is not to say that improved harvesting equipment may not take care of the problem in a different way, or that the plant breeder may not come up with a solution.
Broad Beans:

Broad beans are another type of bean used for processing. The future demand for this crop is hard to forecast, but it may increase gradually. Canterbury is quite suitable for them with a few reservations. Nodulation with nitrogen fixing bacteria is not very effective in broad beans and you can often not rely on them to supply much of their own nitrogen. They have to be fed out of the bag at fairly heavy rates and this makes them much more expensive to produce. There is no entirely satisfactory method of mechanical harvesting available and often casual labour is required for harvest. Finally we are having bumble bee trouble. Broad beans need to be pollinated by bumble bees. We have three species in Canterbury, all introduced, of which one is too rare to be of any consequence. Of the other two, one is unsatisfactory. Its tongue is too short and it gets at the honey in the broad bean flowers by biting a hole, which means that no pollination takes place. Unfortunately, this species is also the most hardy one and first on the job in the spring. Especially after a hard winter the long-tongued species builds up its populations late in the spring and then there is often not enough time for it to set a good crop before the bean plants cease flowering. With careful management honey bees can help out, but there is a major snag here and you need to know what you are doing. Breeding broad bean varieties that continue flowering later into the summer or with a shorter flower tube may help. Broad beans are also susceptible to virus, and insecticidal sprays during aphid flight periods are important.

Brussels Sprouts:

Brussels sprouts are in the process of establishment as a process crop and the area is increasing every season. They are very much at home in Canterbury from the climate angle, especially in the south. There are a few management problems. It would be ideal if this crop could be direct seeded, but I am afraid that we are still waiting for a satisfactory material for chemical weed control. Several materials have possibilities but none is fully satisfactory and research work especially under local conditions is very necessary. It is quite possible that a suitable combination of the materials already available in single material formulations may provide the answer.

Aphid control is very important but the answers are available. Application of a granular insecticide at sowing or planting, followed up by several sprays with long term organo phosphorous compounds are the answer. Materials for control of caterpillar damage may need to be added. Planting systems must, however, be such that the crop is accessible for spraying at a late stage of its life.

Sprouts are gross feeders and heavy application rates of fertilisers are required, especially on hungry land. This can be expensive as rates of between half and one ton per acre of mixed fertilisers may be required and for this reason it may be advisable to grow this crop on the same land for several years running. Harvesting of sprouts is no problem; the whole plants are cut off and carried to the factory where they are machine stripped. The common variety for this work is an F1 hybrid called "Jade Cross." It is safe to say that this variety is quite satisfactory without implying that some local breeding work could not bring further improvement.
Cauliflowers:

Cauliflowers appear to be coming into use as a process crop and climatologically Canterbury is quite suitable for them. They have all the management problems mentioned under brussels sprouts, plus a few of their own. The available varieties are not very satisfactory at all and there is a big job ahead for plant breeders under the guidance of the process firms. Here again direct seeding would be a great advantage, but apart from lack of a complete answer to weed control, we have the problem of "blind seedlings." Anything up to a quarter of the plants sown may lose their growing points once they get about four inches high. This is most probably caused by high soil temperatures at germination—especially broccoli or winter cauliflower varieties are susceptible, but it occurs to a greater or lesser extent in all groups. Market gardeners sow their cauliflowers in a seedbed and sort out the blind plants before planting out by machine or with gangs of schoolboys in the Christmas holidays. This problem must be overcome before any headway can be made with direct seeding of this crop. Breeding to produce finer, less stalky curds is also needed.

Sprouting Broccoli:

Sprouting broccoli is the third brassica crop under consideration for process purposes. Again it is suitable for the Canterbury climate. It can be handled much the same as cauliflower, and has the same problems of being a hungry crop and very susceptible to aphid trouble. There is also a minor problem with what we think is a bacterial disease, but could be caused just by boron deficiency. This problem should not be difficult to sort out.

Peas:

Peas are the major process crop in Canterbury. Their importance is well illustrated by the acreage now grown for quick freezing which has increased during the last three years from approximately 2,000 to near 6,000 acres for the 1968-69 season in the whole of Canterbury. Experience with this crop is being gained on every hand. We can safely say that this is an established process crop and any improvements made to it are marginal, although they can be of great economical importance to growers. Manurial requirements are fairly well known and not high. From the soil management angle it fits in very well with rotations on a cropping farm. Ordinary farm equipment copes adequately with all operations except harvesting. There are occasional disease problems. A rather serious example is bacterial blight and production of disease-free seed is important to ensure clean crops. Choice of the right soil-type and adequate rotation copes with several soil-borne diseases. Aphid infestations and the consequent virus problems can cause trouble sometimes if they occur at a time that the crop is not accessible for spraying without doing damage. We are waiting for something like an agricultural hovercraft to do this job economically. Some improvements in varieties are still possible, especially to combine high production with good quality and in the field of disease resistance.
Sweet Corn:

Sweet corn should make a comeback at any time now. It has been grown with success on a rather small scale in Canterbury for process purposes for many years. On heavy land, and where good irrigation is available it is eminently suited to Canterbury. A major leaf disease present in the North does not occur here. There are some insect troubles, especially caterpillars, but they are not hard to overcome. Sweet corn is a fairly gross feeder and expensive from that angle, but on the other hand it leaves the land in excellent condition for following crops. It can be handled with ordinary farm equipment up to harvest, but then we run into difficulties. Mechanical harvesting of the crop is not yet fully developed. It can be done but at the cost of both production and quality, and casual labour is likely to be required for some years yet.

Tomatoes:

Tomatoes are the big question mark for Canterbury. There is little doubt that we can cope with them as a crop and grow an excellent product. Process tomatoes are a different thing to the high quality staked tomatoes mainly grown here however. We suspect that the major disease problems encountered in the North Island may establish themselves here also and if this is so, the North will have the advantage of climate. All the same, it is quite possible that once suitable varieties for Canterbury have been developed, we will permanently have the edge on quality. Once the process firms begin to show an interest in tomatoes, some concentrated research is likely to be called for.

We have now come to the end of the list of the major propositions for process crops in Canterbury. Along the fringes of this industry there is a very wide range of crops that are useable in some sort of factory process. Many will do well in Canterbury, but will fit into farm programmes only occasionally. Of course both potatoes and onions can be considered process crops but rather the other way around: We have the crops already and plenty of them, but we need to find ways of processing them to be able to market larger quantities. Of course, there is a number of what are at present considered to be exclusively fresh vegetable crops in that same position.

We may also find room for some of the minor crops such as mint, horseradish, culinary and medicinal herbs, angelica, garlic, chicory, rhubarb, carrots, spinach, gherkins, pickling onions and many others. Some of these may be rather complicated to grow or process and may have to be left in the hands of market gardeners or specialist growers. But quite a number may find a place on little areas of the farm that are not much use for anything else, like for instance, mint in swampy patches.
POSSIBILITIES AND PROBLEMS IN GROWING POTATOES FOR PROCESSING

C. M. Driver, Crop Research Division, Dept. of Scientific and Industrial Research, Lincoln.

In the past the major raw materials on which the prosperity of New Zealand has been based have been products of agriculture and this is likely to remain so for many years to come. Our principal product, grass, is used for stock feeding and hence is limited in value by efficiency of utilization and the value of the stock products. A small amount is processed as dried grass or dried lucerne meal, but as this is fed ultimately to stock its value again is limited. Drying does not increase the food value relative to an equivalent amount of fresh grass and as the dried grass must carry the processing charges, the raw material cost must be low. Greater efficiency of utilization may nevertheless make drying an economic proposition compared with direct stock feeding.

Because there is a need to increase exports, and our acreage is limited there is a need to increase the export value per acre of our agriculture. It is useful, then, to see if any other method of land utilization has a greater potential than has straight pastoral farming. In particular, can crops give a higher overall return to New Zealand? Crops are utilized directly for human consumption and can obtain a higher relative price. They can be grown and harvested in a way that allows full utilization of their productive capacity.

Seed crops have entered into international trade for many years. They form a basis for the economy of some other agricultural countries and hence much is known of their trade possibilities. On the other hand many non-seed crops have entered little into international trade because of their perishable nature and the cost of providing suitable transport. With the higher value fruits it has been possible to pay for long distance transport but only in periods of extreme shortages has it been possible to ship other products long distances, e.g. potatoes to New Zealand from U.S.A. in 1956.

Processing of crops introduces new possibilities by putting them into a form with a long shelf life and which does not need special facilities for shipping other than those already available. It would be well worthwhile then to examine both our old established and our newer crops to see if it would be possible to raise our export income by processing crops. In particular today I should like to look at the potato crop.

Potatoes have been a major food crop in the Andes regions of South America for at least 2,000 years and since their introduction to Europe in the late sixteenth century they have become a major energy food of Europeans in many parts of the world. In more recent times there has been a large increase in production in Northern Japan and there is a gradual increase in South Korea and parts of India. Traditionally, the majority of potatoes have been used for human consumption, but in countries of North-eastern Europe (Poland, Germany, Russia) where the grain harvest may be unreli-
## TABLE 1

World Production of Important Crops. 1965 (1)

<table>
<thead>
<tr>
<th>Product</th>
<th>World</th>
<th>Europe</th>
<th>N. &amp; C. America</th>
<th>South America</th>
<th>Asia</th>
<th>Africa</th>
<th>Oceania</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area Production</td>
<td>Area Production</td>
<td>Area Production</td>
<td>Area Production</td>
<td>Area Production</td>
<td>Area Production</td>
<td>Area Production</td>
</tr>
<tr>
<td></td>
<td>Million hectares</td>
<td>Million tons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>218</td>
<td>265</td>
<td>29</td>
<td>67</td>
<td>32</td>
<td>55</td>
<td>7</td>
</tr>
<tr>
<td>Rye</td>
<td>27</td>
<td>35</td>
<td>9</td>
<td>17</td>
<td>1</td>
<td>1.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Barley</td>
<td>69</td>
<td>105</td>
<td>14</td>
<td>38</td>
<td>6</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Oats</td>
<td>31</td>
<td>47</td>
<td>8</td>
<td>16</td>
<td>11</td>
<td>20</td>
<td>0.7</td>
</tr>
<tr>
<td>Maize</td>
<td>99</td>
<td>226</td>
<td>11</td>
<td>26</td>
<td>33</td>
<td>116</td>
<td>15</td>
</tr>
<tr>
<td>Millet</td>
<td>109</td>
<td>78</td>
<td>0.1</td>
<td>0.2</td>
<td>6</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Rice</td>
<td>125</td>
<td>254</td>
<td>0.3</td>
<td>1.3</td>
<td>1.3</td>
<td>4.5</td>
<td>5</td>
</tr>
<tr>
<td>Total Cereals</td>
<td>684</td>
<td>1018</td>
<td>73</td>
<td>170</td>
<td>92</td>
<td>231</td>
<td>30</td>
</tr>
<tr>
<td>Potatoes</td>
<td>23.6</td>
<td>284</td>
<td>8</td>
<td>127</td>
<td>0.8</td>
<td>16</td>
<td>1.1</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>16.1</td>
<td>134</td>
<td>—</td>
<td>0.1</td>
<td>0.3</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Pulses</td>
<td>65</td>
<td>47</td>
<td>6.6</td>
<td>3.4</td>
<td>3.6</td>
<td>2.4</td>
<td>4.2</td>
</tr>
</tbody>
</table>
able potatoes are used extensively for starch and alcohol production and for stock feeding.

World production is given in Table 1 and compared with production of the major grain crops. It will be seen that the potato is a major food crop because of its wide acceptance throughout the world, the tonnage harvested being greater than that of wheat, rice or maize.

The major areas of production are in temperate climates and there are problems in growing them in tropical areas. Some of these problems will be overcome in time by developing better cultural methods and better varieties, but at the present times potatoes tend to be a luxury in many Asian countries, and are not consumed by the masses of the people.

In addition to their calorie content potatoes are rich in some essential vitamins (C, and B1) are high in minerals and have a useful amount of good quality protein and non-protein nitrogen. Potatoes have been shown to be an excellent basic food requiring a minimum of preparation and needing less supplementation than other basic foods to give an acceptable diet. They produce a high number of food units per acre and were it not for the cultural difficulties they would be grown even more widely in tropical and sub-tropical countries than they are now. The present relatively small demand is met by imports.

In the more highly developed Western nations there is an increasing demand for convenience foods. Convenience can take many forms such as convenience for shopping, for storage, for ease and time in preparation and in the variety of forms available to the housewife. In these countries consumption of fresh potatoes has been dropping but other products have risen greatly in sales so that total consumption has tended to increase. It has been estimated that by 1970-72, over 50 per cent of potatoes in U.S.A. will be processed and some time in the 1980s this will rise to over 70 per cent (i.e. some seven million tons). In Britain the rise in processing is expected to be slower but will be not less than 10 per cent by 1970. (550,000 tons) (2). Similar increases are taking place in Europe.

Markets for potatoes overseas in the future then will be:

1. U.S.A., Canada

The substantial market for fresh potatoes will be met by local production. It would be impossible to compete because of transport costs and quality problems. There will be a bigger market for processed potatoes, so long as we can meet the market for quality and price there is every chance of gaining a share of the market.

2. Great Britain and Europe

Probably somewhat similar to U.S.A. except that lower internal costs and trade barriers may make marketing a little more difficult.

3. Australia

Quarantine and trade barriers may continue to restrict the import of fresh potatoes but there are reasonable prospects for processed potatoes especially frozen French fries and potato-chip mix provided the quality of our products is satisfactory.
4. Asia

The market is largely unexplored. The fresh market would be difficult to supply but there are prospects for frozen French fries and dehydrated products such as the potato chip mix. To compete in this market quality would need to be consistently good and the price to be comparable with other staple foods. It should be borne in mind that a small per capita consumption in these countries could be a large export for New Zealand, but in opposition to this, recent developments in higher yielding grains promise to greatly reduce the pressure on food supplies in the near future. Japan is already a large producer in the north, and should the taste for potatoes spread to the south, there could be a demand for potato imports. All-in-all, the Asian market may not be easy to develop without considerable research in marketing and the development of special products for different countries. Supplementary foods in which potatoes combined with meat, fish, eggs, cheese, etc., may be the best way of entering the market in Asia.

5. Africa

There may be some market for potato products among the white population but it is unlikely that there will be any mass market among native races until their economic circumstances improve.

To sum up on the export side, there is no large overseas market just waiting to be supplied with existing products. We could compete in some existing markets especially in Australia with our present products but there will need to be considerable research on products and markets to make an impact on the mass markets of the East.

So much for the problem outside New Zealand, but what of the problems inside New Zealand. Two factors stand out if we want to increase production for export—the quality of the product must be good, and the price must be competitive.

Mittendorf (3) has given an excellent review of the reasons for failure of a large number of industries based on agricultural products. He states, "It is a particular feature of most agricultural processing that the value added by the process is low in relation to the value of the primary commodity and the other materials used. In a complex manufacturing industry, raw materials generally form a very minor part of the ex-factory cost of the product; in the simple processes of agro-allied industry, they generally form the major part. . . . Efficiency in the factory processes, accounting for a minor part of total operational costs, cannot save the project from failure if it is not fully competitive in its buying, transport, marketing and selling operations."

Mittendorf grouped the problems encountered under three main headings:—

"1. Problems of market demand, including over-estimation of prospective demand, misjudgement of tastes, preference and habits of the consumers; under-estimation of competition from alternative market channels and substitutes, and of obstacles to entering foreign markets."
2. **Problems of raw material supply**, which include over-estimation of supply, lack of suitable varieties for processing, insufficient incentives to farmers and lack of supporting services to farmers, such as extension and credit.

3. **Problems of management**, in particular marketing management; lack of adequate marketing facilities, i.e. for collection, storage and distribution, lack of consumer education and sales promotion; inefficient internal management; inadequate financial resources, especially for working capital; over-staffing; inappropriate government intervention.”

The problems of market demand have been touched on already and may be summarized by saying that some markets exist already but that further research is needed in markets, products and product utilization before large scale production could be envisaged.

Problems of raw material supply are of more immediate concern to the farming community. I will discuss them under several headings.

1. **Can we grow enough to supply a factory?** The economic size of a factory will vary with the products, smaller with crisps and largest with dehydrated potatoes. In the latter case a plant handling 10,000 tons of potatoes per annum is considered ample for efficient operation of the factory processes. This would be the production from about 1,000 acres and could be obtained easily in North, Mid, or South Canterbury, Otago, Southland and the Manawatu-Rangitikei area. If special varieties were grown for processing considerably higher yields per acre could be obtained, reducing the acreage necessary for an economic processing unit.

2. **Have we suitable varieties?** Several varieties appear to be satisfactory for various processes. However, there are indications that more suitable varieties may be available and better ones bred. There is a need for research on the best varieties for the various processes and the effect of growing conditions, storage and methods of processing upon final product quality.

3. **Would there be sufficient incentive to farmers?** To enable a processing industry to expand economically into the export field, prices to the grower would need to be low, which would mean production would have to be efficient. Compensations would be that the factory would take the whole crop at harvest at a guaranteed price. Indeed factory staff could do the harvesting as with peas. As large tubers would be no disadvantage, the crop could be left to make its maximum yield instead of spraying off as is done so frequently to avoid oversize tubers. The two largest costs of production are for seed and harvesting. With large scale production seed costs can be reduced and bulk harvesting can greatly reduce harvesting costs. With special varieties and more care with seed growing and storage, regular crops of 15-20 tons an acre or more should be possible. At present world prices for potato products it should be possible to provide a return to the grower considerably greater than returns from other crops commonly grown.
TABLE 2.
Suggested Returns from Potato Processing.

<table>
<thead>
<tr>
<th>Product</th>
<th>Yield potatoes per ton (tons)</th>
<th>Per cent Product</th>
<th>Yield Product (tons)</th>
<th>Export Price (lb)</th>
<th>Export Value per acre $</th>
<th>Farmer's Share at 40% $</th>
<th>Farm Cost $</th>
<th>Net Returns $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen</td>
<td>10</td>
<td>40</td>
<td>4</td>
<td>12c</td>
<td>1075</td>
<td>430</td>
<td>180</td>
<td>250</td>
</tr>
<tr>
<td>French</td>
<td>20</td>
<td>40</td>
<td>8</td>
<td>12c</td>
<td>2150</td>
<td>860</td>
<td>200</td>
<td>660</td>
</tr>
<tr>
<td>Fries</td>
<td>30</td>
<td>40</td>
<td>12</td>
<td>12c</td>
<td>3225</td>
<td>1290</td>
<td>220</td>
<td>1070</td>
</tr>
<tr>
<td>Dehydrated</td>
<td>10</td>
<td>14</td>
<td>1.4</td>
<td>20c</td>
<td>627</td>
<td>250</td>
<td>180</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>14</td>
<td>2.8</td>
<td>20c</td>
<td>1254</td>
<td>500</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>14</td>
<td>4.2</td>
<td>20c</td>
<td>1881</td>
<td>750</td>
<td>220</td>
<td>530</td>
</tr>
</tbody>
</table>

Column 3. Percentage recovery of product from raw material—French fries 30-45 per cent, dehydrated 12-15 per cent.

Column 5. Present export price to Australia of French fries 12-14 cents a pound. Price for dehydrated estimated not less than 20c.

Column 7. The proportion of gross return accruing to the farmer likely to vary from 30-45 per cent.

Column 8. These costs are below those of the majority of present growers but can be attained with mechanization including bulk harvesting and bulk delivery.

Column 9. Adequate returns depend upon a good yield. Oversize tubers are no disadvantage so heavy yielding large tuber varieties could be used with yields of 15-20 tons and over. These returns are likely to be higher than many growers receive now because of incomplete modernization of production.

A fully integrated factory producing a range of potato products could produce more economically than a single product factory.

Problems of management have delayed development but these problems are being overcome. There is still need to reduce the added costs from processing but these will come as the scale of production increases. Already frozen French fries are being produced economically enough for export and tariff barriers rather than price alone have restricted the export of dehydrated products. The entry of stock and station companies into processing could bring a new incentive to reduce processing costs and encourage greater consumption of agricultural produce. In general, finance appears to be available for fairly steady development.
To summarize the possibilities:—

(a) **Crisps.** A slow but steady increase levelling out at about 15 per cent of the crop (say 30,000 tons) in 10-15 years. Consumption mostly within New Zealand but an appreciable export to Pacific Islands.

(b) **Frozen French Fries.** Local usage to increase to 10-15 per cent of the crop (20,000-30,000 tons) within 10 years. Export to Australia should be at least an equal amount and could be greater.

(c) **Dehydrated.** Home use will increase slowly. Use in catering establishments and in prepared foods will increase faster. Export to established market is restricted by trade barriers, and a lower price is needed for new markets. Production may rise to 5-10 per cent of the crop (10,000-20,000 tons).

(d) **Instant Chip Mix.** A dehydrated potato powder, reconstituted and extruded as French fries, and fried for 1 to 1½ minutes. Preliminary inquiries suggest a large developing market overseas for this product and considerable export possibilities. Unfortunately, we have not as yet made a good enough product for export and considerably more research work is needed.

(e) **Other products.** A fully integrated factory can produce other products such as croquettes, shoestrings, patties, and there is opportunity for use in fish pies, shepherd's pies and such like to dilute the more expensive product.

(f) **Mixtures.** Mixtures of varying nutritional standards can be made by mixing potatoes before drying with meats, fish, eggs, cheese and other foods. It may be possible to combine it with grass or other plant proteins but considerable research is needed before any of these products can be recommended for production.

**The Problems**

1. Costs of production are in many cases too high and yields not high enough.
2. There is room for more research on the influence of varieties, localities, seasons, etc., on process quality.
3. Storage and handling facilities will need considerable improvement and research is necessary.
4. Consumer acceptance of many products is growing only slowly.
5. There are still many difficulties with overseas markets.
6. There is an urgent need for research on some of the more promising products such as the potato chip-mix.
7. Some of the processed products will merely be a substitution for raw potatoes and will not materially increase the overall consumption of potatoes.

**Conclusions**

There is room for optimism in that:—

1. We have the know-how to produce potatoes cheaply and some growers already are producing them cheaply enough.
2. Higher yielding varieties are coming available to further lower the cost of production.

3. Crisps, French fries and dehydrated potatoes are already being produced successfully and crisps and French fries are being exported.

4. There is every indication of an extensive market overseas for the chip-mix when the right formula is worked out.

On the other hand processing is likely to result in only a small increase in total production over the next three years or so but could feature as a large exporter with greatly increased production within ten years. Even a relatively small increase in acreage of potatoes could result in a very useful increase in exports because of the very high export value per acre of potato products.

5. Sufficient acreage could be grown to make production economic.

REFERENCES

The use of nitrogen fertilisers in New Zealand is abysmally low. The use of nitrogen fertilisers in New Zealand is abysmally low by the standards of some countries with a highly developed agriculture. On the other hand no other country in the world exploits biological nitrogen-fixation with the efficiency and success of New Zealand farmers. In Western Europe the proportion of nitrogen to phosphate used as fertilisers has gradually increased in the direction of $N : P_2O_5 = 1:1$. Our ratio is approximately 1:63. In other words they use the equivalent of 1 c.p.a. ammonium sulphate for every cwt of super; we use 1 cwt ammonium sulphate or its equivalent for every 63 cwt of super. Europeans and North Americans, including nitrogen fertiliser manufacturers and salesmen, tend to judge the efficiency of a country’s agriculture by the increasing use of nitrogen. On this scale they might regard us as a very backward farming country if they couldn’t see with their own eyes that we can undersell them with most animal products, even after lugging our produce over 12,000 miles of ocean. Let’s make no mistake. The whole economy of New Zealand depends on biological nitrogen-fixation. If we allow only an average of 100 lb N (it probably ranges from 0 to 600) fixed per acre per year on our 20 million acres of improved grassland this would be equivalent to about 5 million tons of ammonium sulphate. To buy this at $50 a ton would cost us $250 million a year. This calculation (probably much underestimated) tells us immediately that we cannot contemplate the wholesale use of nitrogen on our grasslands to replace white clovers.

Having made this incontestable point, it becomes necessary to see where we can use nitrogen fertilisers to increase our efficiency and profits.

Use of Nitrogen Fertilisers in Western Europe and the U.S.A.

Let us see why so much nitrogen is used in these countries. The dominant factor is the intensity of cropping. With a succession of crops, levels of soil organic matter and therefore nitrogen, which is nearly all in organic matter, decline. It was once feared that this decline in organic matter would lead to such deterioration in soil structure that yield would decline. However, with increased use of nitrogen and other fertilisers, and higher crop residues, yields are being maintained or increased, and if they do decline it is more often because of pests and diseases rather than deterioration in soil structure.

With a low supply of nitrogen from the mineralisation of soil organic matter, the need for fertiliser nitrogen is increased, and profitable responses are obtained.

Where rotations of cropping with grassland are still carried out, and rotations are becoming a thing of the past, many British farmers get trapped in a vicious circle of dependency on heavy use of nitrogen. Many of their temporary grass-clover pastures (leys) are established under a cereal crop, and clovers get off to a bad start. Because clovers are poor and soil nitrogen levels are low pasture pro-
duction is miserably low unless nitrogen is used. This stimulation of grass coupled with poor grazing management further suppresses clovers and more and more nitrogen is needed to maintain and increase production. With their costs and prices this is still a very profitable venture. In the case of permanent grass pastures, official complaints are frequently made about too little use of nitrogen, and some farmers (particularly sheep farmers) still rely heavily on clovers in spite of the propaganda. Unfortunately many farmers use very little phosphate or potash on their permanent grass, so that clovers also grow poorly, and production from much permanent grass, getting little or no fertiliser of any kind, can be pitifully low.

The best farmers know that large amounts of nitrogen are needed for high pasture production, but because of poor management or poor climate or both, they fail to grow good clovers and use large amounts of nitrogen to stimulate grass. The Dutch and British dairy farmers in particular, use nitrogen heavily.

The Situation in Canterbury

Although Canterbury is looked upon as the cropping area of New Zealand the real amount of cropping is very small. Grass and clover seed crops, forage crops and winter-feed can hardly be described as very soil-depleting. So we are left with a fair acreage of cereals and small areas of other crops. It is rare to find more than three crops grown in a rotation before sowing down a grass-clover pasture for some years. Our farming is still dominated by the grazing of grass-clover associations. No other system is more efficient at building up levels of soil organic matter and nitrogen and our improved soils are very rich in nitrogen by world standards—indeed some of the highest in the world. If it is good farming lore to leave the soil better than you found it, then most of our farmers can derive great satisfaction from this fact.

Nitrogen and Cropping

Experiments by the Department of Agriculture and D.S.I.R. show pretty conclusively that even the most nitrogen-demanding crops such as maize, chou moellier and potatoes, when grown as the first crop after good grass do not usually respond economically to nitrogen. This may well not be true if ploughing a miserable pasture, inadequately fertilised in previous years. It may also not apply when bringing into cultivation some undeveloped lands where the organic matter has a high carbon-nitrogen ratio.

1. Wheat

There have been many experiments conducted principally by the Department of Agriculture on the response of cereals to nitrogen. The experiments on wheat have been summarised by Lynch (1959) and Wright (1967). I want to refer only to trials carried out since 1956. In the eight years until 1964-65, 120 fertiliser trials were carried out using nitrogen on wheat. Significant increases in yield were obtained in 42 of the 120 trials, and significant decreases in 18, mostly due to damage from mildew or drought. At the prices ruling in 1967, Wright calculated that a yield increase of some 9 bushels/acre was needed to cover the cost of 3 c.p.a. of nitrogen fertiliser such as
ammonium sulphate. With somewhat lower prices for nitrogen, perhaps 7 or 8 bushels would be nearer the mark today. Although 42 trials gave responses, only 15 gave yield increases of 9 bushels or more—the best was 28 bushels and thus highly profitable. There were no economic responses in 19 trials in the North Island and Marlborough. Of the remaining trials, economic responses were obtained as follows:

After a cereal crop 5 from 9 trials
  " brassica " 7 " 43 "
  " peas " 2 " 11 "
  " fallow " 1 " 4 "
  " grass " 0 " 22 "
  " other " 0 " 12 "

Wright further comments that if the price of fertiliser were halved, so that only 4 or 5 bushels were needed to cover the cost of 3 c.p.a. ammonium sulphate or its equivalent, then 35 trials, or more than a quarter, would have given economic responses. A realistic estimate at today's prices is that 1 trial in 5 or 6 would give an economic response to 3 c.p.a. ammonium sulphate. This estimate would probably be higher if less nitrogen were used. The data support the view that nitrogen responses are more certain after a first or second cereal crop.

I should like to look now at some more recent experiments conducted by R. Steven of the Department of Agriculture for the 1967-68 season. These tested 5 levels of ammonium sulphate at each of 5 levels of phosphate on Aotea wheat, the nitrogen being applied in the late August-early September period. The responses to nitrogen (average of all phosphate treatments) were as follows:

<table>
<thead>
<tr>
<th>Ammonium Sulphate c.p.a.</th>
<th>Av. Yields Bushels/acre</th>
<th>Response</th>
<th>Value of increase</th>
<th>Cost of Fertiliser $*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>56.5</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>½</td>
<td>58.3</td>
<td>1.8</td>
<td>2.52</td>
<td>1.88</td>
</tr>
<tr>
<td>1½</td>
<td>59.2</td>
<td>2.7</td>
<td>3.78</td>
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<td>3</td>
<td>60.0</td>
<td>3.5</td>
<td>4.90</td>
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<tr>
<td>6</td>
<td>59.7</td>
<td>3.2</td>
<td>4.48</td>
<td>15.00</td>
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**Wheat taken at $1.40/bushel.
*Ammonium sulphate taken at $50/ton.

Although on the average of these trials one could risk using 1 c.p.a. or so of ammonium sulphate, 5 out of the 13 trials gave depressions in yields, including one of 14 bushels, another of 9, and another of 6½. The three best responses to 6 c.p.a. ammonium sulphate were 28, 20 and 16½ bushels, all profitable even at 6 c.p.a. ammonium sulphate per acre. The smaller responses at 3 c.p.a. fertiliser were even more profitable on these three soils. If I had been advising these farmers on the use of nitrogen, based on previous cropping history of the paddocks, I should have picked one of the very responsive soils at least and I should have recommended the use of nitrogen on two of the soils which gave increasing depressions from every hundredweight applied.

Two similar experiments conducted by Mr Steven on the College farm last year were on a paddock out of grass which gave 90 bushels 101
per acre Aotea without nitrogen, and the other on a paddock out of wheat ex lucerne which gave 76 bushels/acre without nitrogen. There was a very small and uneconomic response to nitrogen on the first and a depression on the second.

In the present state of our knowledge we cannot with complete confidence separate all the responsive soils from the unresponsive soils, or what is perhaps more important pick out those soils where nitrogen depresses yields. So far, attempts to explain these results by soil and sap analyses for nitrogen have not been successful. Even striking improvements in crop vigour have given few clues to ultimate yield responses.

Clearly more intensive research is needed. We need to know more about time of application of nitrogen in relation to water stress, more climatic data, intensive chemical and physical soil analyses, plant composition for macro and micro-nutrients, methods of applying nitrogen, incidence of pests and diseases. Are the depressions induced by nitrogen fertilisers due to increasing acidity with problems such as aluminium toxicity? In view of recent American work on the tolerance of wheat varieties to aluminium, which is a one-gene inherited factor, can our plant breeders incorporate this tolerance into our varieties, if it is not already there? If the Department of Agriculture is too understaffed to tackle these problems, Professor Langer and I would be happy to put post-graduate students on to these problems if we can get financial support. Logically, perhaps, the people who should support this research are those likely to make most profits from the sale of nitrogen fertilisers.

In these same recent experiments, economic responses to 1 c.p.a. super were obtained on all 13 soils. It's not nearly so much of a gamble to spend money on 1 cwt of super as it is on 1 cwt of ammonium sulphate or its equivalent.

When growing cereals in the wetter foothills area, with more reliable summer rainfall, perhaps one could be more confident about the use of nitrogen. Until research has answered some of the problems, you could perhaps risk using the equivalent of 1 c.p.a. of ammonium sulphate in early September, except after ploughing a good pasture, and increase this by a further hundredweight for each subsequent wheat crop with the certainty that some of you will depress rather than increase yields.

Until our cropping with cereals either for flour or animal-feed becomes much more intensive, and this will depend greatly on finding markets, there is not much outlet for nitrogen for cereal-growing.

2. Potato and Vegetable Crops

Where potatoes are grown as a farm crop, responses to nitrogen are likely to increase where potatoes follow other crops in the rotation. Even in England, where farmers commonly use the equivalent of 6 c.p.a. ammonium sulphate on potatoes I have conducted trials where there were no responses to nitrogen after ploughing good grass. It needs few extra hundredweights of potatoes to cover the cost of 1-4 c.p.a. equivalent of ammonium sulphate. When assured of adequate water, a good case could be made for giving the equivalent of 1 c.p.a. ammonium sulphate to the first crop after grass and increasing this to 3 or 4 c.p.a. where potatoes follow other crops.
These higher value cash crops can stand the cost of the granular NP and NPK fertilisers.

In intensive vegetable growing, we have a situation which parallels the intensive arable farming of Britain, and there is much greater scope for the intelligent use of nitrogen.

Nitrogen and Grass

1. Grass-seed production. The traditional method of ryegrass seed production in New Zealand tries to make the best of several worlds, by taking grass-seed in the first year, clover seed in the second year, and finishing up with a good grass-clover pasture. I have a profound admiration for the managerial skill of those Canterbury farmers who get away with it. Grass needs a lot of nitrogen for high seed-production, and when sown down at the end of a cropping rotation, should respond to nitrogen. If enough nitrogen is applied to get a good yield of grass-seed, clovers may be severely depressed, particularly in a dry autumn when it gets little chance to recover, and the prospects of getting a good yield of clover seed or a good pasture are reduced severely. Where you can get an extra 10 bushels of seed for 2 c.p.a. equivalent of ammonium sulphate, and can maintain clovers, it is a good risk.

Where climate and managerial skill make this proposition risky, a good case can be made for sowing pure stands of grass, as is usually the case with cocksfoot. It is probably better to aim for 100 bushels of seed by using up to 4 c.p.a. equivalent of sulphate of ammonia, rather than 25 bushels from sowing with clover. Perhaps this is one place where we can profitably emulate European and American practice.

2. Establishment of new grass. There is an increasing tendency to use a little nitrogen on sowing down a new pasture. After two or three crops response of the grass to nitrogen would be expected, but much depends on when the autumn rains come. The practice is not without risks. The late Peter Sears experimenting on this problem concluded:

(a) Use of nitrogen stimulated grass and gave higher production initially. Clovers however were suppressed and pasture growth slumped until clover recovered.

(b) Without nitrogen, initial growth was slow while clovers were establishing, but production gradually increased and there was no slump.

With proper management, by which I mean adequate and early grazing to stop the grasses from shading the clovers, I find it difficult to believe that it is not possible to use 10 to 20 lbs of nitrogen/acre without suppressing clovers.

3. Out-of-season grazing on established pastures. I consider this an emergency measure only. Autumn applications are too dependent for their success on favourable mild, moist weather to be generally recommended and after September they should not be necessary. This leaves August as about the only month where there is much certainty of getting an economic return. The pasture should contain H1 or Italian ryegrass capable of growing at this time. Experiments show responses of up to 10 to 15 lb D.M. per pound of nitrogen up to 40 lb N/acre. If you can convert 10 lb of Dry Matter into animal
products worth more than 10c, there is a good case of its use in emer-
gencies. It is more likely to be profitable for town milk supply than
other purposes.

4. Winter greenfeed. Although Canterbury farmers have ex-
ploded the ability of rye-corn, oats and Italian ryegrass to grow
during the cool season, the new Zealand bred Tama—a tetraploid
Western Wolths, offers still further scope. The ability of Tama to
recover from hard grazing, especially if rotationally grazed at high
stocking rates and resting for four weeks or longer, gives it some
advantage over the cereals. Numerous experiments have been car-
rried out by the Department of Agriculture and D.S.I.R. on the use
of nitrogen on winter greenfeeds. Details of management of Tama
have been well-covered by Vartha and Rae (1968).

While there may be little response to nitrogen after ploughing a
good pasture and fallowing, quite useful responses may be obtained
particularly after growing a crop or two. Twenty pounds N/acre
at drilling is recommended only on depleted soils, but 80 to 40 lb may
be used profitably some 6 to 8 weeks before feed is required. Average
responses will be 10 to 15 lb D.M. per acre per lb of N, and are
obtained more surely than from the use of nitrogen on established
pasture.

D. Davies has shown the merits of establishing greenfeeds into
lucerne stands and clover-dominant swards with the use of nitrogen.
There are difficulties of establishment where the legumes are vigor-
ounous, but the main problem is a dry autumn, and it looks as though
the practice may be most profitable where irrigation is carried out.

Conclusion

I foresee no dramatic rise in the use of nitrogen but a slow
gradual increase as we learn where to use it profitably. If we could
find markets for our arable crops, and if they can provide higher
returns than animals there will be a more rapid increase, but we
have already saturated our local market for wheat, and new higher-
yielding varieties will worsen the situation. With higher and higher
stocking-rates, the main place for nitrogen will probably be on winter
greenfeeds. The reduction in price of nitrogen fertilisers because of
over-production overseas will help but it becomes more difficult to
decide whether to make our own nitrogen fertilisers. Like most
farmers who pay dearly for many homemade items, I am a little
sceptical about our ability to produce nitrogen more cheaply than
the Japanese or the Australians, without some form of subsidy. I
do not believe that we can copy the recent decision in Australia to
subsidise nitrogen fertilisers at the rate of $80 per ton of nitrogen.
I would rather see the money spent on breeding higher-yielding varie-
ties of wheat and other crops, and winter-growing grasses and
clovers.

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THE MAKING AND MAINTENANCE OF A BEAUTIFUL LANDSCAPE

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This talk today is about "landscape"—its appearance and its modifications. Since you and I may not think in the same terms about this word "landscape," I'd better define my terms first of all.

In the minds of most people the "landscape" which is regarded as going to be made and maintained is the area of the homestead, and its horticultural planting; and it is left firmly in the hands of the lady of the house.

This is far from being the concept of the landscape as the professional landscape architect sees it or, indeed, as the employers of these people see it. The landscape is the whole scene that we see—the land, the water, the vegetation and the man-made structures that are placed on this segment of the earth's surface. The term landscape may be restricted to the garden area of the homestead, but it can also be extended to cover horizon to horizon, for certainly everything that's placed in this space affects its appearance. Quite definitely it is this wide landscape that affects the appearance of our country far more than the garden-scale landscape. To a greater or lesser extent everybody in this audience is involved in modifying the appearance of the piece of landscape that he lives and works in. But he's doing it purely incidentally, in the process of earning his living, and rarely in any conscious way is appearance being considered. The landscape of New Zealand—the overall, broad-scale landscape—is being modified by hundreds of professions, each of which makes incidental changes that affect the appearance of our country for better or for worse.

It is in this broad, overall landscape—that contains hydro-electric schemes, soil conservation works, forestry, sub-divisions, national parks and motorways—as well as agriculture—that I see a need for recognition of beauty, and for maintenance in a state of beauty, not just in the homestead area.

In recent years people have realised that the changes in the overall landscape—incidental changes which result from utilising the many resources of the land—are cumulative and are significant. Uncontrolled, these changes can slowly modify the appearance of our country to one which quite certainly was not intended.

This is the normal story of development in a new country though. There's a pressure to do first things first, and drastic changes to the environment result in the process. Later, attitudes change, and there's a demand, not just that things be done but that they be done well. At first, land is seen only as a commodity for exploitation, but later it's seen as a resource that should be developed sympathetically, and whose secondary resources—aesthetic appearance for one—should also be conserved. There's a realisation that there's a conflict between the man-made and the natural that must be resolved. The
utilising of resources doesn't have to be incompatible with satisfactory appearance.

Not until we get to this state of affairs, when people begin to accept that man-made developments—and landscape appearance as a result—should be in sympathy with nature, is the climate favourable for that peculiar bird, the landscape architect, to emerge. Certainly there have been landscape gardeners around for a long time, but the landscape architect, who is concerned with the broad-scale landscape that I have been discussing, is a new arrival, a product of the increasing sophistication of man and his realisation of the significance of his impact upon the environment.

I believe that we've now arrived at this point in New Zealand, and that we're developing our new courses in landscape design at the College at just the right time. Mark you, I've got no illusions about the number of people who still have to be converted to the need for aesthetic considerations in the landscape as a whole, but I am sure that informed public opinion is with us.

Now you are practical people, and I can see quite easily that there can be a tendency to regard this sort of discussion as being an idealistic and theoretical trend. But it certainly is not. We are simply following a trend which many developed nations started on years ago. We've started later simply due to our lower density of population.

The natural scenery of New Zealand is amongst the most beautiful in the world, but it must be conserved, for it is not an inexhaustible resource. Even the Government is not above reproach, for it's only a few years ago that they were forced, by the pressure of public opinion over Manapouri, to agree to finance tree felling around the shoreline. Otherwise trees would have been drowned when the lake level was lifted, and have left dereliction for generations—smack in the middle of an area with considerable tourist attractions.

New Zealand's man-made scenery leaves a lot to be desired, however, and you have only to consider a sample of our towns to realise this. The sites are often superb in outlook and interest, and with good climate and fertile land their potential is first-rate. But the actuality is a sadly unimaginative use of natural resources, particularly in sub-divisions, and the built-environment is a very poor reflection of the natural potential. In particular, resources are wasted where natural landscape features are ignored, removed, or covered over, instead of being incorporated in the process of development. The conservation and utilisation of natural landscape resources should be a fundamental preliminary in the beautiful landscape which is to be man-made.

Now I'm not a theoretical idealist—I am as practical as you are, and my job as a landscape architect is to integrate the demands of practical necessity with the need for concern over aesthetic appearance. And then both of these features have to be tailored to the forces which control the landscape overall. You all know quite well that the landscape we see is an integrated response to the environment. The geology and the climate control the development of soils and vegetation. And this in turn controls the animal population. If the farmer breaks the natural chain that results when nature is left
alone, then the result of his modification, too, is a response to the specific environment that he's provided. Replace trees with grass, and we get different mineral recycling, and water run-off and soil loss increases. Increase your stocking rate, or change the grazing animal from sheep to cattle—and the vegetation changes.

This is the basic concept of the landscape architect's profession—that the landscape is a living entity, it's a coherent entity, and it's an integrated response to the environment. He works through this system and—particularly in the landscape as a whole—if he doesn't do so he's building up problems for the future, or he's going to cost money which should be spent in other ways. The problems of making a beautiful landscape, and certainly of maintaining it are considerably magnified if he defies nature rather than works with her. This approach through the ecological system is one which has been largely ignored in New Zealand. Man has decided to be his own controlling system. But I think that if we critically examine many of our problems today we will realise that, fundamentally, they arise from an ecological source. We have to relearn how to accept nature, and this will be a hard path for many to tread.

The best example I can give of this is the gradual changes occurring in many of our lakes. Over the years some of the more popular of these lakes have lost their crystal clarity which once made them famous. Basically, the cause of these changes is the increasing mineral content of their waters, which encourages plankton and lake-weeds, and so slowly changes the natural lake flora—and the lake's appearance. This increased mineral content has come from the removal of natural vegetation, which had adapted itself to the climatic soil conditions of the region, and its replacement with agriculture. Now don't mistake what I'm saying. I am not saying that agriculture shall be prohibited around the lake shores for these aesthetic reasons. But I am saying that there must be a conscious appraisal of the situation, and an acceptance or denial of it by a deliberate policy, not a state of inevitable change occurring through neglect.

In one case—that of Lake Taupo—this conscious appraisal has been made. Its scenic resources, which have world-wide renown, and its fish resources, which bring overseas funds as well as New Zealand-wide acclaim, have, say the Government, got to be given prime consideration over other factors. The increasing mineral content of the lake has to be checked, and the creation of almost 50,000 acres of new reserves around its shores has been proposed as a vast buffer to ensure this increases in forestry, almost 120,000 acres in extent are proposed to control mineral loss from other watersheds. This is landscape planning, on a scale that this country has never seen before, fundamentally for the sake of the environment. For the first time we see a conscious effort over hundreds of thousands of acres, for the sake of the beauty of the landscape. Certainly the forester is thinking of timber resources, and the Maori owner of a share in the financial returns, and the Taupo County Council of the income from tourism, but they're also thinking of the beauty of the landscape as well. Beauty in the landscape doesn't exist in isolation only—it also comes from the major financial considerations, which must then be moulded to allow considerations for beauty to take their rightful place.
Probably the most important unpaid landscape architect anywhere is the farmer. The appearance of the countryside rests on the way he manages his holding. There certainly are individual differences between farms but the overriding unity that we see in the countryside results from the basically similar management practices. The response of nature to this treatment produces an overall similarity of appearance and it's this unity in the countryside that produces the feeling of visual satisfaction one experiences there.

In the town, with the many conflicting demands resulting from different owners, with different attitudes, and different requirements from their piece of real estate, there's frequently discord and even disunity in visual appearance. The lack of this common theme, which was present in the country, results in visual dissatisfaction. This basic unity of the landscape is fundamentally important for its appearance.

Now the unity can come, as I've indicated, from the acceptance of the dominance of the ecological system—replanting major earthworks with naturally occurring vegetation which will then be self-perpetuating, but it can also come from artificial means—painting all the different shapes and sizes of pavilions in Hagley Park with a co-ordinated colour scheme. But in both cases you've got to consider the environment as a whole, not as bits with no interrelationships.

In 1967 the N.Z. Institute of Engineers held a conference on “The N.Z. Countryside in 1980.” I think their letter of invitation to this conference was quite significant. They said, “We want changes in New Zealand to reflect not only the best of technology, but also a profound sense of what is truly valuable, and a deep care and respect for nature.” Obviously, these men of iron and steel and concrete recognised the significance of considering the environment as a whole. It is too easy for an engineer or an architect to look at land primarily as a site for their particular activity, with no regard for what happens to an adjoining piece of ground. Certainly they're not the only offenders in this land of ours. But it is this ignoring of the desirable basic unity of the landscape that produces the symptoms of decay in the visual environment we see everywhere in New Zealand. The recognition of this fragmentation of the visual scene, and its avoidance, is one of the starting points for a beautiful landscape. The motorway that unfeelingly slashes its way through an attractive landscape is, fundamentally, no worse an act of vandalism than the placement of rows of telephone and electricity poles between you, on a scenic road, and the view that's to be seen. Both these faults can be avoided, and an integrated scene produced, as long as we exercise a little care at the beginning. It is the single-purpose, blinkered attitude that is the real problem, and a change can only result from the pressure of public opinion, not from the exhortations of high-minded landscape architects. The attitude of a people to their physical environment is a measure of their progress in civilisation—whether that environment is natural or man-made. Fundamentally, it means that we have to adopt new attitudes and values, and a new sensitivity to our environments, and it's this that is the real core of my talk today. Making a beautiful landscape doesn't necessarily mean spending money. It often means the deliberate appraisal of alternative choices, which have different environmental effects. Never-
theless, we rarely get something for nothing today, and it can be that these alternative choices do carry different cost factors. It is important to realise that a decision which is based purely on economic grounds could have very damaging effects on the physical environment, out of all proportion to the actual money which has been saved.

It is here that the landscape architect can play one of his most significant roles in ensuring the beautiful landscape. Ideally, he should be a primary member of any team which plans major changes to the landscape, whether these are in soil conservation, motorways, or hydro-electric schemes. He's obviously got to recognise and accept the practical essentials of the job being done, but his job is to present alternatives, so that the people concerned with practicalities don't ignore everything else. The landscape architect can produce alternatives which are not only more desirable aesthetically, but which save money. Now obviously, he can't do this if he's not called in until afterwards, when the damage has been done, if his sole role is seen as one of subsequent beautification and not of original contribution. Our Government departments, which have an enormous impact on the landscape, are beginning to recognise this fact, and to seek professionally-trained landscape architects.

As an example of this I have recently been assisting the N.Z. Forest Service, in their afforestation proposals that I mentioned around Lake Taupo. The concern of the Forest Service is that their planting proposals do not interfere with the visual amenity of Lake Taupo, its shore line, the views from the road, and the views one sees of the forestry itself. This is not mere prettyfication of the forest edge, but placement of planting, and choice of species, with regard to the overall scene, along 140 miles of road, four miles of river valley, and with amenity considerations being regarded as of primary importance over 5,000 acres of land. The contribution that I can make to the appearance of this area would have been infinitely less, had the Forest Service called me in after they had finished their planting. Here is real recognition of the fact that for our beautiful landscape we must consider the eventual appearance of what's being done at the beginning of the job and not at the end. If the landscape architect is regarded as a beautifier, a healer of wounds, a last thought, then his skill is not being utilised as it should be. His job is to integrate man with his environment, not patch the edges, where man has been imposed on it.

This problem at Taupo has got to be examined in depth, for really it revolves round the problems of establishment and maintenance, as well as the appearance of the proposed plantings. And here is where the landscape man uses nature's ecological system. You can't even consider horticultural type maintenance over an area of this size, even if it were desirable—which it is not. The species selection has to be capable of accepting local conditions and of making its own environment, by nature's competitive methods. This subdues weeds and avoids maintenance. And yet at the same time the species shouldn't be invasive, even though ideally, self-perpetuating. We have enough weed problems without creating more. I mention this simply to emphasise that if we use nature's systems the beautiful landscape can be largely self-maintaining. The landscape maintenance on the farm comes through the agricultural cropping system.
A landscape not managed in this way has to be held in the state of equilibrium which we consider beautiful by other methods. Deliberate control by man, in parks and gardens; the yearly mowing of roadside verges; or the utilisation of natural competitive systems.

I believe that we don't utilise this concept often enough in the small scale landscape. Our approach to maintenance is too frequently a clearly controlled spick and span pruning and polishing, as the only answer. What we really want is variety of treatments and of maintenance methods. This applies in parks and reserves, as well as the open landscape. Low cost-level maintenance will produce different landscapes which are an alternative type of experience. The horticulturist has been singularly backward in looking for alternative maintenance methods. He's blinded by what he's got. Even the plastic sheet covered with stones becoming so popular these days is, to my mind, a relatively high cost answer, and certainly not suited to the open countryside. Here's a wide open field for research by the horticulturist. In Britain, where more and more open land is being used, with amenity as its primary aim, the demand has arisen for estate managers able to think in terms of low cost maintenance methods, in preference for the horticulturist with his precise, but more costly, methods.

Ideally, our landscape development should be looking to the future, too, if it's going to be really useful, seeking matters of change that are going to effect future appearance, whether directly or indirectly. In some respects what I've been talking about reflects this already, for this preoccupation with landscape appearance overall reflects the importance we're beginning to place on tourism and its financial significance. The Tourism Committee of the National Development Conference forecasts an increase of overseas tourists from 93,000 in 1962-63 to 886,000 in 1978-79. The figure for 1967-68 already stands at just under 200,000. And the income from overseas travel is estimated to be $108 million by 1978-79. This money comes from people who want to see the scenery and we can't put blinkers on their eyes when they go through some of our less attractive man-made scenery, the acres of wire-scape that desecrate our cities, or some of our unattractive and featureless grid-iron subdivisions. A little concern over the visual appearance of our country-sides today is vital for tomorrow's income.

So far as townscape is involved, there is real concern on whether our open space pattern is in fact suited to today's changing needs. The emphasis on centrally situated sporting activities, rather than on distributed areas is one facet; another is the greater demand for passive recreation areas. Both require a complete rethink if we are to face tomorrow's needs with confidence. When one considers that the estimated expenditure on housing in the next 10 years is $2000 million you can see that these problems are not minor ones. A poor physical environment is bad economics, for it leads to declining land values and social blight.

How do we achieve these—and many other desirable aims—which revolve round the production of our beautiful landscape? I've mentioned already the need for an informed public opinion. Without a public opinion which accepts the need for planning as a means of doing things efficiently and well, and doesn't regard it as the slow
erosion of private freedoms, we shall scarcely be able to mould the landscape to our advantage, to renew beauty where it has been destroyed, or serve and satisfy the whole man, and not merely his economic needs. The social benefits of living in a community have to be attained at the cost of some personal freedoms, and the greater our population becomes the truer this statement is.

So the attitude begins at a personal level, and proceeds through this to communal effort over local domains and recreational areas. But you know this. The real problem is finance. We’ve already seen what could be regarded as a significant departure at Taupo. Here is an area not only of national importance—for 87 per cent of the annual fishing licence-holders live outside the district—but of international significance. This raises Government interest, action through Government Departments, and, possibly, national funds. Work on the scale required at Taupo could not possibly be financed from local resources. Other developments controlled with Government funds—National Roads Boards, Electricity Dept., Forest Service—can build the costs of landscape treatment into the overall cost structure of the specific project. But what about the small Council with a scenic resource used by surrounding areas? Unless we are careful we shall end up with a two-fold structure and two levels of quality. It may be that we should seriously look at a nationally available financial pool, along the lines developed in the British “Countryside” Act. I appreciate that this means some sort of grading of the significance of our landscape resources, but better this than the non-development of a resource or the non-provision of facilities where the main users are not from the financially responsible area.

Are the legal authorities there to do the things we want? The Physical Environment Committee of the National Development Conference says that it is, and you certainly only have to look at the list of ordinances in any development scheme to realise what powers there are to call on. But I wonder how well these powers are appreciated and, in particular, how well they are applied, or at least those which specifically apply to amenity considerations. It seems to me that much of the poor visual appearance of, say, sub-divisions—with their street linearity emphasised by the equidistant rows of poles and by equal set-backs of houses on either side—is in fact due to faulty interpretation of these ordinances. When a minimal layback requirement, for example, is interpreted as a design criterion, then there’s something wrong. I would emphasise that thousands of British “Coronation Streets” were built in Britain—all of which were in complete accord with the Housing bye-law regulations of the day and equally all concerned with granting not an inch more than they were required to in law. The parallel is a poor one, but I feel that the needs for considering the environment could be better met by positive promotional programmes rather than limitations which are interpreted in negative fashion. The leadership must come from local government first, who must be convinced of the need for positive environmental planning, who must adopt and implement standards for the total environment and should take the initiative in promoting quality development. We need imaginative application of legislation and rules and regulations, as well as improved standards of
design, too. The professional designer in the landscape can do no more than local opinion, and local—as well as national—legislation allows him to. The problems of dealing with a national body, such as N.Z. Forest Service, are slight, compared with those resulting from a community of individual owners, each with his own aims—and, usually, each believing that he knows all the answers anyway.

The ball is in your half, gentlemen. I have presented you with ideals, attempted to show some of the problems. When you go home and sit around the local council table, I hope that you remember—and apply—some of the things I have said today. You are controlling the future appearance of New Zealand; and it is well worth careful attention.
CHEMICALS FOR CULTIVATION


1. INTRODUCTION

For several years it has been known that the most important effect of cultivation is to control unwanted plants before sowing a crop or pasture. Chemicals were first used for this purpose over 15 years ago and so-called "chemical ploughing" techniques have been investigated in several countries. The development of new chemicals and special drilling machinery and a better knowledge of the relationship between plants and soil has taken direct-drilling nearer to the farm, if not actually on to the farm. In general, it has been shown that where all unwanted plants can be controlled by suitable herbicides and where seed is correctly sown in uncultivated soil, normal crop yields can be expected under a wide range of conditions: there is no mystical beneficial effect of cultivation on crop growth.

In the past few years research has been carried out on direct-drilling methods in New Zealand and some techniques have been adopted on a farm scale. This work has to a large extent defined those conditions under which success with direct-drilling is most likely. The major factors which determine the relative costs and benefits of cultivation and chemical methods are better known and as a result, we can now begin to evaluate chemical methods under farm conditions.

The main object today is to describe direct-drilling techniques in detail and briefly give an indication of the possibilities for reducing or eliminating cultivation for growing crops and improving or renewing pasture.

2. CULTIVATION

First, however, let us take a look at cultivation. Man has been cultivating the land for centuries and the dictionary defines "agriculture" as "cultivation of the land." The iron plough was first used in the 18th century and it is still basically the same implement doing much the same job in spite of refinements: we now use several furrows and we use more power. In spite of this, ploughing and other cultivation is still relatively laborious and time-consuming.

In ploughing a paddock of 20 acres a farmer moves over 10,000 tons of soil and a 12-inch furrow from this area would stretch from Christchurch to Oamaru, a distance of about 165 miles. A square paddock of this size ploughed round and round would need over 400 circuits of a 3 x 12 inch furrow plough taking nearly 14 hours actual ploughing time at 4 m.p.h. Each year New Zealand farmers move over 500 million tons of soil to grow crops.

The initial cultivation to control weeds (ploughing, grubbing) has to be followed by rolling and harrowing to consolidate the soil: consolidation is necessary to produce a firm, fine seed-bed, conserve moisture and prevent the regrowth of half-buried grasses. At the same time however the germination of some weeds such as fathen and spurrey is encouraged.
Cultivation reduces the organic matter content of soils and largely destroys the structure built up under normal pasture. As a result cultivated soil can be blown away in dry, windy conditions or washed away in periods of high rainfall; soil capping, crusting and frost lift can severely reduce seedling emergence and the water-holding capacity of soil is reduced.

In recent years cultivation has been carried out by higher-powered units with a tendency to shorter periods of cultivation. Often, ploughing is replaced by discing or chisel-ploughing. In some areas chemical sprays are applied in conjunction with cultivation. In New Zealand, farmers frequently drill pasture directly into burnt cereal stubble and winter-feed species can be over-drilled into established lucerne. Thus there is currently a general trend to less cultivation to save time and reduce costs. The logical, if not the most profitable outcome is to eliminate all cultivation.

3. CHEMICAL METHODS

In the present paper the term “direct-drilling” will be used to mean the introduction of seed into undisturbed soil: the terms “sod-seeding,” “chemical ploughing” and “over-drilling” are frequently used with a similar meaning. It has been shown that normal crops can be grown by direct-drilling methods provided that:

First: The soil is free-draining and the general level of fertility is adequate.
Second: All plant species are controlled by herbicides which leave no toxic residues in the soil.
Third: Seed is correctly placed in the uncultivated soil.
Fourth: Fertiliser nitrogen is added where soil nitrogen is low.
Fifth: The method is applied under conditions where soil moisture at and shortly after drilling is adequate for crop growth.

We now believe good pasture to be the ideal starting point for direct-drilled crops. The growth of pasture plant roots produces a stable, well-structured layer of soil at or near the soil surface. In direct-drilling, this layer is left undisturbed: losses of organic matter are reduced, and erosion by wind and water is eliminated. Direct-drilling is made easier by the fact that pasture can be grazed short, is usually levelled before sowing and several important crop weeds are normally under control.

In the past few years we have direct-drilled brassica and cereal crops, grasses and legumes (including clovers, peas and lucerne) into chemically-desiccated pasture.

As a result of recent trial and development work it is now possible to set out the main factors which determine the degree of success in direct-drilled crops and pasture:

(a) Selection of a suitable site:

First, it is important to carefully select areas for direct-drilling. High-fertility, free-draining soils, reasonably free of stones and deep ruts give the best results. Direct-drilling will not overcome drainage problems in heavy, wet soils. Obviously the soil type must be suitable for the crop to be grown and a soil test is important, particularly if pasture has been
down for several years. Present herbicides will control seedling weeds, ryegrasses, annual grasses and perennial clovers. Flat weeds such as docks, dandelions and thistles should be controlled during the season before direct-drilling. It must be emphasised that yarrow, twitch, cocksfoot, dense browntop or other difficult-to-kill plants cannot be effectively controlled by available herbicides at economic rates.

(b) Control of Insect Pests

Suitable insecticides must be applied either some time before direct-drilling or with the fertiliser at drilling to control grass-grub and porina, particularly where a crop or pasture is sown in autumn. Springtails which are commonly present in pasture must be controlled before direct-drilling brassicas; for this a suitable insecticide can be applied mixed with the herbicides.

(c) Preparation for Direct-Drilling

Loose hay and straw can affect spraying results and cause blockages at drilling by collecting in front of hoe coulters. Such trash must be cleared by raking, burning or grazing well before spraying. For best spraying results and to make drilling easier pasture should be close-grazed with sheep, so that it is short, green and clean at the time of spraying. Soil on plant leaves can affect spraying results.

(d) Use of Chemicals

To control ryegrasses, annual grasses and seedling weeds, we have applied paraquat at 2 to 16oz per acre (= ½ to 4 pints of “Gramoxone,” the commercially formulated product). Perennial clovers have been controlled with dicamba at 4 to 6oz per acre (1 to 1½ pints of the formulated product).

Paraquat alone is applied at the lower rates (2 to 4oz) to suppress grasses before direct-drilling new pasture species. For crops it is essential to kill or severely check all plant species before drilling: for this purpose paraquat is applied at 12 to 16oz to control grasses, mixed with dicamba at 4 to 6oz per acre to control clovers. Because grasses and clovers are more difficult to control in spring and early summer the higher rates are necessary at that time of the year.

There are some crop situations where only one chemical or lower rates would be sufficient: for example, pure ryegrass or clover pasture or cereal and brassica stubbles would often require less chemical.

A selective herbicide can be used, preferably well before direct-drilling, to control a range of flat weeds such as plantains and dandelions. Post-emergent herbicides may be necessary, particularly in cereals, where clovers or weeds recover from the pre-drilling spray or where weeds germinate after drilling.

(e) Drills

Many conventional drills are designed for drilling in the easily-penetrated, loose soil tilth produced by cultivation. For direct-drilling extra pressure is required. Coulters must be relatively narrow to minimise soil disturbance and to aid penetration and seed coverage. In New Zealand we have used four types of drill for direct-drilling:
(i) Dished-disc coulter. Pasture species can be direct-drilled into sprayed or unsprayed pasture with drills fitted with a dished-disc coulter. With this type of drill, however, some seed is usually split on the surface and the disc leaves other seed either buried under a flap or exposed in an open groove, depending on soil type, moisture content and drilling speed. Exposed seed is removed by birds or subjected to unfavourable conditions for germination and development. Seed buried under a flap of soil will only emerge in very light soil types.

(ii) Hoe Coulter Design. A narrow "knife" coulter preceded by an 8 to 10 inch diameter disc will penetrate soil under a wide range of conditions and place seed in a vertical groove with minimal soil disturbance. Springs provide pressure for penetration.

A Duncan "700 Seedliner" drill fitted with 8 inch diameter skeiths and narrow V-shaped points has been used for much of the trial and development work so far. Penetration in uncultivated soil for drilling pasture species and brassicas has generally been satisfactory: a depth of about 1 inch appears adequate. The degree of soil tilth and depth of seed coverage depends mainly on the soil type and moisture content at the time of drilling. Autumn and spring-sown cereals have been successfully established but birds have removed seeds and seedlings in some trials where the drill slit was left open. To prevent this it is necessary to drill grain crops at a minimum depth of about 1 to 2 inches and cover any exposed seed by rolling or, preferably, chain harrowing to close the drill slit. In stony soils the skeith is removed to prevent damage and increase penetration. Loose hay and straw on the ground surface tends to block in front of the hoe coulter.

In general the overall wear and tear on drills is increased by direct-drilling, particularly in compacted, dry and stony soils and the drill could be damaged if used carelessly or under unsuitable conditions.

(iii) Rotary Blades. A machine which has been developed specifically for the direct introduction of seed into uncultivated soil is the Howard Rotaseeder. This is based on the Howard EMU 70 model Rotavator to which a seedbox has been attached. The Rotaseeder is mounted on the tractor three-point linkage and is powered by the P.T.O. The rotor is fitted with 15 flanges at 5 inch centres. Blades mounted on the flanges are designed to rotavate a strip in the soil, one inch wide, into which seed is drilled. Rotavation to a depth of about 4 inches is controlled by depth wheels. Although the machine is 70 inches wide, the total width cultivated by the blades is only 15 inches. Because of the shallow cultivation and the small proportion rotavated, the total amount of soil moved is equivalent to about 5 per cent of that moved by conventional methods of cultivation.

Use of the Rotaseeder in New Zealand has shown that it will easily penetrate uncultivated soil, even when compacted and dry, and will leave a fine tilth in the drill row suitable for germination and early growth. It will deal with turfy pasture conditions but long straw tends to block in front of the seed sowing tubes. In stony soils wear of the blades is likely to be rapid or other parts of the drill could be damaged. With the present design fertiliser must be applied in a separate operation, usually before drilling. In favour-
able conditions it will drill at the rate of two acres per hour. The Rotaseeder cannot be used in cultivated soil.

(iv) Triple-disc Coulter. To overcome problems with trash and to reduce the rate of wear on coulters an all-rolling triple-disc coulter has been developed. This consists of a single small diameter (8 to 10 inches) front disc to penetrate and cut through trash followed by two inclined discs running side by side to open the drill slit and allow for the introduction of seed and fertiliser. Drills fitted with this coulter system are now commercially available in the U.K.

Triple-disc coulter drills require up to 150lbs per coulter for adequate penetration and as a consequence weigh about two tons. There is a generous allowance for independent up and down movement of individual coulters to allow for uneven ground. Although the draught requirement of the coulter system is low, the weight of the drill would necessitate the use of a medium-powered tractor. If the front disc is removed it can use for drilling in cultivated soil.

A prototype triple-disc drill is currently being used in the South Island. Although its full potential for direct-drilling in New Zealand conditions is not yet known, experience overseas has shown that this type of drill will work in trashy conditions, e.g. in unburnt cereal stubble. The system has a low wearing rate, seed can be placed accurately in the soil and disturbance is reduced to a minimum. It could overcome problems with "smearing" which can occur when a hoe coulter is used for direct-drilling in wet heavy soils.

(f) Drilling

Crops have been drilled from a few hours to about five weeks, after spraying. In general, the interval between spraying and drilling should not be less than about four hours and should not exceed about three to four weeks in autumn and early winter and about 10 days in late winter, spring and summer. The difference is due to the possible quicker recovery of sprayed pasture species in spring and summer. If soil conditions are suitable, drilling should follow spraying as soon as possible: ideally soil should be moist but friable.

We have generally applied seed at normal rates for cereals and pasture species but for brassicas the seed rate has varied from normal up to 50 per cent above normal. A higher-than-normal rate appears warranted particularly where the distance between rows is reduced. Fertiliser phosphate is required at levels normally used with cultivation and is usually applied with the seed as superphosphate. With brassicas and legumes we have used reverted forms of fertiliser to avoid any danger of germination damage.

Fertiliser nitrogen is required at about 40lbs nitrogen (= 2cwt ammonium sulphate) per acre under some conditions to give satisfactory crop yields. The nitrogen requirements for successive direct-drilled crops is not known. Various granulated forms of calcium ammonium nitrate (21 to 23 per cent N) are available and can be drilled with the seed. Other forms such as ammonium sulphate (21 per cent N) and urea (46.4 per cent N) have usually been topdressed shortly after drilling with satisfactory results. Germination of grain crops has not been affected by ammonium sulphate at 2cwt per acre drilled with the seed.
4. APPLICATION OF CHEMICAL METHODS FOR CROP AND PASTURE ESTABLISHMENT IN NEW ZEALAND

Apart from the main points already described, the main factor governing the success of direct-drilling appears to be soil moisture levels during the early stages of crop or pasture growth. Direct-drilling is therefore likely to be most reliable where the annual rainfall is above about 35 inches. Favourable areas would include much of the foothill country, the West Coast, and the southern half of the South Island as well as a large part of the North Island. In other drier areas crops and pastures are best direct-drilled in late summer, autumn through to late winter to ensure adequate soil moisture for a reasonable period after drilling. The way in which chemicals and direct-drilling methods are used depends to a large extent on these differences in "effective" summer rainfall or, of course, the availability of irrigation water.

To suppress annual grass weeds and increase the clover content of pastures we are currently applying paraquat at 2 to 4oz per acre (3 to 1 pint of the formulated product) in the period from September to January. Such grasses as Poa species, sweet vernal, hairgrass and goose grass can be severely checked or killed: the effect appears to be greatest when paraquat is applied when grasses are at the green seed-head to early-flowering stage. Where the perennial ryegrass content of pasture is low, a pasture mixture can be direct-drilled, shortly after spraying in the high summer rainfall areas, or following autumn rains in the drier areas. In this way the life of a pasture can be extended before the need for complete renewal, if necessary, by cultivation methods.

As with grasses cereals can be direct-drilled in the autumn to mid-winter period in most areas but results so far suggest that satisfactory spring-sown crops can only be reliably direct-drilled in the summer rainfall areas or where irrigation is available. We have recorded yields of 65 to 100 bushels in Southland with wheat drilled in October. In North Canterbury a September-drilled crop failed completely. In the previous season (1967-68) wheat drilled in mid-July on the same farm gave yields varying from 58 to 73 bushels per acre depending on the amount of clover regrowth and nitrogen application.

Current development of direct-drilled brassicas in the mid-Canterbury foothill area has confirmed the need for near-complete pasture suppression and for control of springtails. Of the brassicas, chou moellier, giant rape and turnips have grown successfully where pasture was adequately checked before drilling and where rainfall was sufficient: swedes establish and develop at a slower rate than other brassicas and for this reason, control of pasture species must be complete for good bulb development.

5. ADVANTAGES AND LIMITATIONS OF CHEMICAL METHODS

The research and development carried out so far has indicated or demonstrated a number of the potential advantages of the direct-drilling method and also some of its limitations. As mentioned earlier, the surface structure of the soil is retained when a crop is
direct-drilled. Apart from reducing the risks of wind and water erosion this has also reduced pugging when grazing winter-feed crops. Stones and boulders have not been brought to the surface as with cultivation. Direct-drilled brassicas this season have been relatively free of spurrey, fathen, and other weeds which readily germinate in a cultivated seed-bed.

Pasture growth, grazing and top-dressed fertiliser acting together tend to build up a top layer of fertile soil in the less fertile shallow soils. Direct-drilling methods of pasture improvement leave this layer intact. There is evidence from Australian research that by mixing this layer and its added phosphate with unweathered deeper soil, cultivation can lower the availability of phosphate for plant growth. (Williams and Simpson, 1965.)

Although the period of cultivation is being reduced in some areas it is likely that this will affect the reliability of cultivation methods. Adverse weather can cause delays in cultivation and drilling and weed problems could arise. Direct-drilling has only been affected by extreme windy or wet weather when spraying or drilling has been delayed. Even where this has happened the pasture has at least been available for grazing until it could be sprayed.

Capital outlay could also differ. For direct-drilling, spraying equipment, tractor and drill would be required instead of the range of cultivation implements normally used for cultivation, often with two tractors to cope with different operations.

Because the period between spraying and drilling is so short pasture has been grazed to within a few days and even hours of drilling. Extra grazing in spring and early summer would make it possible for some farmers to raise the carrying capacity of their farm and capital in the form of land would be better utilised.

The method lends itself more readily to contract work so that the labour requirement can be virtually nil. Even if the farmer prefers to do all his own work the labour requirement can be drastically reduced. For example the 20-acre paddock mentioned earlier would take nearly 14 hours to plough (3 x 12 inch furrows at 4 m.p.h.) but only just over two hours to spray (20ft boom at 4 m.p.h.) and 4.12 hours to drill (10ft wide at 4 m.p.h.) i.e., the crop could be drilled in about half the actual working time it takes to plough. Under English conditions cultivation and drilling has been estimated to take about one-fifth to one-tenth of the time for normal cultivation depending on the soil type.

6. COSTS

The apparent costs of the chemical method can be relatively high. For example, to direct-drill a winter-feed brassica into vigorous ryegrass/white clover the costs could be as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraquat (16oz) to control grasses</td>
<td>$12.50</td>
</tr>
<tr>
<td>Dicamba (6oz) to control clover</td>
<td>$4.33</td>
</tr>
<tr>
<td>Fenitrothion (6oz) to control springtails</td>
<td>$1.19</td>
</tr>
<tr>
<td>Spraying (contract)</td>
<td>$1.20</td>
</tr>
<tr>
<td>Drilling (contract)</td>
<td>$4.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$23.22</strong></td>
</tr>
</tbody>
</table>

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The cost of nitrogenous fertiliser could add an extra $5.15 (2cwt ammonium sulphate, ex-works). In general the response to nitrogen fertiliser will be greater where the soil fertility and the clover content of pasture are both low.

The costs of chemicals for controlling plants in other situations would, however, be much less. For example:

<table>
<thead>
<tr>
<th>Plants</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perennial ryegrass/white clover for autumn wheat</td>
<td>12.27</td>
</tr>
<tr>
<td>H1 short rotation ryegrass</td>
<td>6.25</td>
</tr>
<tr>
<td>Annual grasses/white clover</td>
<td>9.14</td>
</tr>
<tr>
<td>White clover alone</td>
<td>4.33</td>
</tr>
<tr>
<td>Cereal stubble weeds for autumn wheat</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Furthermore, where brassicas can be grown relatively weed free, it may be possible to direct-drill grasses and cereals immediately after grazing without spraying: more information is required on such possibilities. In pasture improvement techniques, chemical costs are much lower between $1.60 to $3.00 per acre.

By comparison the direct costs of cultivation appear relatively low. The actual cost of cultivation will however be much higher than the direct costs. For a tractor and implements, costs will include depreciation, running costs, repairs and maintenance: to this the cost of labour at about $1.00 per hour must be added.

The true costs can however only be compared by fitting the method into the whole farm system. As an example we have taken a farm in the Canterbury foothills where the rainfall is adequate for brassicas direct-drilled in mid-summer. Mr John Morris, Lecturer in Farm Management at Lincoln College, has prepared a partial budget for this farm. The values are calculated on the normal procedure for growing brassicas for winter-feed and for a chou moellier crop which was direct-drilled during this past season. Under normal cultivation practice pasture is ploughed in winter, sown to swedes in November followed by spring-sown barley. New pasture would then be drilled in autumn. Under a direct-drilling system chou moellier would be drilled in mid-December to replace the swedes. Calculations were based on an acreage of 40 acres winter-feed using market values for the 1968-69 season. On this basis the production from the extra stock carried shows an increased profit of over $750 per annum. Details of the comparison are given in the handout.

The main differences between the systems in this particular case are:

1. Extra grazing from June to December.
2. More stock carried on the extra grazing.
3. A reduction of 376 hours in labour requirement.

It must be emphasised that this is only an example: the relative merits of the two systems will vary considerably depending on the ease and speed of cultivation, labour availability, stock carrying capacity of a farm and other factors.
7. CONCLUSIONS

Direct-drilling is a revolutionary method of growing crops but essentially quick and simple. It is not a straight substitute for ploughing as the term "chemical ploughing" implies. Nor can it be used as widely as cultivation. It has distinct limitations. There are many situations where cultivation is the only effective method of levelling ground, burying trash and destroying pasture and weeds.

In the longer term, machinery and labour costs are likely to rise and highly-trained labour will be less satisfied with cultivation work. The adoption of direct-drilling methods is however still at an early stage of development and there is much to learn about its application in the field and its effects on the farm system: its reliability can only be accurately assessed over a period of a few years. The ultimate place for direct-drilling in New Zealand farming is difficult to assess at present. There is no doubt that one important factor will be the ability of farmers to adopt and adapt the appropriate techniques to suit their own local conditions.

REFERENCE

To illustrate the application of direct-drilling under farm conditions and to assess differences in costs and returns, a partial budget has been prepared for a case where direct-drilling is being applied. The farm of about 580 acres is in the Canterbury foothills with an annual rainfall of 48 inches with adequate summer rain for direct-drilled brassicas. The farm at present carries about 3,680 sheep and some cattle.

Cultivation costs were calculated for a rotation from old grass (ploughed in June) to swedes (sown in November) to barley (sown in October) to new grass (sown in February). With direct-drilling, pasture would be retained for grazing until about the end of December before spraying for giant rape or chou moellier, direct-drilled in late December or early January for winter-feed, followed by direct-drilled barley and then pasture. As there are two men on the farm, cultivation would be carried out by farm labour: for direct-drilling, both spraying and drilling would be carried out by contractors.

The available grazing between lambing and mid-December determines the carrying capacity of this farm. If 40 acres of brassicas are grown for winter-feed a direct-drilling system would add an extra 40 acres of pasture between June and mid-December. Under the conditions on this farm 40 acres direct-drilled chou moellier or giant rape are considered to be equivalent to swedes for winter grazing when taking into account yield, feed value, expected weed growth and pugging effects: an allowance is also made for extra nitrogen fertiliser for the direct-drilled brassica crop. The following calculations are based on prices, costs and actual stock performance during the 1968-69 season:
1. CONVENTIONAL CULTIVATION COSTS

ROTATION:
40 acres old grass to swedes to barley to new grass.
(ploughed June) (Nov.) (Oct.) (Feb.)

WORKING COSTS:

Cultivation: Old grass to swedes
- Plough @ 1 acre/hour = 40 hours
- Grub @ 3 x 4 acre/hour = 30 hours
- Level @ 7 acre/hour = 6 hours
- Ridge @ 1 acre/hour = 40 hours
- Scuffle @ 2 x 2 acre/hour = 40 hours

Total hours = 156 hours

Tractor running expenses: 156 hours @ 35c per hour $54.60
Tractor repairs and maintenance: 156 hours @ 15c per hour $23.40
Seed: 40 acres @ 12ozs swedes = 30lbs @ 45c per lb $13.50

Fertiliser:
- 40 acres @ 1 cwt Borated super = 2 tons @ $32.20 = $64.40
- 40 acres @ 1cwt Reverted super = 2 tons @ $23.95 = 47.90

Spray:
- 40 acres @ 6 pints Fodderkleen = 30gal @ $8.40 = $252.00

Application: 40 acres @ $1.20 = 48.00

Total = $503.80

Cultivation: Swedes to Barley
- Plough @ 1 acre/hour = 40 hours
- Level @ 3 x 4 acre/hour = 30 hours
- Drill @ 2 acre/hour = 20 hours

Total hours = 90 hours

Tractor running expenses: 90 hours @ 35c per hour $31.50
Tractor repairs and maintenance: 90 hours @ 15c per hour $13.50
Seed: 40 acres @ 2½lb = 90 bushels barley @ $1.84 per bushel = $165.60

Fertiliser: 40 acres @ 2cwt ammoniated super = 4 tons @ 38.20 = $152.80

Total $363.40

Cultivation: Barley to New Grass
- Plough @ 1 acre/hour = 40 hours
- Level @ 3 x 4 acre/hour = 30 hours
- Drill @ 2 acre/hour = 20 hours
- Heavy roll @ 1 acre/hour = 40 hours

Total hours = 130 hours

Tractor running expenses: 130 hours at 35c per hour $45.50
Tractor repairs and maintenance: 130 hours @ 15c per hour $19.50
Hire of heavy roller: 40 acres @ 30c per acre $12.00
Seed: 40 acres @ 19lbs N.G. mixture @ $5.30 per acre $212.00

Fertiliser:
- 40 acres @ 1¼cwt Di-amm. phosphate = 3 tons @ $105.70 = $317.10

Total $606.10
2. DIRECT DRILLING COSTS

ROTATION:
40 acres old grass to chou moellier to barley to new grass
(sprayed Dec.) (Dec.) (Oct.) (Feb.)

WORKING COSTS:

Spray: Old Grass to Chou Moellier
3 pints Gramoxone @ $3.125 = $9.38
1½ pints Dicamba @ $2.89 = 4.33
¼ pint Gramothion @ $2.39 = 1.19
Application = 1.20
Total per acre = $16.10
40 acres @ $16.10 = $644.00

Drilling: 40 acres @ $4.00 per acre (contract) = 160.00

Seed:
40 acres @ 4 lbs chou moellier = 160 lbs @ 45 c per lb = 72.00

Fertiliser:
40 acres @ 2 cwt reverted super = 4 tons @ $23.95 = 95.80
40 acres @ 2 cwt ammonium sulphate = 4 tons @ $52.65 = 210.60
Total = $1182.40

Spray: Chou Moellier to Barley

Drilling: 40 acres @ $4.00 per acre (contract) = $160.00

Seed:
40 acres @ 24 lb = 90 bushels barley @ $1.84 per bush. = 165.60

Fertiliser:
40 acres @ 2 cwt ammoniated super = 4 tons @ $38.20 = 152.80
Total = $478.40

Spray: Barley to New Grass
1 pint Gramoxone @ $3.125
Application $1.20
Total per acre $4.33
40 acres @ 4.33 = $173.20

Drilling: 40 acres @ $4.00 per acre (contract) = 160.00

Seed: 40 acres @ 19 lbs N.G. mixture @ 5.30 per acre = 212.00

Fertiliser:
40 acres @ 1½ cwt Di-amm. Phosphate = 3 tons @ $105.70 = 317.10
Total = $862.30

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3. GROSS MARGIN PER EWE

10 lbs wool, 105% lambing, ewes last 6 years.

Gross Revenue:

- 10 lbs wool @ 20c net: $2.00
- Lambs wool 1 1/2 (1.05 lambs @ 3 lbs per head) = 1.58 lbs @ 20c net: 0.32

- Lambs 1.05 @ $5.00 net: 5.25
- C.F.A. ewe 1/6 @ $3.30 per head: 0.55

**Total Gross Revenue:** $8.12

Direct Costs:

- Shearing: 1 @ $15.00 per 100 = $0.15
- Crutching: 1 @ 5.00 per 100 = 0.05
- Vaccinations: 2-tooth ewes — B.L. (Lambs — Se): 0.01
- Drenching:
  - Ewe @ Nilverm pre-lamb = 0.06
  - Lamb 2 x Nilverm and Se = 0.10
- Docking = 0.01
- Footrot = 0.01
- Dipping = 0.03

Ram cost net (1 ram: 70 ewes) cost $70 for 5 years = 0.20

Replacement 2-tooth ewes: 1/6 + deaths (.167 + .05) = 0.217 2-tooth ewes @ $8.00 = 1.74

**Total Direct Costs:** $2.36

Therefore Gross Margin per Ewe = $8.12 — $2.36 = $5.76 per Ewe

4. SUMMARY OF COMPARISON

<table>
<thead>
<tr>
<th>Working Costs</th>
<th>Cultivation</th>
<th>Direct Drilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>OG to winter feed</td>
<td>$503.80</td>
<td>$1182.40</td>
</tr>
<tr>
<td>Winter feed to barley</td>
<td>$363.40</td>
<td>$478.40</td>
</tr>
<tr>
<td>Barley to new grass</td>
<td>$606.10</td>
<td>$862.30</td>
</tr>
<tr>
<td>Farm labour requirement</td>
<td>(376 hours)</td>
<td>(Nil)</td>
</tr>
<tr>
<td><strong>Overhead Costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional capital involved in plant ($2028 @ 7%)</td>
<td>142.00</td>
<td>—</td>
</tr>
<tr>
<td>Repairs and maintenance on plant ($1028 @ 10%)</td>
<td>102.80</td>
<td>—</td>
</tr>
<tr>
<td>Additional insurance on tractor and plant</td>
<td>12.10</td>
<td>—</td>
</tr>
<tr>
<td><strong>Loss of Grazing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 acres @ 8 ewes per acre = 320 ewes @ $5.76 per ewe gross margin, less feed cost of 1 1/4 bales of hay per ewe at 60c per bale leaves a net margin of $4.86 per ewe</td>
<td>$1555.20</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$3285.40</td>
<td>$2523.10</td>
</tr>
</tbody>
</table>

This gives an advantage of $762.30 to the direct-drilling system, equivalent to $19 per acre of winter-feed brassica under these conditions.
SEED BED MECHANISATION FOR EFFICIENT CROP PRODUCTION

Mr J. S. Dunn, Senior Research Officer, N.Z.A.E.I.,
Lincoln College.

All our farm crops with the exception of potatoes are established from seed and with many of them this has to be done annually. Crop establishment therefore is one of the most important operations on any farm.

Are you familiar with the old saying, "A crop well sown is a crop already half grown"? If the importance of crop establishment was recognised in days gone by when hand labour to patch up and cope with crop variation was plentiful, how much more important is it to us who depend wholly on mechanised methods of cropping.

To get the best out of our machines when growing any crop we must present them with as uniform a condition as possible. Any factor which induces variables in the rate of growth, in the habit of individual plants or in the time of maturity is likely to result in difficulty in setting machines to perform efficiently and it may also make it impossible to obtain effective pest or weed control. In many cases losses at harvest will follow and product quality may be lowered.

Uniformity of crop depends largely on the start the crop receives and uniformity of establishment is dependent on the seed bed we provide. As our cropping becomes more intensive and the use of machinery increases we must look at our seed bed much more seriously than many of us are doing today.

How did you decide on your present method of seed bed preparation? Everyone probably has different views on how to produce a seedbed and most of us produce crops quite satisfactorily. But could we not do better?

From observations I wonder whether we are not inclined to use methods which have become traditional without thinking very much what we are doing. Are these methods not a relic of the old brown-top days when we had to contend with a dense mat of turf and the more this was ripped and battered with the discs and grubber the better was the crop we were likely to get.

This approach seems to persist. We have seen paddocks this last season worked twenty-two times between ploughing and sowing, and I know this is not the upper limit! There seems to be a belief that with the ready availability of power the more effort we can put into our soils the better will be the resulting crop.

I believe that many thousands of man and tractor hours are being utterly wasted in producing what is anything but a good job when it is finished.

By looking at the requirements for a good seed bed and devising simplified methods by which we might obtain them I am sure we can achieve better results much more quickly and much more cheaply.

A seed bed should enable us to:

1. Place the seed beneath the soil surface so that
   (a) it will be buffered against changes in the weather,
(b) it will be in constant contact with a supply of soil moisture,
(c) it is protected from birds.

2. It should also be possible in a good seed bed to place the seed uniformly at the required depth in a soil having a suitable structure to allow roots to penetrate to give anchorage and obtain water and nourishment.

To introduce seed mechanically and obtain the uniformity we are seeking a number of more detailed requirements may be added.

3. The seed bed should be level. Most operations are carried out by wheeled tractors and wheeled implements. We are aiming to give consistent treatment at all stages, cultivations, sowing, hoeing and perhaps spraying. Wheels on an uneven surface will not allow this. We are not wanting to produce a billiard table effect but local undulations must be removed. These are mainly formed by previous cultivations and do not involve the movement of much soil.

4. The seed bed should be firm and of uniform density; not with a rolled skin which is hard on the high spots and soft in the hollows. Tractors and implements were not intended to rock and roll. There must be a datum to which our depth of working can be set.

5. The seed bed should be fine, but only on the top where the seed is placed. I am assuming that the ground was originally well ploughed. With a digger or semi-digger mouldboard the underlying soil of the furrow slice will already have been fractured and opened in turning sufficiently in most cases to allow any roots to penetrate. Fine soil around the seed permits easy moisture transfer into the seed.

6. The seed bed must be moist at drilling depth. Immediate germination of all seeds is required if our aim of uniformity is to be achieved.

Having stated our requirements, how do we obtain them?

A technique for doing just this was developed in Europe and U.K. during the 1950s and we have found that it works well under many New Zealand conditions.

For spring sowing I prefer to work on autumn or winter ploughed land although it can give quite satisfactory results, too, after spring ploughing.

If you are cropping for grass, surface-working with discs before ploughing is recommended then plough as well as you know how; round and round for preference or in lands, but keep the opening-ridges and finishes shallow. All turf or weed growth should be completely buried and the furrows well closed.

After autumn or winter ploughing nothing further is needed until immediately prior to sowing. The seed bed is prepared the day of sowing or just before so that any weeds are given no chance to emerge ahead of the crop. With spring ploughing a partial treatment should be made immediately ploughing is completed, with the final treatment being given immediately before sowing.

There is nothing unusual about any of this except that in preparing the seed bed we work the reverse way to what is traditionally done. That is from the soil surface downwards.

Traditional Method

In the normal way discs and grubbers are used. These lift underlying soil and much of the surface tilth produced by weathering is
lost between the clods brought to the surface. We then have to start at the beginning to do what the weather has already been doing for us all winter. Every time we stir the soil in trying to do this moisture is lost and clods often become baked so that the roller is brought out to crush them. It becomes an alternating operation of lifting up the soil and squashing it down again.

By the time a considerable depth of soil has been reduced to particles approaching something like the size required a great deal of work has been done and much invaluable soil moisture has been lost. Consolidation is difficult to obtain because of the depth of working and the drill sows at varying depths into soil which might or might not start some of the seeds on their day before the next rainfall. I have painted rather a black picture, but isn't this what often happens in practice?

**Shallow Seed Bed Technique**

By working from the surface down with a shallow straight-tined implement any surface tilth at the start of the operation remains on the surface. The tine points remove further soil from the underlying furrow slice which is held rigidly and by repeated working the depth of tilth is deepened progressively and consistently. No raw soil in the form of clods is brought to the surface and the continuous surface tilth ensures that moisture loss is minimised. We have formed satisfactory seed beds in three passes on winter ploughed soil. A further two or three passes will be required when working spring ploughed ground.

We have used a Dutch harrow for this work; a simple straight-tined implement looking something like a heavy clod crusher with harrow tines on its cross members. It combines the actions of a clod crusher, a leveller and a harrow and no further working is needed before sowing. Our 10ft wide implement provides a good load for a 45 h.p. tractor but a narrower implement could be made for lighter tractors. The existing model weighs about 4cwt and there are 59 tines each cutting on a 2-inch track. Operating speeds of up to 7 and 8 m.p.h. are possible.

This is not the only implement for this type of work. You may know of others. A powered harrow in two or four row forms has recently appeared in Europe and I believe one or two have already reached New Zealand. These could be the next step in achieving the same result in fewer passes. It has been claimed that only one pass is necessary. However this is a powered machine working in soil; it is likely to be expensive and maintenance costs could be high. But the performance might justify the extra outlay.

**Conclusion**

In my paper I have attempted to focus attention on some aspects of the fundamental operation of crop establishment. But I have only dealt with the physical side. Chemical considerations are no less important and soil analysis, the use of lime and fertiliser, and efficient methods of applying these are all part of the same operation.

They all have an equal part in the rethinking we must do if we are to achieve the maximum benefits from mechanising our cropping.
In October last year I was very fortunate to be given a grant to visit the United States for six months, to look at project evaluation procedures. While there I managed to see a little of the farming on the West Coast and the Great Plains.

The topic "Farming Trends in America" is very wide and I am not qualified to cover the full width of the subject; however, I shall attempt to cover a few trends which I thought were of particular interest to New Zealand. I should point out that I soon found that the United States is not one country but 50 different countries, and the conclusion one draws from observations in one State is not necessarily valid in any other State.

The State of Oregon is similar in many ways to New Zealand. It has an area a little smaller than New Zealand, with a population of two million people. Its latitude is similar to that of the South Island of New Zealand, with the 45 deg. north latitude running through its capital, Salem. It is possible, therefore, that New Zealand can learn something from the trends which are taking place in Oregon.

The major industry of Oregon is based on timber from a vast area of Douglas Fir and Ponderosa Pine. However, agriculture is a most important second industry. The arid parts of Eastern Oregon and Central Oregon run a traditional Beef Ranching system of farming with the cattle spending the spring on irrigated pasture and the summer grazing on leased public lands under the control of the Bureau of Land Management, or the Bureau of Forestry. The cattle are then wintered on alfalfa hay, and grain which is grown under irrigation on the valley floors. Much of this country exports feeder cattle, and imports feed lot fed cattle from the States which specialise in feed lot feeding.

However, it is from the arable areas of Oregon, mainly in the Willamette Valley, that New Zealand can perhaps learn something. This country receives 60 per cent of its 45 inches of rainfall in the three winter months of November, December and January, while the summer and fall are relatively dry. Here the agriculture is turning away from livestock farming, towards more intensive fruit, vegetable, nut and seed production. There are few sheep or cattle, and the area is farmed under continuous cropping, with fall wheat, spring barley, crimson clover, fine fescue (a type of fine turf grass) on the rolling country; and on the fertile river flats sweetcorn, bush beans, pole beans, boysenberries, strawberries, asparagus, onions, potatoes, peas, peppermint and spearmint are the major crops.

In addition there are many orchards of walnuts, sweet cherries, filberts (a kind of hazel nut) and prunes and pears. Much of the land under intensive fruit, vegetable and berry production is irrigated by the sprinkler irrigation systems, from small farm ponds, built under assistance from the Soil Conservation Service of the United States Department of Agriculture. The most common method of irrigation
seen is a set of sprinklers on an aluminium pipe up to a quarter of a mile long, mounted on large wheels and moved by a petrol motor at the centre. This is very suitable for flat or gently undulating country, and fits in well with the lack of livestock as there are no fences to impede the progress of the system. Such a system with electric pumps, from either a pond or well, represents an investment of $125/acre.

Many of the irrigation schemes in Eastern and Central Oregon were established as flood irrigation but all are converting to sprinkler irrigation for several reasons.

The soil is often sandy and of undulating topography, so that water infiltration is very uneven, under flood irrigation.

The land is unsuitable for setting up automatic irrigation, as we have in Canterbury, so that a great deal of expensive labour is required to flood irrigate, and in many cases this involves being on hand at all times to guide the water round contours with a shovel. Even at $1.85/hour, this labour is now not available.

Finally, in the arid areas the water for irrigation comes from water stores in the dams in canyons, from the winter rains, and very little rain falls during the summer. Hence the limiting factor to irrigation is the amount of water available, and sprinkler systems use two inches of water to apply two inches of effective water, while flood irrigation may use four inches of water to apply two inches effective water. The net result is that new schemes are being planned as sprinkler schemes with lined canals, or completely piped systems, and old schemes are being converted to sprinkler.

At present most irrigation schemes in the Willamette Valley are small private schemes. However, the Bureau of Reclamation of the Department of the Interior, and the Soil Conservation Service of the United States Department of Agriculture have plans for about 15 irrigation schemes of approximately 20,000 acres each, which will produce intensive fruit, vegetable and nut crops.

At present Marion County in Oregon produces a higher total value of vegetables than any other county in the United States. Under further irrigation development this would greatly increase. However, the United States market with its 200 million consumers must not be thought insatiable. One irrigation project alone in the Willamette Valley could produce two and a half times the total annual United States consumption of bush beans.

With several of the other States, particularly California, in its Central Valley, also producing irrigated vegetables the major limitation to growth will be the growth of the total market, which will in turn control the growth of the vegetable processing factories, and hence the contracts in individual farmers.

The Pacific North West at present contains 2.7 million acres of irrigation under the control of the Bureau of Reclamation, which is the largest public irrigation authority in the Western United States.

A quick look at statistics of this area shows how irrigation is allowing intensification of production. Of the 2.7 million acres irrigated, one-third of a million acres is in field crops such as dry beans, hops, mint and sugar beet, with an average revenue of $270/acre. A further third of a million acres is in vegetables such as processing
beans, asparagus, sweet corn and potatoes, with an average revenue of $260/acre.

One hundred thousand acres is in fruit such as sweet cherries, apples, grapes and pears, with a revenue of $750/acre.

The remainder is in cereals and forage with a revenue of $70/acre.

The changes which are taking place are:
1. A small increase in the total crop acreage.
2. An increase in the proportion of the crop area that is being irrigated.
3. A shift to the more intensive and higher value types of agriculture.
4. An increase in the crop yields of about 4 per cent per annum, due to many factors such as improved harvesting techniques, better disease and weed control, more efficient use of fertiliser, and improved varieties.

An increase in total yield by a factor of four is possible in many areas, when a change is made from wheat, fallow rotation to wheat every year at double the yield.

5. Mechanisation of tasks formerly performed by hand is a further factor. The price of unskilled, agriculture labour is now about $1.85/hour and even at this price casual, unskilled labour is now difficult to get particularly at harvest time. Even in California the cheap Mexican labour is now not available. The net result of this has been the mechanisation of as many tasks as possible. Fertiliser and spray are spread by large wheeled tractors with long booms.

Tomatoes are harvested with a device like a potato digger. Pole beans which require hand picking have been replaced by bush beans which can be picked by machine. Lettuce, cabbage and strawberry picking are being at least partially mechanised.

Walnuts, filberts and almonds are all mechanically shaken from the tree into large portable funnels.

Peppermint and spearmint are crops which I believe have great application to New Zealand and in particular to Canterbury. Peppermint oil is used to flavour chewing gum, candy, toothpaste. The market growth for these products is steady but not spectacular.

About 60,000 acres of mint is grown in the United States and about one-third of this is grown in Oregon. This crop requires a climate with long, sunny, summer days and a deep, rich, loose-textured or sandy soil, with a pH of 6.0 to 7.0, and has a high nitrogen fertiliser requirement.

The crop is propagated by stolons and is spread each year by skim ploughing the old paddock, allowing the stolons to start new plants. A field of mint will normally last five to ten years from the one planting of stolons.

The crop requires a considerable amount of irrigation during the summer and it is usual to irrigate every one to two weeks with one or two inches of water either sprinkled or applied in a furrow.

The mint is harvested in the early bloom stage, by mowing it, then picking it by forage harvester into portable distilling tubs. At the still, high pressure steam is passed through the tub and the oil is distilled out.
The average yield of mint oil for the Pacific North West in the irrigated areas is about ninety pounds to the acre and the average price about $5.00 per pound. This price varies considerably from $3.00 to $6.00 per pound according to the quality of the oil, which depends in turn on the growing season, time of harvesting and impurities caused by weeds in the crop and diseased plants. However, the average gross revenue under irrigation is about $425/acre. Mint oil distillation plants are usually owned by the local farmers, and these charge about $1/lb of mint oil produced, reducing the gross revenue to about $325/acre.

The cost of establishment of a stand of mint, including the stolons is about $300/acre, and annual costs about $200 per acre. These costs are, of course, higher than could be expected in New Zealand as a large part of the cost is labour, valued at $1.85/hour.

A word of warning should be sounded at this point on the mint crop. Verticillium wilt is the limiting factor in the production of mint. This wilt may start in isolated spots in the field, and spread, killing the plants. The fungus remains in the soil almost indefinitely, and it will last through many other crops. Mint farmers in Oregon go to great lengths to obtain wilt-free stolons, as the disease can completely wipe out the crop in an area.

There is great scope for a similar development of intensive processing vegetable production under irrigation in Canterbury in the areas of better soil types, such as Willowbridge, Hinds, Leeston and Prebbleton.

I believe we must give consideration to changing the emphasis of the public irrigation schemes away from the light lands and on to the soils which will allow the production of higher value crops.

In contrast to the efficiency of intensive cropping in Oregon the sheep farming industry is a poor relation. Sheep meats are a small and declining part of the average American consumer's meat diet. Lamb and mutton consumed is only 3.8 lb per head and this figure is falling, compared to beef at 110 lb per head and rising at 3 per cent per year.

Lambs are slaughtered at about 100 lb liveweight and in Washington and Oregon bring about 27 cents per lb liveweight or about $27.00 for the lamb. In addition, the price of wool is subsidised from its market value of 33 cents to about 65 cents per pound, depending on the quality. However, the sheep farmers of Oregon are not making money at fat lamb farming and the number of sheep is falling by 2½ per cent per year.

The major reason is the small flock size with sheep flocks being between 200 to 500 ewes. Secondly, the very high price of land means that the farm has a total investment of about $400/ewe compared with about $50/ewe for New Zealand. Thirdly, little use is made of roots for winter feed, and up to 100 lb of grain may be fed to a ewe and her lamb. The winter in Oregon is wet and cold, but wintering could be done much more cheaply. Fourthly, due to inefficient management the amount of labour required is too high and the high revenue per head is lost in a high wage bill.

An interesting development in irrigation is about to take place in Oregon. Several nuclear power plants will be established in
Oregon in the next five years to produce electricity for the rapidly expanding industry. Vast amounts of cold water are used in the cooling of these plants and the warm water must then be discharged. The water is not polluted with any nuclear wastes or other impurities, but is merely warm. The water cannot be discharged back into the rivers as the resultant “thermal pollution” will discourage the fish spawning run in the rivers. The fish resource of the Pacific North West is extremely important both from a commercial fishing and the recreation-sport fishing points of view.

Several solutions have been suggested. One is to allow the water to boil off in cooling towers, but the idea of allowing 25,000 cu. ft of water per year to go into the atmosphere as steam in an industrial area is unacceptable from the standpoint of air pollution.

A trial area of 170 acres has been established to test the possibility of using the warm water to irrigate crops such as sweet corn, rice and beans. This would enable two crops per year to be grown on the same area and could be used to control the ripening time of crops. It would avoid the cold water shock which occurs when crops are irrigated early in the season with water directly from a pond. The warm water will also be used to prevent frost damage to fruit blossoms early in the growing season by sprinkling the trees with warm water when the temperature drops below 32 deg. F. It has been shown that it is possible to grow 14½ tons of alfalfa hay per acre using warm water irrigation.

An alternative procedure is to pipe the warm water three feet underground, at 20 ft spacing, to increase the soil temperature during the winter to allow double cropping.

On a larger scale at the Oroville Dam in California over $1 million have been spent on a water intake which will allow warm water from the surface of the lake to be used at the beginning of the irrigation season for irrigating rice, and cold water from deep in the lake to be released down the river in the mid-summer to encourage the fish spawning run.

At the other end of the scale of development from intensification, is an increase in the scale of the enterprise.

I would like to describe briefly the increases in scale on three enterprises.

1. A dairy farm in California.
2. A beef feed lot in Colorado.
3. An irrigated land development in Colorado.

The health conditions placed on dairy farms producing milk for liquid consumption have made it extremely difficult for the small farmer to continue.

On the other hand, the high price of liquid milk at retail ($1.20 gallon) has made it very profitable for large concerns with direct links with supermarkets to produce liquid milk. The high price of milk is in keeping with the price of other dairy products, but is helped by the product differentiation. The housewife in the supermarket has the choice of four different fat levels, two different S.N.F. levels, homogenised or otherwise, the addition of a range of vitamins and even in some cases a range of flavours from chocolate to orange.
A typical large dairy farm in the Central Valley of California has about 4,000 cows, mainly Holstein, in a feedlot on a well-drained sawdust pad. Each pen contains about 100 cows and has a large rise in the middle to keep the cows dry in wet weather. In the middle of the pen is a roofed area to provide shade in the very hot summers.

Only a small proportion of the feed is actually grown on farms due to the high cost of land in the area. One cannot afford to grow alfalfa hay on land which could be growing table grapes. However, many dairy farms grow an allotment of 30 per cent cotton and put manure back on the cotton. Grain sorghums, alfalfa hay and mineral and protein supplements are fed in troughs under the roofed area. The cows are brought into the milking area in batches of about 100 and washed underneath by rotating sprays in an outside yard. They are then milked through a 25-a-side, low line, herringbone shed. Depending on the size of the herd, milking may go on for 18 or even 24 hours a day, with relatively unskilled labour milking in shifts. A refrigeration plant is attached to the milking plant. The milk is packaged in cardboard containers and transported directly to the chains of supermarkets. The air of such a farm is one of the unhurried efficiency of factory.

While I do not believe that New Zealand should switch to feed-lot dairy systems, I think that this example shows that even our largest dairy herds are nowhere near the limits of the number of cows that can be handled through one milking shed, or in one enterprise and we must get used to the idea of seeing dairy herds in the 2,000 to 4,000 cow class.

If the New Zealand dairy industry is to remain profitable, it must overcome the lower margins per lb of butterfat produced by increasing the scale of the enterprise.

I was fortunate in being able to visit two large feed lots in Kansas and Colorado.

While there is a very large area of ranch land devoted to beef farming in the United States, the real key to beef production is the feed lot. Beef cattle production has doubled in the last 20 years and this is largely due to the growth of the feed lots with the increase in fed cattle marketings being 7 per cent per annum.

When we look at a cross section of beef production in the United States some interesting facts emerge. Feed lots with more than 1,000 cattle represent only 1 per cent of the total beef farmers in the United States but produce 47 per cent of all beef. Feed lots with more than 8,000 cattle represent only one tenth of 1 per cent of all beef farmers but produce 27 per cent of all beef. Clearly a study of the 1 per cent of the large feed lots will tell us as much as studying the 99 per cent of small beef ranches. However, a feed lot of 400-600 head is an important part of the great majority of beef ranches of the Great Plains and the Mid West. The beef industry is following a policy of vertical integration demonstrated so clearly in the meat chicken industry. In the meat chicken industry one organisation owns or controls the complete flow of materials from the growing of the feed, the breeding, feeding and processing of the birds right through the distribution to final retailing of the polythene packaged bird at the supermarket. With this method the organisations have been able
to reduce the margins within the industry to the point where the farmer growing the chicken receives less than 1c per lb of meat as his own profit and chicken is marketed at 35c per lb compared with $1.60 per lb for beef and $1.30 per lb for lamb.

A large feed lot I visited in Colorado fattens 50,000 cattle at a time in two separate lots. These cattle are in the feed lot for 140 days resulting in a total throughput of cattle of 130,000 per year. (This should be compared with the total slaughter of adult cattle, through the South Island export works for 1967-68 of 137,000.) Cattle come into the feed lot at 10-14 months of age at a liveweight of 700 to 1,000 lb, gain weight at about 2.1 lb per day and are killed after 140 days at between 1,000-1,400 lb liveweight. In winter the weight gains do not fall but the consumption of feed increases. The feed consists of a ground ration of corn grain, corn silage, milo, salt and additives. In some feed lots the corn is steam cooked and while it smells delicious, rather like a breakfast cereal, there is some doubt whether the elaborate processing increases the conversion rates.

Grain is stored in grain elevators; but airtight silos for haylage are too expensive for this type of operation. Corn silage is stacked in heaps of 50,000 tons about 30 feet high. The top one foot suffers from spoilage but this is a very small proportion of the total stack. About 10 per cent of the feed was grown on the property, the remainder being bought in. The ground and mixed feed falls from overhead elevators into trucks and is then placed in troughs along both sides of roads running through the feed lots. The pens, which contain about 200 cattle each, are cleared out with rubber-tyred scrapers and the manure sold for about 50c ton which covers cleaning costs. Four cowboys are responsible for the day to day moving of the cattle and for the removing of any sick ones in a lot containing 20,000 cattle. Cattle are bought in at about 25c per lb liveweight and sold at 28c per lb liveweight which represents about 45c per lb carcass weight. Approximately half the cattle are owned by the feed lot company and half are fattened on a custom rate basis for other individuals or companies.

The feed lot had its own killing and packing plant on the property and had sales links with supermarkets in Chicago and on the East Coast.

In spite of the obvious efficiency of this feed lot and the relatively low price of feed grains, the manager assured me that if the price dropped by 2c per lb, as it did two years ago, the feed lot's profit margin was gone and many feed lots in Colorado would go out of business altogether.

I believe that with our relatively high price of feed grains and our relatively low price of beef cattle, such an operation could not possibly survive in this country.

Large feed lot operators do not regard imports of beef from New Zealand, which are largely manufacturing beef, as competitive with their product. They realise that as more beef is fed through feed lots they are less able to meet the demand for manufacturing beef and it is logical to fill this gap with imported beef.
The need for the feed lot to increase its vertical integration by supplying its own cattle, and its own corn grain and corn silage, brings me to my final topic, that of large scale, private, irrigation land development.

Because of its outlets for packaged beef in Chicago and on the East Coast, this feed lot has access to enormous amounts of capital which allows it to develop large tracts of semi-arid country very rapidly. Because of this rapid development, its land development company is possibly ahead in ideas and technology of the public irrigation development run by the Bureau of Reclamation.

Land with water underneath it, in a completely undeveloped state, which means sandhills and sage brush, can be bought in Colorado for about $100 per acre. This is desolate country in its natural state, with no trees, at an elevation of 4,500-5,000 feet, generally flat with undulating sandhills. The occasional buffalo can still be found in this country. The land can be developed to sprinkler irrigation for about $200-250 per acre and, as corn growing and cattle-raising country, is worth about $500 per acre.

It is apparently a paying proposition for the feed lot company to develop this country to supply its cattle and feed as it is developing 5,000 acres per year. The rolling nature of these sandhills and the texture of the soil make flood irrigation an impossibility. However, the conventional forms of sprinkler irrigation with their long pipes on wheels moved across the field by hand or driven with a motor, require all the technical skills and physical labour of flood irrigation and hence are unacceptable for large-scale development.

The type of irrigation used, therefore, is the first true automation of sprinkler irrigation. It is self-propelled or circular system. A metal pipe is attached to a pivot at one end, at a well and a pump, mounted at the centre of the field. Water is sprinkled from heads mounted on top of the metal pipe. The whole assemblage rotates around the field thereby providing self-propelled irrigation.

The circular system is almost always attached to a well, but this is not essential. So long as the water is free from abrasives it can be attached to a ditch (with bridges for the wheels). The optimum size circular system is about 17 towers representing a field radius of 600 yards irrigating 190 acres. The circular system may be attached to clocks to start and stop the system automatically at given times or to sensing devices which automatically regulate the system depending on soil moisture, consumptive use of water and temperature. A circular system of this size completes a revolution around the field in from 1½ to 3 days placing from 3½ in. to 1¾ in. of moisture on the ground.

Approximately 2 cubic feet of water per second is pumped from the well with the pressure at the first sprinkler of 85 lb per square inch falling to 35 lb per square inch at the far end. Each tower has a valve attached to the pipe which controls the water flow to the water motor. Should one tower fall a little behind the line of towers the valve opens, supplying more water to the motor, causing the tower to speed up a little and fall back into line. This means that the speed of rotation of the whole system is controlled by the speed of
the outside tower and all other towers follow it. A circular system will cope with the slope of 8 per cent or 60 inches per chain so that an absolute minimum of levelling is required. In fact all that is required is to take off the very steep pinches with a carryall pulled by a D8 tractor. One man can look after six circular systems at a time which means about 1,000 acres of irrigation are completely controlled by one man. Should it be necessary to move a circular system to a new site, two men can tow it by tractor to a new well and have it running again in four hours. The cost of a circular system is about $1,000 per tower or about $17,000 for the full system or about $100 per acre irrigated.

While the automatic border-dyked irrigation of Mid-Canterbury is very efficient, the possibility should not be ruled out of using the circular systems of sprinkler irrigation for irrigating large areas of lucerne or even processing vegetable crops such as peas, beans or potatoes, on land which is too undulating to be economically border-dyked. The efficiencies to be gained by having 200 acres uninterrupted by head races, or border dykes, may well off-set the higher capital costs of such a system.

A further development is taking place on this land development area. This is the stationary system which consists of 5-inch P.V.C. pipes laid 36 inches underground from a well head, branching out to lateral lines of 2-inch diameter with risers extending above the ground surface to sprinkler heads at 60 x 80 ft rectangles. The pipes are joined and the risers inserted in a trailer moving across the field and the completed system is fed into a ditch made by a huge plough, hence the whole system is laid at about two miles per hour. The optimum size field for this system is about 200 acres. Normal cultivation can take place with the system in position and the irrigation is controlled by sensing devices for completely automatic control. The cost of a stationary system for an optimum size paddock is about $250 per acre compared with about $200 per acre for the complete land development and equipment for the circular system. There are three major advantages of the stationary system over the circular system. First, because the stationary system is underground its life is likely to be 30 years or more compared with 15 for the circular system. Second, the stationary system can be placed on extremely hilly country; in fact the limitation is how steep the country can be and still be cultivated. Third, it has been shown that yields of grass and corn are depressed if the temperature is allowed to rise above 80 deg. F. The ground temperature in Colorado can often get above 100 deg. F. in summer so that there is a considerable depression of yield. With flood irrigation occurring only every ten days or circular system every three days, there is little scope for temperature control by irrigation. However, with a stationary system it is quite feasible to irrigate twice a day if necessary for optimum temperature control reducing the crop by 20 deg. F. below the outside temperature. This temperature factor and several other factors such as the avoidance of over-watering and salt build-up by careful water control and more accurate fertilisation have resulted in yields under sprinkler irrigation being from 30 to 50 per cent higher than yields under flood irrigation.

The land development block in East Colorado which was carrying one cow to 20 acres two years ago is now growing 180 bushels of
To the acre or supporting three cows and their calves per acre with a grain supplement. With these levels of production the $350 per acre for irrigation development and the cost of the land represents good business. The land development company has solved the problem of housing of agricultural labour during the development period in an interesting way. In this desolate country they have placed groups of ten trailer houses at the site of the development to house the manager, tractor drivers and labourers. A trailer house is a long caravan, 68 ft long and 12 ft wide with all the fittings of a modern American home including wall-to-wall carpeting, central heating and air conditioning and a most elaborate bathroom. After the development stage is over most of the trailer houses can be removed to a new site. Trailer houses cost about $9,000–$10,000 each which represents a considerable saving compared with the expense of building equivalent housing. Trailer houses can be built in New Zealand for about the same amount and could clearly solve the problem of housing of agricultural labour on developing farms.

I am sure that some of the developments which are occurring in the United States agriculture will occur in New Zealand, and indeed are occurring at present.

We should ensure that we are ready for the developments when they take place.
Performance testing is the comparing of animals on the basis of what they themselves can do or have done in some standard environment. If a large number of animals are compared together, with the kind of uniform feeding and housing, provided for example by a boar performance test centre, it is possible to pick out the superior animals. Use of these animals for breeding will result in at least some of the superiority being passed on to the offspring. Performance testing of boars for various characteristics which can be measured during the growing period enables us to select, in advance of breeding use, the probably superior boars from a large number of potential parents.

Some farmers will be pig breeders and some will be buying breeding stock and selling only meat. Performance testing is a tool that the breeders can use to help them produce the type of pig that the buyers want. Of course, over the years breeders have made quite a lot of changes to the pig. However, they cannot rest content because many good changes can yet be made. There are still too many pork chops or slices of bacon being produced that are far too fat and much of this is due to breeding.

I want to stress at this point that breeding is a business of sampling. The things that an individual pig inherits come half from its sire and half from its dam and it is in this halving that the sampling occurs. Since an offspring gets only half of its breeding from its sire it could get a good half, or a bad half, or just an average half. Similarly with the dam the sample is left to chance. This means that the offspring of an excellent pig will not necessarily be excellent itself. This depends upon "the other half" and on the sampling. It is all quite easy.

How then can progress be made? The important point is that we must get into the habit of thinking in terms of averages rather than individual pigs. Geneticists always talk about averages. They say—"on average, such and such will happen if we do this." What is meant is that we cannot guarantee a particular result from a particular action, but if we do it many times we can predict the average result. In terms of pigs, if you mate sow A to boar B, no one can tell you what the offspring will be like, only what you might expect it to be like. However, if you mate a lot of sows like A to a lot of boars like B, you can predict quite accurately what the average offspring will be like. So we can talk about the probable results of breeding programmes, knowing that these results will apply on average but that chance will affect the results for a particular pig.

It is obvious that pigs differ from one another in merit, however that is defined. What is not quite so obvious is that these differences are only partly due to differences between pigs in qualities they have inherited from their parents, even under ideal uniform conditions of feeding, housing and management such as those prevailing at a boar
Some of the differences are due to the environment because this can never be the same for every pig, and because such things as growth and productivity are affected by many factors outside the control of the farmer. A boar's growth today depends not only on how he is treated today, but on how he has been treated since his conception, and much can happen in this length of time. All this means that only a part of the difference between any two pigs is genetic or will show up as a difference between the offspring of the two pigs.

The fraction or proportion of an animal's superiority above the average of the herd (or inferiority below average) that it will transmit to its offspring differs with the character we are considering. As well as being economically important, the characteristics of boars that we measure in a performance testing programme must be highly or at least moderately inherited. Growth rate, food conversion efficiency and lean meat content as measured indirectly by back-fat thickness, come into this category.

In spite of what I have said to now, it is safe to say that generally the offspring of a superior pair of parents will be superior to the offspring of inferior parents. So if we breed only from superior pigs and cull the inferior pigs, we should move the average of the population along towards the desired goal. This breeding from specified individuals only is what is known as selection. It should be realised that selection is the only way that permanent genetic improvement can be made by man in a herd of animals unless known superior individuals are introduced from outside. By selection we can move the average of the herd along towards our goal, but we will always have a range of animals within the herd. We can never expect all our pigs to be as good as the best.

The next problem is to decide what is meant by superiority, best and goal. This is where performance testing comes in. At the boar performance test centre of the New Zealand Pig Producers' Council, we have defined the goal in terms of growth rate, food conversion efficiency and back-fat thickness. Boars are grown from 60 to 180 pounds liveweight on a simple ration of barley meal, maize meal and buttermilk powder, plus the necessary vitamins and minerals. The number of pounds gain per day and the food eaten per pound of gain are recorded. At 180 pounds, the depth of backfat is measured with an ultrasonic machine at three different places, one and a half inches off the midline.

To make selection easier the measurements on the boars are combined into a single measurement or index, taking into account the relative economic importance, the variability and the degree of inheritance of each character.

\[
\text{Index} = \left[4 \left(\text{growth rate, lb/day}\right) - 2 \left(\text{Efficiency, food/lb gain}\right) - \left(\text{back-fat depth, ultrasonic mean}\right) + 5\right] \times 100.
\]

This index is quite simple and easy to use, and is itself inherited to a degree, depending upon the characters included in it.

In order to compare pigs tested at different times of the year and in different years, each boar is compared with 30 of his contemporaries and given a rating depending upon the difference between his index and the average of his contemporaries. These ratings range
from -5 to +5. A boar with a +5 rating is a very good boar indeed while one with a -5 rating should be shot on sight. The largest group of boars was a rating of +1. This scheme has been in operation for less than a year now, but we have so far rated 66 boars. We have had only one +5 boar, and this should be a challenge to all breeders. Four boars have rated +4 and 11 boars +3. At the other end of the scale we have had one -4 and two -5 boars.

I suggest we now look at the figures for a few boars taken from the first group of 30 rated under this scheme.

Test Performance of Four Boars

<table>
<thead>
<tr>
<th>Daily gain</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.91</td>
<td>1.87</td>
<td>1.94</td>
<td>1.74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>2.47</th>
<th>2.64</th>
<th>2.44</th>
<th>2.70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back-fat thickness</td>
<td>4.65</td>
<td>6.95</td>
<td>6.05</td>
<td>4.68</td>
</tr>
<tr>
<td>Index</td>
<td>305</td>
<td>25</td>
<td>183</td>
<td>188</td>
</tr>
<tr>
<td>Difference from average index</td>
<td>+140</td>
<td>-140</td>
<td>+18</td>
<td>+23</td>
</tr>
<tr>
<td>Rating</td>
<td>+3</td>
<td>-3</td>
<td>+1</td>
<td>+1</td>
</tr>
</tbody>
</table>

Average Index (30 boars) = 165

Boar 1 is fast-growing, efficient and lean, a good boar. Boar 2 is slower-growing, less efficient and fat, a poor boar. It cannot be stressed enough that boar performance testing is only useful if selection takes place as well. It would be futile taking home a tested boar if he were like boar 2. On the other hand, boar 1 would be an improver in most herds. The difference between the indexes of boars 1 and 2 is 280. With several assumptions we might expect the average difference between their offspring to be about 42 index units. Put another way, boar 1’s offspring might average +1 while those of boar 2 might average -1. The offspring of boar 1 could be like boars 3 and 4 in the table which are both +1 boars. They differ in that 3 is fast-growing but fat while 4 is slow-growing but leaner.

Now, what about the performances of the offspring of such boars back on the average farm? We have good reason to believe that the offspring of a superior boar will prove superior on any farm. As an example of what might be expected we have little information from a simple comparison made at Ruakura. A fat boar and a lean boar of similar growth rate were each mated to six sows in two seasons and the progeny grown under uniform conditions. The progeny of the lean boar were leaner, meatier and slightly more efficient. The average difference in actual weight of muscle in the 133lb carcass was 7lbs.

High and Low Back-fat Boars—Performance of Progeny

<table>
<thead>
<tr>
<th>Boar</th>
<th>Fat</th>
<th>Lean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of muscle in carcass (lb)</td>
<td>54</td>
<td>61</td>
</tr>
<tr>
<td>Weight of fat in carcass (lb)</td>
<td>61</td>
<td>54</td>
</tr>
<tr>
<td>Eye muscle area (sq. cm.)</td>
<td>27.6</td>
<td>30.9</td>
</tr>
<tr>
<td>Back-fat depth (mm.)</td>
<td>29.4</td>
<td>22.6</td>
</tr>
<tr>
<td>Efficiency (FU/lb gain)</td>
<td>3.56</td>
<td>3.36</td>
</tr>
</tbody>
</table>

The difference in efficiency alone could result in differences in costs for a 100-sow herd of $800-1200 per year. In addition, it should not be very long now before the grading of commercial pigs is altered in such a way as to give adequate premiums for lean, meaty pigs.
Finally, I want to stress that the unit of improvement is not the individual pig but the herd and that although breeding for improvement is a slow business, in the long run it is slow but sure. In a recently completed experiment, American scientists selected Duroc and Yorkshire (Large White) pigs solely for decreased back-fat and obtained a response of about one m.m. decrease in back-fat for each generation of breeding. We have a long way to go in improving our pigs so it is urgent that we make a start. Performance testing can help, so breeders should take advantage of the testing facilities available. They will only do this however, if there is a consistent demand by other pig producers for breeding stock with the potential to produce fast-growing, lean progeny.