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The pastoral lease tenure for Crown land came into being on April 1, 1949, following the passing of the Land Act, 1948. The reason given by the then Minister of Lands, when introducing the Land Bill, for the establishment of a lease of this kind was "that it may be necessary for some control to be exercised over the type of land contained in the lease for soil conservation purposes to prevent erosion and regenerate some of the hill country contained in the lease".¹

As at 31 March 1978 there were 465 pastoral leases current, involving 2.8 million hectares of Crown land.²

The Land Settlement Board, established under the Land Act, 1948, and taking the place of the previous Land Boards, has issued and administered pastoral leases since 1950. Figure 1 shows the number of individual or combined leases due for renewal after 1983.

Figure 1. Renewal of pastoral leases (1983–2007)

Compiled from Lands and Survey Department records.

* Lincoln College
The Land Settlement Board has the statutory duty to 'carry out the provisions of the Act for the administration, management, development, alienation, settlement, protection and care of Crown land ...' The Board is required to have regard to any representations that may be made by the Minister in respect of exercising any powers and functions under the Act. Further, the Board is required to give effect to any decisions of the government in relation to the Board's powers as functions when conveyed to it in writing by the Minister. A purpose of the pastoral lease tenure is to give a secure form of tenure to land classified by the Land Settlement Board 'as being suitable or adaptable only for pastoral purposes'.

Pastoral leases under the Land Act, 1948, entitle lessees to the exclusive right to the pasturage over the land comprised in the leases, but give no right to the soil. They have a term of 33 years with perpetual right of renewal, but carry no right of freehold. A 'fair annual rent' is fixed by the Land Settlement Board. The Board is not required to set a rental value for the land. Reviews of rent, following renewal of lease, are currently carried out every eleven years.

Every pastoral lease may be subject to stock restrictions. Apart from conditions governing good husbandry and improvements and residence, that are common to all Crown leases, pastoral leases are subject to further conditions set by the Board governing the number of stock that might be carried, the burning of vegetation, the cultivation, cropping and grassing of land, travelling stock and the adjustment of boundaries.

The following table sets out the number and area of pastoral leases or combinations of pastoral leases in the respective provinces of the South Island:
TABLE 1
NUMBER AND AREA OF INDIVIDUAL OR COMBINED PASTORAL LEASES

<table>
<thead>
<tr>
<th>Land District</th>
<th>Number</th>
<th>Area (ha)</th>
<th>Total</th>
<th>$\bar{x}$</th>
<th>$\sigma$</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marlborough-Nelson</td>
<td>17</td>
<td>167539</td>
<td>9855</td>
<td>10390</td>
<td>417 - 28126</td>
<td></td>
</tr>
<tr>
<td>Canterbury</td>
<td>119</td>
<td>999692</td>
<td>8401</td>
<td>9848</td>
<td>230 - 76550</td>
<td></td>
</tr>
<tr>
<td>Otago</td>
<td>268</td>
<td>1326345</td>
<td>4949</td>
<td>4978</td>
<td>269 - 25453</td>
<td></td>
</tr>
<tr>
<td>Southland</td>
<td>46</td>
<td>329928</td>
<td>7172</td>
<td>10384</td>
<td>273 - 51824</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>450</td>
<td>2823504</td>
<td>6275</td>
<td>7591</td>
<td>230 - 76550</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: $\bar{x}$ = mean
$\sigma$ = standard deviation

Of the 450 pastoral leases, or combinations of pastoral leases, 247 (55 per cent) are within the high country and the balance, 203 (45 per cent) are South Island hill country properties. It was found that 341 (76 per cent) of the 450 pastoral leases, or combinations of pastoral leases, are farmed in association with other tenures or other pastoral leases, and 109 (24 per cent) are farmed without other tenures or pastoral leases.

Thirty two per cent of the leases comprise land in the 'low' rainfall zone which has less than 500mm rainfall each year and is subject to eight months of moisture deficit in a year. Some 242 (54 per cent) of the leases are considered to lie predominantly within a 'high' rainfall zone of greater than 1000mm annual rainfall and experience only short periods of moisture deficit. The balance of the runs (62, 14 per cent) are considered to lie within a 'moderate' rainfall zone with an average rainfall range of 500mm to 1000mm and normally experience six months moisture deficit in a year.

Whilst all leases are subject to some snow risk, 36 per cent are regarded
as being in a high risk zone. These runs are principally those situated in the 'gorges' and higher lands of Canterbury (16 per cent) and Otago (16 per cent). It is noteworthy that a high proportion (81 per cent) of leases are of hill topography and that few are steep (five per cent).

There has been a 61 per cent increase in overall stock limitation since 1950. Cattle have increased 414 per cent over this period and sheep 26 per cent. The compound increase in mean stock limitation (as stock units) over the period 1950-1976 is three per cent per annum.

![Figure 2. Mean stock limitation (in stock units) - Pastoral leases (1950-1976)](image)

The mean rent for 450 pastoral leases farmed either individually or in combination, is $420. The annual rent for two-thirds of all pastoral leases is within a range of $262 - $578 and the absolute range in rents per lease is $25 to $3340.

The mean annual rent of pastoral leases over the period 1950 - 1976, in relation to the unimproved value of land, is shown in Figure 3.
RENTAL POLICY

Consideration of policy for fixing a 'fair annual rent' for pastoral leases has been a matter of continuing concern to the Land Settlement Board since its establishment in 1978. The initial policy of the Board for fixing a 'fair rent' appears to have been one of aiming to 'find a basis of fixation which will promote good husbandry, the all-important factor in the national interest'. 7

A rental based on unimproved value was considered by those administering pastoral land to be 'unrealistic' as far as pastoral land was concerned. The reason for this view has not been clearly enunciated, apart from an opinion that 'the factors entering into rent fixation did not apply on pastoral land with equal force in the case of ordinary farm land which is let at a rental based on unimproved value'. 8

The method of rent fixation chosen was based on the carrying capacity of the unimproved run at the date of issue of the lease. It was to be generally assumed that the lease was in 'good heart' at the date of issue
and that 'an average carrying capacity related to net returns over a
spread of years' had been established for the lease. The possibilities of
'special factors' such as a severe infestation of rabbits were noted. It
was policy for the Chief Pastoral Lands Officer to discuss with each lessee
what his recommended rental would be and that such discussion should be
frank and include negotiation for 'regrouping' as provided for in the Land
Act 1948. If, at the date of rental fixation, the carrying capacity of the
lease was 'below par', recommendations for reduced rent for a period (as
provided for in S 57 (1) of the Land Act 1948) were to be considered as a
means of bringing the lease into 'good heart', subject to any husbandry
conditions set by the Board.

A formula was devised by the Chief Pastoral Lands Officer to assist in
assessing rentals for pastoral leases. The rate per 1000 stock units was
to be $140 for an 'average' pastoral lease. Adjustments (up or down) were
to be made at the rate of $4 per 1000 stock units for each 2½ per cent
change in lambing, 2½ per cent change in death rate and $10 per 1000 stock
units for each 0.4kg change in wool per sheep. Other factors to be con-
sidered were access, mustering conditions and distance from railhead.
Maximum rate was to be $200 per 1000 stock units and the minimum rate $100
per 1000 stock units.

At that point the methods of rent fixation for pastoral leases had con-
tained many elements of arbitration between lessee and lessor. In spite of
a recognised need to do so, no significant regrouping took place during the
negotiations.

Concern was expressed by Commissioners of Crown Lands as early as 1953
that there would be a disparity between the current market value and the
rents of pastoral leases. It was agreed at a Departmental Conference in
1957 that the Chief Pastoral Lands Officer would 're-examine his rates per
1000 and step up the rates ruling at June 1956'. Some minor adjustments
were made by the Board as a result of this re-examination. A similar review of rates was undertaken in 1965. The then Minister of Lands informed the Mackenzie Branch of Federated Farmers in June 1965 that the Land Settlement Board had not approved any change in the basis for fixing rent 'from that which was used for runs which had been renewed for some years' and would not do so without first consulting the High Country Committee of Federated Farmers.\textsuperscript{13}

It was decided by the Board in June 1966 (on receipt of recommendations for increasing the rates per 1000 s.u. for assessing rent) that it was undesirable to change the rental basis as there were but a few Pastoral Run Licences remaining to be renewed as pastoral leases.

In the early 1970s, consideration was being given to the basis of future rentals. A working party was set up by the Director-General of Lands in 1971 to 'examine alternative methods of fixing "a fair annual rent" on renewal of pastoral leases and to recommend the most suitable method'.\textsuperscript{14} The working party sought submissions from Commissioners of Crown Lands and reviewed alternative methods which were principally either (a) rent based on a rate per 1000 s.u. as 'before' or (b) rent based on the value of land exclusive of improvements. The Land Settlement Board, on receiving this report as a whole, decided in 1972 that 'the basis of rental for all pastoral properties should be the value of the land exclusive of improvements at a rental rate of three per cent.'\textsuperscript{15} In further consideration of the working party's report, the Board decided in 1973 to set out and explain all the resolutions of the Board on pastoral lands policy in a paper which would be discussed with the High Country Committee of Federated Farmers before implementation. In 1974 the Board decided as pastoral lands policy that 'the fair annual rent for a pastoral lease shall be three per cent with a rebate of 10 per cent for prompt payment, giving a net rental rate of 2.7 per cent. The rental value is to be the value of land exclusive of improvements assessed on a pastoral farming use and ignoring
any potential for tourism or other non-farming purposes, but taking into consideration the stocking limitations required to protect soil, vegetation and water values'. The Minister of Lands approved the Policy. 16

In 1975, the High Country Committee of Federated Farmers expressed concern that a three per cent rental rate on current values of land exclusive of improvements would be 'crippling'. 17 Early in 1976 the Board, in view of the concern of pastoral lessees, announced it would re-open the matter of pastoral rents for discussion with High Country Committee of Federated Farmers. The Board considered that whatever system was used, it should be:

(a) related to some provable factor;
(b) fair to lessee, lessor and renewable lease lessees;
(c) in the interests of the country itself. 18

In 1976 the Land Settlement Board resolved to set up a sub-committee consisting of Fields Director, Valuer General and two farmer Board members to consider the matter of pastoral rents and advise the Board. The sub-committee sought submissions from all lessees, interested persons and organisations on what they regarded as appropriate for rent-fixing procedures for pastoral leases.

In May 1978 the sub-committee recommended to the Board that the rent for pastoral leases should be three per cent of the value of land exclusive of improvements. It was recommended that this three per cent rental should be progressively introduced in three equal stages over 33 years, beginning with $1\frac{1}{2}$ per cent for the first eleven years, two per cent for the second eleven years and $2\frac{1}{2}$ per cent for the third eleven years. In recognition of the concession of a progressive introduction of three per cent rental it was recommended by the sub-committee that the differences between a three per cent rent and the proposed rent for each step ($1\frac{1}{2}, 1, \frac{1}{2}$ per cent LEI) should be rebated as a suspensory loan written off after eleven years - provided that this loan was expended on approved capital or maintenance works on the
farming unit. In the event of a sale of a pastoral lease to other than a direct family descendant, the sub-committee recommended the suspensory loan should be repaid to the Crown in full.

As an alternative to the three per cent rent it was recommended by the committee that lessees be offered the opportunity to prepay 90 per cent of the rent in perpetuity through purchase (on a 30 year deferred payment licence basis at 6½ per cent interest) of 90 per cent of the rental value (value of land exclusive of improvements) less the present value (at 4½ per cent) of the lessee's goodwill in the unexpired term of the lease.¹⁹

The Land Settlement Board agreed with the committee's recommendation and the Ministry of Lands approved the Board's adoption of it as policy.

An amendment to the Land Act, 1948, is proposed to allow this policy to be implemented.

**VALUATION**

According to the Land Act, 1948, "the expression 'capital value' means the sum which the land and improvements thereon might be expected to realise at the time of valuation if offered for sale, unencumbered by any mortgage or charge thereon, on such reasonable terms and conditions as a bona fide seller might be expected to require'.²⁰

This definition of capital value differs very little from that contained in the Valuation of Land Act, 1951, and has been interpreted by the Courts to mean the same.²¹

As there are comparatively few freehold properties on high country land that would normally be classified by the Land Settlement Board as 'pastoral land', the assessment of capital value of high country pastoral leases
requires a somewhat subjective exercise in adjustment of leasehold sale prices to a freehold sale basis.

The definition of the value of the improvements under the Land Act, 1948, differs from that under the Valuation of Land Act, 1951. However, in both Acts, improvements are defined as giving 'added value' to the land. The Land Valuation Court has, in the past, taken the view that, for most practical purposes, the separate definitions have the same general meaning. The value of the improvements means the "added value which at the time of valuation these improvements give to the land". As value is market value, it is clear that the value of improvements on a property are not the costs of the improvements but rather the added value given to the property as a whole by the improvements.

The Valuation of Land Act, 1951, prescribed unimproved value of land to be an estimate of the market value of the land (in its legal sense) as if no improvements had been made to the land, but it was never-the-less in the existing environment. The market value of the land must always be consistent with its best use. It has been accepted that the value of land exclusive of improvements under the Land Act, 1948, is generally the same as unimproved value under the Valuation of Land Act, 1951, when the value of improvements is the same under each Act.

In ascertaining unimproved value, improvements must be considered as being nonexistent. Unimproved value must be assessed 'on the assumption that the block of land being valued had remained in an undeveloped state, but the surrounding district was in its present state of development. The price paid by an informed purchaser of unimproved land will be largely influenced by the productivity of land in relation to its development costs and annual expenditure, together with the services available and the cost to the land. Nationwide, sales of unimproved land are very rare indeed, and sound evidence as to the original state of the land is becoming scarce.
Pastoral land, however, is comparatively less developed than other farm land and can more readily be visualised 'in its natural state' or 'undeveloped state'.

"Not earlier than two years and not later than one year before the expiry of a renewable lease" (but not a pastoral lease), the Land Settlement Board "shall cause the following values to be ascertained:

(a) The value of the improvements which are then in existence and unexhausted on the land included in the lease.
(b) The value at the commencement of the lease of all improvements included in the rental value at the commencement of the lease.
(c) The value of the land included in the lease exclusive of the improvements."  

In the event of the necessity for rental values for pastoral leases to be established, it is likely that the above procedures will be followed. It has been stated by the Land Settlement Board that any rental value of pastoral land set by the Land Settlement Board shall be the value of land exclusive of improvements excluding any potential value for non-farming purposes. How the influences of potential alternative uses on the rental value of pastoral land can be accurately assessed is a matter of conjecture, subject as it is to both the institutional restraints of the Land Act 1948 and other statutory restraints on the private use of alienated land.

The changes both in actual and real terms in mean capital value and in mean unimproved value/value of land exclusive of improvements for pastoral leases over the period 1950 - 1976 are shown in Figures 4 and 5.
Figure 4. Mean valuations of pastoral leases (1950–1976)

Compiled from Valuation Department, Lands and Survey Department and County Council records
The mean, standard deviation and range of unimproved value at five-year intervals for all pastoral leases issued is shown in Figure 6.
From a regression analysis of the 1950-1976 unimproved values it is estimated that, given a continuance of 1950-1976 trends, the mean LEI of pastoral leases will be approximately $125,000 in 1983, the year in which valuations will be made for the first leases due for renewal.

The benefits (or disadvantages) of occupying land by way of a lease accrue to the lessee subject to restrictive or beneficial conditions applying to the lease and the payment of a series of payments which are the rent for the land leased. The lessee has all the benefits of freehold subject to future rent payments and any other condition applying to the lease.

The interest of pastoral lessees in the unimproved value over the period 1950-1976 has been calculated by establishing the sum of present value of the rent gain over the remaining term of the lease and for future renewals (Figure 7).

**Figure 7.** Estimated mean lessee's interest in U V of land.

Pastoral leases (1950–1976)

- Interest 9%
- Inflation 6%
The relationship between indices of mean unimproved value of pastoral land and gross domestic product, money supply and selected liquid assets, wool prices and the value of production from sheep farms is shown in Figures 8 and 9.

Figure 8. Indices of money supply and selected liquid assets (money).

Gross Domestic Product (G.D.P.)
Wool prices (Wool)
U.V. of pastoral land (UV) 1950–76
(Base 1950 = 1000)

Compiled from Reserve Bank and Statistics Department data, Valuation Department, Lands and Survey Department and County Council records.

Figure 9. Percentage changes in money supply and selected liquid assets (money) and U.V. of pastoral lands (UVPL) (1950–1976)

Compiled from Reserve Bank and Statistics Department data, Valuation Department, Lands and Survey Department and County Council records.
The index of unimproved value of pastoral land in general follows that of the gross domestic product. The index of money supply and selected liquid assets appear less directly related. Increases in the velocity of circulation of money supply account for the widening gap between the indices of money supply and unimproved value of pastoral land.

When the percentage change in unimproved value of pastoral land is compared with that for money supply and selected liquid assets, it is apparent that after a delay of one to two years unimproved values respond to changes in money supply.

**NATURE OF RENT**

The term 'rent' is generally used to define the price paid per unit of time for the services of a durable good and, in particular, land and buildings. 'Economic rent' is a term used in economic theory to describe the surplus earned by a factor of production (e.g. land) over and above the minimum earnings necessary to keep it in employment (e.g. farmers). Apart from any land tax or rates which may apply to the land exclusive of improvements, there are no payments required to keep it in production, hence virtually all earnings that arise from the unimproved land may be classed as economic rent.

Rent accrues to land because it is essentially fixed in area and is subject to a demand for its use in production (e.g. farming). In Figure 10, D-D' represents the total demand for land and S-S' its generally fixed supply.
The intersect point E is the factor price for land and the point to which rents will tend, given a free market for land. If rents are above this point, some land owners would be unable to lease their land and would lower their rent to a point where they could arrange leases. Alternatively, if rents fell below the factor price (E), then rents would be bid up to satisfy demand. Should there be a rise or fall in the value of the product produced on the land the demand for the land will be reflected in higher or lower rents that will be paid for the land.

Land has a capacity to earn an economic rent according to its use capability. Normally, land of high fertility produces more from the same inputs than does land of low fertility and thus is capable of earning a higher economic rent. Separate areas of land of similar productive capacity with differing distances from markets, or otherwise subject to differing conditions of
use, have differing capacities to earn an economic rent. The extent of this difference reflects the economic disadvantage to which one area of land is placed in respect to another.

Land, such as that classified as pastoral land, is by its very nature incapable of earning an economic rent to the same extent as can, for example, high quality arable land. Unless the special characteristics of pastoral land can be utilized for high value production (or conservation) then the economic rent that will be earned by it will be lower than, say, arable land. 35

Figure 11 illustrates possible cost curves of a farm. The cost curves represent the average cost (AC) and the marginal cost (MC) per unit of output from the farm. The cost curves exclude payments for land (i.e. excluding rent), but include normal profits to management and to capital employed on the land. Each farm (or pastoral lease) will have unique average and marginal cost curves.

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**Figure 11. Average and marginal cost curves of a farm.**

- **Factor costs** (Including normal profits but excluding rent)
- **Economic surplus** (Economic rent)
In a situation of perfect competition (i.e. the farmer cannot influence prices), the farm will maximise profits at output $Q$ (receiving prices $OA$) where the marginal cost of production per unit of output equals the price received per unit of output (i.e. $MC = OA$). At point $Q$ the total revenue received by the farm is $OADQ$ ($Q$ units of output at price of $A$), the factor costs (including normal profits, but excluding rent) amount to $OBCQ$ and the economic surplus (or economic rent) is $BADC$.

In a situation where rent is set at less than economic rent there is the possibility of an inefficient utilisation of the land resource. This is so because the tenant is not obliged (though it is never-the-less rational to do so) to maximise production to make normal profits. Conversely, should rent be set at more than economic rent, it becomes impracticable for the farm to remain in business and still attain normal profits to capital and management.

The farm which maximises output is able to make payments for all factor costs including those for land (rent), capital and management (normal profits).

To maximise profit a landlord would aim to set rent at the true economic rent. Any farm producing less than the economic rent would have to increase output to remain in business because at any lower output it would incur a loss.\(^\text{36}\)

In setting a true economic rent the landlord is forcing efficient allocation of the land resources being leased.

If rent is set at less than economic rent it is probable that any rental advantage held by the lessee will be capitalised in the form of 'goodwill' which will effect an increase in the market value of the asset leased. Should rent be set at a level in excess of the economic rent of an enterprise then inevitably there will be a fall in the market value of the lease.
until an incoming lessee is able to earn an economic rent and acceptable returns to capital and management.

The Land Settlement Board in classifying land 'as being suitable or adaptable only for pastoral purposes' is by implication recognising the higher physical risks of asset deterioration to which such land is subject when comparing it with its farm, urban or commercial counterpart.

Part of the lessor's risk is covered by the covenants in the lease which are intended to ensure conservation of the land resource. The remaining risks are not related to the lessee's actions and do not affect the determination of rent.

The physical risk to which the lessee's improvements are subject, together with the economic risks (snowstorms, product price variations, etc.) associated with farming of pastoral land, increase the normal profits required by the lessee as a return for factor inputs. The risks incurred decrease the economic surplus of the farm and consequently decrease its rental value and thus total rent payable.

Bearing in mind that the lessor's (Crown) interest is secured against the effects of inflation, it would appear that the alternative investments having an equivalent risk to that moderate risk implicit in a pastoral lease would approximate those in the first mortgage market, adjusted for the effects of inflation, the (currently long) periods between reviews of rents, and the relative illiquidity of the Crown's investment in the land.

The average mortgage interest rates and rates of inflation over the long term (1920-1978) are shown in Figure 12.
The average 1920-1978 rates of interest on mortgages are 5.8 per cent and rates of inflation 3.8 per cent, giving a net yield of two per cent.

In periods of low inflation, first mortgage interest rates have tended to yield about three per cent in real terms. In period of high inflation it is clear that investments in mortgages are earning, in real terms, a negative yield. Without either annually adjusting the value of mortgages to real terms or regularly reviewing interest rates to ensure a positive two to three per cent real terms yield, it is unlikely that rational lenders of funds will make them available for mortgages.

Provided there are regular reviews of rental rates, lessors are normally protected against the effects of inflation. Provided also there are minimal costs of administration of leases, it could be concluded that a lease with an annual rent yielding three per cent is at least a comparable and often a
significantly better investment than first mortgage investments that are secured against the effect of inflation.

LEGAL CONSIDERATIONS

The following factors relevant to pastoral leases, have, in legal judgments, been held to govern lessor-lessee relationships:

(a) What a prudent lessee would pay for the lease having regard for all the terms and conditions of the lease and not what the prudent lessor would consider he ought to get.\(^{38}\)

(b) A ground rent secured by a power of distress is regarded as one of the highest forms of security.\(^{39}\)

(c) The terms of the lease must be considered in establishing a 'fair annual rent' as a percentage of unimproved value.\(^{40}\)

The terms and conditions of pastoral leases which appear to affect what a prudent lessee would pay for the lease are:

- the period between reviews of rent (hitherto 33 years, henceforth 11 years)'
- rights of 'pasturage' only with no rights to the 'soil'; and
- the restraints on husbandry covenanted in the lease.

Because of the effects of inflation there is a substantial advantage to the lessee of a pastoral lease in a long (11 year) period between reviews of rent. A substantial lessee's interest (in part recognised by the Crown)\(^{41}\) accrues to the lessee for the unexpired term of the lease. Depending on whether or not the rent for the lease reflects the value of the land rights leased, there may or may not be a lessee's interest in the lease at the time of renewal.

The rights to pasturage only confer no apparent rights to the pastoral
lessee to carry out any other business on the land. In performing the covenant of the lease the lessee is obliged to fulfil the duty created by it. Any business other than carrying out pastoral farming would in fact be in breach of the covenant to carry out pastoral farming only and any lessee so doing could risk action for forfeiture unless the terms and conditions of the lease were varied by the Crown.

Any right to acquire the fee simple in leasehold land is valuable, particularly when the rent for the land reflects the factor price for the unimproved land. In a situation of concessional rent the freeholding right is proportionally less valuable. The effect of the absence of a right to acquire the fee simple (or other increases in property rights) on the rents payable by a prudent pastoral lessee depends on what the costs of acquisition of fee simple are for similar land.

Prudent utilisation of 'pastoral land' for pastoral purposes dictates adherence to all of the conditions in pastoral leases relating to good husbandry. No significant long term commercial disadvantage to any lessee is normally recognised in the "good husbandry" clauses of pastoral leases.

The theoretical power of distress that the Crown has over its pastoral tenants is considerable. This power is based on requirements for the lessee to observe the conditions of the lease including residence, payment of rent and rates. In practice this power has been abated by the effect of inflation in reducing the real amount of rent payable, the possibilities of remission of rent in periods of adversity and the number of absentee lessees of pastoral land. In spite of this abatement the security held by the Crown is considerable though currently substantially less remunerative than a comparable first mortgage security on land, even though the renewal is 'indexed' against inflation.

The term 'fair annual rent', where there is a perpetual right of renewal,
has been variously defined by Statute and by the Courts to mean an equitable rent, being that which a reasonable tenant might be prepared to pay having regard to the conditions of the lease.\textsuperscript{42}

The rent payable for pastoral land as a percentage of the unimproved value of the land needs to account for the particular conditions of the lease. Clearly the principal factors to be considered are the period between reviews of rent, the absence of rights to the fee simple and ground rents paid for similar land elsewhere.

Long periods between reviews of rent are to the advantage of the lessee, who may capitalise on the 'goodwill' in the unexpired term of the lease. This is so because the lessee discounts (at his own time preference rate) the future increase in rent due at the end of the period between rent reviews. Conversely, to overcome this disadvantage, the lessor will attempt to compound in loss of rental revenues and add it on to the rental rate at the rent review time. In an inflationary period any lease which provides for rent reviews at long intervals, such as has been the case with the pastoral lease thus far, inevitably leads to the development of a disparity between rent paid for the lease and the current rental value. In the interests of lessee and lessor, regular rent reviews are necessary. Ideally, in an inflationary period such reviews should be annual. Practical consideration of administration, valuation and arbitration in setting rents for pastoral leases make five years the most appropriate minimum. The Land Act 1948 prescribes 11 year reviews of rent for pastoral leases.\textsuperscript{43}

In the over-all demand for farm land there has been, over recent years, a remarkable growth in sale prices of Crown leases and in pastoral leases in particular (Figure 4, page 12). This has occurred in spite of a prospect of substantial increases in rents. The evidence is that the present and future rents have been heavily discounted to the extent that some leases have sold at close to freehold prices. Whether the advent of eleven year
rent reviews will substantially affect sale prices of Crown leases is a matter of conjecture, but economic common sense suggests that this should have a steadying effect on future sale price increases.

Because pastoral lessees are unable to freehold their leases they may be considered to be at a disadvantage when compared with some other Crown lessees. This disadvantage principally arises from the absence of equity in the unimproved land and the resulting escalation of rent with land prices.

A Crown lessee's right to acquire a freehold tenure will generally have an extra value in addition to the present lessee's interest in the land leased. In times of rapid escalation in land values and comparatively low interest rates this right to freehold tenure is relatively high. Since 1950 when the pastoral lease tenure came into being there has been a yearly 2.6 per cent compound growth in real rental values. Because rents for pastoral leases have hitherto been set without regard to changes in rental value and with long periods between reviews of rent, there has been a growth in lessees' interest in the land. Because of this 'indexing' of the lessees' interest to real growth in rental value the value to pastoral lessees of a right to freehold has been comparatively low when compared with lessees of 'farm land'.

With the prospect of a valuation based rental system with shorter periods between reviews of rent and continued escalation in land prices, the value of any right to freehold is markedly increased.

ECONOMICS

Contrary to the national average for sheep and beef farms, both groups of farms have increased stock units substantially (hill + 104 per cent, high + 56 per cent) and have maintained stock performance.

The mean gross income and expenditure per stock unit in real terms of
South Island hill and high country farms over the period 1959 - 1977 is shown in Figures 13 and 14.

Figure 13. Mean gross income and expenditure per stock unit on South Island hill country (real terms) (1959–1977)

Figure 14. Gross farm income and expenditure per stock unit on South Island high country (real terms) (1959–1977)

Compiled from N.Z. Meat and Wool Boards' Economic Service data
The narrowing of margins per stock unit for hill country farmers, as the real terms return per stock unit has declined with increasingly less favourable terms of trade, is clearly demonstrated.

Following the Korean war boom of 1950, real gross incomes per stock unit remained relatively constant until 1972, the start of the unsettled financial conditions which have prevailed since.

Since 1959, gross farm income per stock unit of hill country properties has consistently exceeded that of high country properties (Figure 15.). The overall differences in returns to livestock clearly reflect the more benign conditions for livestock production in hill country farming. There is an apparent trend towards parity of gross income per stock unit for both groups of farms.
 Principally because hill and high country farmers have increased stocking by approximately 104 percent and 56 per cent respectively, and high country farmers have increased margins per stock unit, mean net farm incomes in real terms of both groups of farmers have doubled since 1959. The large differences in natural and developed resources of, and management skills applied to pastoral farms generally are reflected in the wide distribution in gross farm income per stock unit on hill and high country farms (Fig. 16). The 26 per cent advantage held by hill country farms over their high country counterpart is further emphasised by the threefold advantage of the highest revenue producer over the lowest. Such wide variation indicates major

Figure 16. Estimated percentage distribution of gross farm income per stock unit from 1200 hill and high country farms (1975–1976)

<table>
<thead>
<tr>
<th></th>
<th>High Country</th>
<th>Hill Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest</td>
<td>$4.56</td>
<td>$6.30</td>
</tr>
<tr>
<td>Median</td>
<td>$8.68</td>
<td>$11.38</td>
</tr>
<tr>
<td>Highest</td>
<td>$14.11</td>
<td>$15.96</td>
</tr>
</tbody>
</table>

Compiled from N.Z. Meat and Wool Boards' Economic Service data
differences in livestock performance between farms within the region. This observation is confirmed by analysis of a series of high country production surveys by Tussock Grasslands and Mountain Lands Institute.\textsuperscript{45} The effect of this variation in stock performance on gross and 1975/76 net farm income is further illustrated by a comparison of two performance groups ('high' and 'low'), each within separate samples of hill and high country farms. This comparison shows, approximately, a forty per cent advantage in net farm income per stock unit for the 'high' performance group of each sample of farms.\textsuperscript{46} The changes in percentage return on total farm capital for both hill and high country farms since 1959 is shown in Figure 17.

\textbf{Figure 17.} Mean percentage return on capital—South Island hill and high country (1959–1977)

\begin{center}
\begin{tikzpicture}
\begin{axis}[
    width=\textwidth,
    height=0.5\textwidth,
    ymajorgrids=false,
    xmajorgrids=false,
    xmin=1959, xmax=1977,
    ymin=0, ymax=7,
    xlabel=Year,
    ylabel=Percentage return on capital,
    legend pos=north west
]
\addplot[red,dashed,mark=none] table [x=Year, y=High country, col sep=comma] {data.csv};
\addplot[black,mark=none] table [x=Year, y=Hill country, col sep=comma] {data.csv};
\legend{High country, Hill country}
\end{axis}
\end{tikzpicture}
\end{center}

Compiled from N.Z. Meat and Wool Boards' Economic Service data

The mean return on capital from 1959–1977 for hill country farms is five per cent and for high country farms 4.6 per cent.

Because farm expenditure data invariably includes inextricable items of new investment, the calculated returns appear likely to underestimate returns of 'status quo' situation.
As a reflection of the overall return on investment, a cash equivalent return from hill and high country farming has been calculated by adding the inflation in land values (tax free) to economic farm surplus net of income paid.

Three year moving average changes in cash equivalent return, 1959-1977, for both hill and high country farming, is represented by Figure 18.

Figure 18.  Cash equivalent return on South Island hill and high country farms
(1959-1977)

Three year moving average

Compiled from N.Z. Meat and Wool Boards' Economic Service data

The 1959-1977 average tax paid cash equivalent return for hill and high country farms is 5.2 per cent and five per cent respectively.

Whilst there is a comparatively low rate of return on the total farm capital employed, there is, however, a significant tax paid cash equivalent
return from hill and high country farming. The cash equivalent returns are largely indexed against inflation and compare favourably with yields from most low - moderate risk investments available in New Zealand.

As illustrated in Figure 19, the real terms total liabilities per stock unit over the period 1959-1977 has remained fairly constant for hill country farms, but has almost doubled on high country properties in spite of lower margins per stock unit. Total liabilities per stock unit of hill country properties remains, never-the-less, significantly higher than high country properties.

**Figure 19.** Total liabilities per stock unit on South Island hill and high country farms (real terms) (1959–1977)

Compiled from N.Z. Meat and Wool Boards' Economic Service data
Increased borrowing by hill and high country farmers (Figure 19 above) against an increasing asset (land, stock and plant) has been carried out with comparatively little change in percentage farmer equity in total farm capital (Figure 20 below).

Figure 20. Equity as percentage of total assets on South Island hill and high country farms (1959–1977)

Compiled from N.Z. Meat and Wool Boards' Economic Service data

While maintaining equity in their enterprises at about 80 per cent, hill and high country farmers have earned an approximate real terms growth in equity (net worth per farm) of 41 per cent and 70 per cent respectively over the period 1959-1977.

The effect of narrowing margins per stock unit on liquidity (cash in bank plus other liquid assets, less current account balances) per stock unit, is illustrated in Figure 21. Reducing margins per stock unit without compensating increases in total production has caused a steady trend towards a loss
in liquidity for high country properties. Conversely, hill country properties have maintained liquidity largely by substantial increases in production.

Figure 21. Liquidity per stock unit on South Island hill and high country farms (real terms) (1959–1977)

Compiled from N.Z. Meat and Wool Boards' Economic Service data

'Economic rent' of land is the surplus earned by the land after all the factors of production have been paid for. The economic farm surplus of a property can be regarded as the economic rent of the unimproved land, plus costs of the capital employed in farming the land. It is implied that the true economic rent is earned by the land at a point of maximum profitability (i.e. maximum economic efficiency).

The trends in approximate economic rent (as estimated) earned by unimproved land of both hill and high country farmers over the period 1959-1977 are shown in Figure 22.
Figure 22. Approximate economic rent on South Island hill and high country farms (1959–1977)

Three year moving average

Compiled from N.Z. Meat and Wool Boards' Economic Service data

The average estimated economic rent earned by unimproved land of hill and high country farms for the period 1959–1977 is 5.8 per cent and 6.9 per cent respectively.
METHODS OF SETTING RENT

The Value of Land
In the New Zealand real estate market the generally accepted form of ground rent is a percentage of unimproved value of land or the value of land exclusive of improvements. As a pastoral lease is essentially the lease of land for a specific purpose (pastoral farming) under particular conditions (covenants) it is appropriate to consider a rent for pastoral leases as a percentage of the value of land exclusive of improvements as a practicable means of establishing a 'fair annual rent'.

The valuation of land exclusive of improvements under the Land Act, 1948, in the case of most pastoral leases, will generally reflect the unimproved value of the land.

Relative to Crown renewable lease farms on high quality land, both lessee and lessor of pastoral leases are subject to a relatively higher risk. These risks should either directly or indirectly (through rebates) be reflected in the total rent payable for such properties.

In a valuation-based rental system the lessor’s interest in the lease (the LEI) is protected against inflation as it moves according to the price of land. With strong, albeit seldom used, powers of distress held by the Crown over pastoral leases, there is no doubt that the Crown is in a 'secure' position as landlord. It is generally considered that the rental rate should reflect this security.

The rental rate required to give equity to both lessee and lessor at three rates of interest and inflation and rental review periods of 1, 5, 11 and 33 years is shown below.
TABLE 2
RENTAL RATE REQUIRED
LEVELS OF INTEREST AND INFLATION

<table>
<thead>
<tr>
<th>Interest</th>
<th>Inflation</th>
<th>Years Between Reviews of Rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>3.0</td>
</tr>
<tr>
<td>12</td>
<td>8</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Because both benefits and disadvantages of pastoral leases to both lessee and lessor seem equally balanced, there does not appear to be any special case for adjustment of rental rate, either up or down, from that dictated by consideration of interest rates and inflation rates (which reflect the relative liquidity and risk of each party's investment).

In the case of a pastoral lease, a rent based on the value of output from the farm has the apparent advantage of sharing the risks encountered in pastoral leases between lessee and lessor. In a pastoral lease with mixed wool, sheep and cattle economy, such a share rent would normally be a proportion of the annual total turnover of the farm adjusted for revenue arising from lessee's improvements (which belong to the lessor).

The situation is further complicated by the usual existence of other land tenures (both secure and insecure) having a collective output which are farmed in conjunction with the pastoral lease.

Provided the original stock limitation in the lease truly reflects the carrying capacity of the unimproved land/land exclusive of improvements and provided the output from the non-pastoral lease section of the farm can be ascertained, it is probably equitable to determine the output of
the lease as a proportion of the original to the current stock limitation.

Because of the administrative difficulties in detailing the provable factors (function, output, prices) in an equitable share rent system, it is unlikely that such a system could be implemented in spite of its advantages.

Pastoral leases issued in terms of the Land Act, 1948, attracted a rent based on the carrying capacity of the unimproved run at the date of issue. Adjustments were made in some cases to determine an 'original' carrying capacity, thus taking account of the amount by which lessees' improvements increased carrying capacity. In most cases the stock limitation for the lease was a confirmation of the stock actually grazed on the run at the date of issue of the pastoral lease. A formula for setting the rental rate per 1000 stock units was devised by the Chief Pastoral Lands Officer of the Department of Lands and Survey. This rate ($140 per 1000 stock units with adjustments for stock performance) was initially within the range 3.2 per cent to 4.3 per cent of the value of land exclusive of improvements, or 11c to 17c per stock unit.

To maintain equity between lessee and lessor a rent based on an original carrying capacity of a run must necessarily reflect:

- changes in current market rate per stock unit for pastoral leases;
- (b) the value of any improvements added by the lessee either directly or indirectly;
- (c) technological or extrinsic improvements leading to real increases in carrying capacity.50

To establish a fair annual rent based on carrying capacity of a run, an analysis of all sales from recent years and on a continuing basis will be necessary so that the rates per stock unit can be accurately determined. It is, however, relevant to note that this rate will normally be reflected in the value of the land exclusive of improvements.
It is concluded that because the land exclusive of improvements is the origin of the rate per stock unit, then the latter is an inappropriate basis for rents of pastoral leases.

There is a close relationship between the Valuation Department's Farm Land Prices Index, and the value of land exclusive of improvements of pastoral leases.

If all pastoral leases had been issued on the same terms, then upgrading the present rent according to changes in Farm Land Prices would appear to be equitable. However, rentals of leases issued after 1955 were set at a decreasing percentage of the land to be leased. Thus, any upgrading of present rentals for existing leases by adjustment according to Farm Land Price Index would perpetuate this inequity.

The land use capability classification of land as used in soil conversation in New Zealand is 'a systematic arrangement of different kinds of land according to those properties that determine its capacity for permanent sustained production'. In this sense, 'capacity' is used to define 'suitability for productive use' after taking into account the physical limitations the land may have. For land suited only to pastoral use, a land use capability classification may have application in assessing the maximum carrying capacity of a unit of land and collectively of the run as a whole.

Other elements than land use capability make up the value of land for pastoral purposes. These may include location, snow risk, 'balance' of run, and community services available. There are currently differences (albeit relatively minor) in land use capability standards between districts.

Whilst land use capability classification may provide a basis for separating land into units for valuation purposes, it does not appear to be useful for setting rents for pastoral leases save where such a rent is based on a stock
limitation is not favoured.

Other possible methods for fixing a 'fair annual rent' that could be considered are:

(a) Stock net output as an index to rent payable.
(b) Productive valuation.
(c) Percentage value of stock carried.
(d) Arbitration.

An index of production based on a net stock output (including wool production) would be a valuable measure of a run's production capability and in turn rental value. The administration problems inherent in making adjustments to calculate net stock output because of the location, and original stock limitation of the lease, act against the ready adoption of such a system.

Because a productive valuation of land is not necessarily a reflection of all the market forces at work, there has been little use made of such a system in recent years.

A rent based on a percentage of the capital value of the livestock carried is a step away from a rent based on the gross revenue of the livestock and as such is a share rent with the many administration problems applying to pastoral leases as previously described.

There is a large measure of fairness in the system of rent fixing that relies on arbitration to resolve differences. Arbitration may not achieve an 'optimal' solution to rent fixing, but may nevertheless be a good 'second best' solution. A fair system of arbitration requires the services of an arbitrator to judge the merits of each case for both lessee and lessor. To ensure fairness to all it appears essential that such an arbitration be a formal proceeding and the results reported in the law
journals and be subject to a higher court. Hitherto rents for pastoral land have, to a large degree, been an arbitration between the lessee and the lessor's agent. While noticeable disparities occurred through this arrangement, it did allow for development of a 'special' lessee-lessee relationship which, if well administered, would have achieved the principal purpose for which the pastoral lease was established - namely '... some control to be exercised over this type of land ...', Through subdelegation, or failure to enforce authority by the Land Settlement Board, and the advent of de facto administration of Crown land by other agencies, much of this special relationship has been lost or foregone. Given the judicial review and appeal procedures open to lessees there is no doubt that finally many, if not all, pastoral rents will be settled by a form of arbitration.

Allowing rebates of rents for improvement to the value of the land leased (e.g. weed control) may be attractive to the lessor as there is an assurance of improved husbandry of the land leased by those seeking a rebate. The basis of the unrebated rent has, however, to be set before rebates could be considered, so that an equitable assessment of the improvements made could be determined.

Being without a right to acquire the fee simple estate in the land leased, the pastoral lessee is inevitably subject to regular reviews of rentals at amounts related to the value of land exclusive of improvements. Along with other farm land values the rental values of pastoral leases are likely to continue to increase in real terms unless either the terms of trade or conditions of tenure move markedly against pastoral leases. Any right for pastoral lessees to prepay rent in perpetuity as a means of insulation against the increases in rental value is clearly a valuable right, conferring a higher estate in the land than was held previously.

The annual costs of the two options within the pastoral lease rental proposals of the Land Settlement Board have been calculated for the average pastoral
lessee with a prospect of experiencing a continuing trend in real terms value of land exclusive of improvements (Figure 23).

Lessees opting for the proposed rental option will be required to expend the amount of the proposed suspended rent rebate on capital and maintenance expenditure on the farm. For the purpose of the above example it is assumed that most lessees will be able to meet the prescribed conditions within their normal farm expenditure.
Lessees with available funds and without a more valuable alternative investment opportunity may wish to proceed with the prepayment option either before expiry of their present lease or early thereafter. However, those lessees who will have no difficulty in including the amount of the suspended rent as normal capital or maintenance expenditure are likely to be, initially at least, in a better financial position than if a prepayment option had been taken up at an early stage.

Eventually those lessees who are able to take up prepayment options to advantage will be substantially insulated against the effects of inflation of rental values. Such lessees will, in spite of other conditions of pastoral leases being retained, advance their estate in the land to a level enjoyed by few other Crown lessees.
REFERENCES


35. Ibid Chap. 6.


39a. Ibid
39b. Ibid


44. Taylor, N.W., pers. comm.


46. Taylor, N.W., pers. comm.


49. Drapery and General Importing Co. of New Zealand v Mayor, etc. of Wellington, 1912: New Zealand Law Reports. Court of Appeal per Stout, C.J. Vol 31, p 598. Butterworths, Wellington.


Pastoral Lease Rentals:

SOME PROBLEMS

R. FRIZZELL *

Introduction

At the risk of over simplifying what is a very complex issue I would suggest that the major 'problem' associated with rental fixation of Pastoral Leases is a fact which many of us will not admit to, and that is, "more money is made by owning land than is made by farming it". This phenomenon is encouraged by the taxation laws of the country, regarding capital gain which in an inflationary economy discourages investment for cash returns and encourages investment in shares and land. An additional encouragement to invest in land is the allowance of interest payments as a production expenditure for income taxation purposes.

Capital Investment Criteria

In an economy suffering from the prospect of continual double digit inflation, the wealth storage characteristics of land are having a relatively greater influence on the price paid for land, and the productive characteristics are having a relatively smaller influence.

The mind boggles at the though that land may well (if no institutional changes occur, and inflation continues at its present rate) assume wealth storage characteristics akin to gold. This could mean that at its market price land might be unable to sustain a significant rent at all and its value would be based on the markets confidence of it being forever in increasing demand as a medium storage

* Lincoln College.
at ever increasing monetary prices.

The following table shows the estimated tax-paid yields from four different areas of investment for the two periods 1960/70 and 1970/77. It illustrates the increasing real return on land investments, the reducing real return on cash and share investment and the changes in the ratio between tax paid income and reversionary yield at an investment time horizon.
$1000 CAPITAL INVESTMENT IN REAL TERMS

(Tax Paid)

Marginal Tax rate at 50c in $1

<table>
<thead>
<tr>
<th></th>
<th>1960-70 (10 years)</th>
<th></th>
<th>1970-77 (7 yrs)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Mortgage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) 6% Interest</td>
<td>= +3.0%</td>
<td></td>
<td>(a) 9% Interest</td>
<td>= +4.5%</td>
</tr>
<tr>
<td>(b) Reversion ($1000 Cash)</td>
<td>= $690 = -3.1%</td>
<td></td>
<td>(b) Reversion ($1000 Cash)</td>
<td>= $459 = -7.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET</td>
<td>= -0.1%</td>
<td></td>
<td>NET</td>
<td>= -3.2%</td>
</tr>
<tr>
<td><strong>Company Shares</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) 5% Dividend</td>
<td>= +2.5%</td>
<td></td>
<td>(a) 8% Dividend</td>
<td>= +4.0%</td>
</tr>
<tr>
<td>(b) Reversion ($1576 Cash)</td>
<td>= $1086 = +0.85%</td>
<td></td>
<td>(b) Reversion ($832 Cash)</td>
<td>= $382 = -8.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET</td>
<td>= +3.35%</td>
<td></td>
<td>NET</td>
<td>= -4.8%</td>
</tr>
<tr>
<td><strong>Residential Property</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) 4.5% Net Rent</td>
<td>= +2.25%</td>
<td></td>
<td>(a) 4.0% Rent</td>
<td>= +2.0%</td>
</tr>
<tr>
<td>(b) Reversion ($1453 Cash)</td>
<td>= $1002 = -</td>
<td></td>
<td>(b) Reversion ($2637 Cash)</td>
<td>= $1211 = +3.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET</td>
<td>= +2.25%</td>
<td></td>
<td>NET</td>
<td>= +5.0%</td>
</tr>
<tr>
<td><strong>Rural Property</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) 5.5% Net Rent</td>
<td>= +2.75%</td>
<td></td>
<td>(a) 4.5% Net Rent</td>
<td>= +2.25%</td>
</tr>
<tr>
<td>(b) Reversion ($1715 Cash)</td>
<td>= $1183 = +1.85%</td>
<td></td>
<td>(b) Reversion ($2887 Cash)</td>
<td>= $1326 = +4.65%</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>NET</td>
<td>= +4.60%</td>
<td></td>
<td>NET</td>
<td>= +6.90%</td>
</tr>
</tbody>
</table>
ref: (1) CPI, Index Ordinary Share Index, Mortgage Interest Rates - Dept of Stats.

(2) Residential and Farm Land Price Index - Valuation Dept.

(3) Company Dividends and Property Rentals - Author's estimate.

The table shows that in the 1960-70 period of relatively low inflation the rural property cash tax-paid rent represented 60 per cent of the total tax paid return on original capital. The relative amount of cash tax-paid rent for the 1970-1977 period of higher inflation represented 33 per cent of the total tax paid income on original capital.

Lessor/lessee relationships

The owner of a farming business will expect to obtain an appropriate return on all the assets employed in his business including the land. The return may be received in cash or in a mix of cash and capital gain each year. The total return from whatever source will reflect the opportunity cost of the owner's capital relative to the investment risk which is accepted for the particular investment.

If the Crown entered into a true partnership without a lessee's right of renewal it could be expected to receive a return which would include its share of entrepreneurial return on the undeveloped land and the benefit of the wealth storage proportion of the value at the annual reversion of the land excluding improvements.

The Crown, however, has not entered into a true partnership but within the lease reserves to itself a first charge on "rent" and by fixing the annual return moves the entrepreneurial risk directly to the lessee. The Crown can therefore not expect to receive in rent the full economic rental from the land excluding improvements, but only the rental of an almost riskless investment. The entrepreneurial rent return becomes "lessees
goodwill" in the lease.

The granting of a lease with a perpetual right of renewal transfers the value of the land which is attributable to its pure non-income producing wealth storage characteristics to the lessee and this portion of the fee simple market value becomes "lessees goodwill" also.

In an inflationary situation the lessee is likely to find his "goodwill" increasing in monetary terms but is likely to find it increasingly more difficult to service a rental based on a fixed percentage of market value.

The following table illustrates the change which has occurred in the lessee's ability to pay rent over recent years.

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>-</th>
<th>Year 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Value of Land</td>
<td>$1000</td>
<td>-</td>
<td>$4951</td>
</tr>
<tr>
<td>Rental Return (est)</td>
<td>$ 70</td>
<td>-</td>
<td>$ 173</td>
</tr>
<tr>
<td>Lessees Share of Rent (40%) (est)</td>
<td>$ 28</td>
<td>-</td>
<td>$ 69</td>
</tr>
<tr>
<td>Lessors Share of Rent (60%) (est)</td>
<td>$ 42</td>
<td>-</td>
<td>$104</td>
</tr>
<tr>
<td>Fair Rent (est)</td>
<td>= 4.2%</td>
<td>-</td>
<td>= 2.1%</td>
</tr>
</tbody>
</table>

It is apparent that if the rental rate of 4.2% is appropriate in year 1 the same rate of return on the year 17 would require a rental of $208 or $35 more than the property can produce.

Criteria of fair rent

The fixation of periodic ground rentals for perpetually renewable leases is most uncommon in the private sector and is confined largely to the public
or quasi-public lessors.

The leasing statutes with the exception of the Public Body Leases Act 1969 have fixed rental procedures but the present Pastoral Leasing rent fixation law appears to me to be almost identical with the above Act.

For this reason it seems appropriate to examine case law (in particular DIC v WCC NZLR 31-598, WCC v National Bank NZLR 1970-660) arising from this Act and the Court's interpretation of what a "fair rent" is, where there is no fixed rent - fixing formula. We should be fully aware that the leasing conditions of a pastoral lease are sufficiently onerous in terms of land use that the usage could not be compared with fee simple land. The market value of pastoral leasing rights cannot be fairly compared with the value of land sold as fee simple freehold tenure.

The Courts have determined that a fair term rent should be fixed on the basis -

(1) of what a prudent lessee would pay for the term and under the terms and conditions of the lease.

(2) would consider only matters which affect the mind and ultimately the judgement of the prudent lessee in making an offer.

(3) the contention that a lessor should make some sacrifice because it enjoys an appreciation of value of the land is irrelevant in view of the fact that what has to be ascertained is what a prudent lessee would pay.

(4) the lessee in considering the payment of too high renewal rent, having determined the return to the lessor by accretion in value, would be still more unlikely to pay it.

Within the above context and in a non-inflationary situation the prudent lessee would be prepared to pay the lessor a rental based on his (the lessees)
evaluation of a "safe" rate of interest return to the lessor plus whatever risk allowance on the land is not directly attributable to lessee usage (in other words he would apply his marginal investment criteria to the lessors interest).

**Fair rent in inflationary periods**

The affect of inflation (both real and pure) make rentals which absorb an appropriate amount of the cash return to land in the first year, innappropriately low in later years.

In my opinion the prudent lessee (rather than not renew his lease) would be prepared to pay a rent in the early years of his lease above what would be considered "fair" on an annual basis in anticipation of paying rents in the later years of his lease below that which would be considered "fair" on an annual basis. He would be prepared to pay a rent which over the total term of the lease was "fair".

He would be prepared to pay a higher initial rental the longer the period between rental reviews (based on his estimate of future inflation rates) reducing to no premium on an annual lease. Therefore, if a prudent lessee considered an appropriate rental to pay on an annual basis was three per cent and estimated future inflation at five per cent, he would be prepared to offer one rent of eight per cent annually. Intermediate renewal terms from one year to an infinite term would fall into the three per cent to eight per cent range.

**Conclusion**

I forsee problems of administration in Pastoral Leasing in the following areas:
(a) The establishment of rental value

The absence of sales comparable freehold land makes it impossible to establish L.E.I. (Land exclusive of improvements) as currently defined in the definitions contained in the Land Act: It seems to me that three new definitions should be enacted i.e. Pastoral Capital Value, Pastoral Land Excluding Improvement Value, Pastoral Improvements Value. Definitions would be similar to the present definition but with the addition of, "but subject to the restrictions to the fee simple estate incorporated in the Pastoral Lease".

(b) The establishment of rental rates

I consider there would be less lessor/lessee conflict (as occurred between the Crown and Renewable Lessees in the late 1960's) if rental fixation rates were not fixed by legislation but by Order-in-Council in a more understanding manner. This would entail a continuing audit of the current cash returns obtainable from land and the equitable sharing of this, bearing in mind the future inflationary prospects in the community. Terms shorter than 11 years might be an appropriate means of lessening conflict because of the closer relationship between a fair rent and the immediate income resources of the lessees.

(c) Rental pre-payment

The pre-payment of rent will remove most of the financial conflict existing between the Crown and lessees at rental reviews but will of course, without goodwill on both sides, present some problems in the enforcement of lease covenants on land use when rent becomes an inconsequential amount of the total farm costs.

(d) Progressive rental rate

The deferrment of portion of the total proposed legislative rental rate on a suspensory basis subject to development expenditure criteria would appear to assist in the further development of the land - it might also
increase the living standards of the lessees. It may also create an area of conflict in that it will not benefit the "good" lessee who has developed his land well in the past.

(e) The conflict in use

The future may well introduce conflicts between pastoral and other land use for which the use of the Public Works Act as now administered may not be an appropriate vehicle for achieving change.
Mr I.G.C. Kerr, Lincoln College
Mr R. Frizzell, Lincoln College.
Mr H.F. McDonald, Valuation Department, Wellington.
Mr J.M. Kelland, farmer, Omarama.

Mr Frizzell raised the mind-boggling thought that land may assume wealth storage characteristics akin to gold, if no institutional changes occur and inflation continues at the present rate. What kind of institutional changes could occur that would prevent this happening?

Mr Frizzell:

The question requires one simple answer, in that the introduction of a Capital Gains Tax would in fact remove a lot of the demand for land as a wealth storage, but it would not remove it entirely. In other words, we have this desire to invest our wealth, in a non-eroding sense, and if it is not in land it would be in something else.

Given that there were differences in Mr Kerr’s figures between hill and high country profitability, how can it be argued that lower country freehold can be used as a basis for judging high country leasehold values? Will the basis for establishing the proportion of goodwill of leasehold property be valid in inflationary times, or at any time?

Mr Frizzell:

It is part of the skill of the valuer to compare near-like with...
near-like. We cannot base our rentals on leasehold sales and call it, in effect, fee simple. It is only the good will of the rights contained in the pastoral lease which are being transferred. And the pastoral lease rights are quite different to the rights of the use of fee simple land and they are quite different from the rights of use in renewable leases. That is the reason I am not very happy with the definition of "capital value" and "land exclusive", which is currently contained in the Act and presumably will continue to be used for fixing rent for pastoral leases.

Mr McDonald:

I think you have to analyse sales to see what the purchasers and the vendors are dealing with and I think it is fairly well established that the sales of some run properties have been selling at what is generally accepted as freehold values. After discussing with the purchasers we find they generally expect to have paid a freehold price or close to it. Now I know that technically that is not correct and Mr Frizzell is quite correct in saying that they are paying lessees interest in the property, but for want of something better I fail to agree with him that he should disregard the sale as being an unreliable basis.

Mr Kelland:

All the discussion up until now has been on the way LEI is established, but as a runholder and farmer I am concerned with the rate the Land Settlement Board has come up with for new rents. Certainly Mr Kerr and Mr Frizzell have both shown us that runholders are not able to sustain an increase in rent now as net incomes have increased very little. We are expected to pay out an additional rent about nine times higher than it was twenty years ago and that is at present values. We have still got another thirteen years to go. I cannot see how farmers can be expected to pay this rent. As far as the rent option goes, I would like to see a smaller proportion of that paid out as straight rent and a higher proportion put
back into the land because by doing that, both the country and the run-
holder benefits. If it is put back into the land then the farmer benefits 
in his gross income and it filters right back into the community and every-
one is better off.

Mr Kerr:

The value of land reflects the community's demand for land. The 
community is now more affluent than in 1950 and there is more purchasing 
power for land and more opportunities. Those people who hold land now have 
got more competition to retain it. Therefore the price they pay to hold it, 
necessarily, it seems, has to be higher.

At the commencement of these leases, a rental on a per hectare basis 
was something under ten cents and the interest paid at that time was, I 
think, under twenty cents. Now the interest paid per hectare is approach-
ing seventy cents. Now is it fair to the landlord, lessor, that his rent 
should be rightfully kept at eight or nine cents while other people's returns 
rise three or four times that because of the increased price in land?

Mr Frizzell:

I would be inclined to agree that the Land Settlement Board has a duty 
to see there is a fair return to the New Zealand taxpayer for the asset that 
they are controlling and, as such, I accept this general line of comment.

It has been pointed out by Mr Kelland that the new proposed figure 
is going to be very difficult to face in the light of present returns. I 
think Mr Frizzell said that with inflation it will become increasingly 
difficult to service rent where it is based on land value and this is the 
point that worries us as lessees. It is not only that we are going up a
big step now that cannot be serviced on present productivity figures, but that from then on land values are going to put us in an impossible position with inflation.

Mr Frizzell:

In my paper, I suggested rates should not be fixed by statute but should be fixed by Order in Council so that, in fact, the rental rate to be charged, if the present trend continues, can be downgraded if necessary in a much less flamboyant manner than requiring legislative amendment to do so.

Do property improvements increase the value of LEI?

Mr McDonald:

I assure you that there are no improvements valued in the LEI so any improvements carried out will not be reflected in the LEI. However, the potential for development is reflected in LEI.

Mr Frizzell:

I would entirely agree with this; we have two means by which LEI increases. One is in terms of pure inflation, wealth storage, loss of purchasing power, that is one reason for LEI increase. Another reason is the technological advances and the productive use of land where the return is greater than the cost. If we look at the situation that Mr Kerr showed you in terms of costs and returns, the difference between the two is economic rent and economic rent becomes part of LEI, after the allowance for a rent return on the developed land and improvements.
Mr Kelland's comments are typical of many of the high country farmers. The interesting factor about the 'phase in' portion of the rent over 30 years in the minds of many of the Land Settlement Board members was that farmers could cope with it initially and economically. Then, as their eleven year period passed, they would move into a higher rate of rental that would allow them, and those people who purchased runs during that period, to become more conscious of the problems of servicing the increased rental. This would ensure that leaseholders of runs would become more oriented towards their capacity to earn as farming units. Runholders and people who purchase pastoral leases must become more conscious of the rental factors. I would be interested to hear what Mr Frizzell has to say in this area, as I am quite sure that up to now, runholders have not given this as much consideration as they perhaps should have done.

Mr Frizzell:
I would agree with you entirely and I think the Land Settlement Board made a wise decision in endeavouring to introduce the increase steps from time to time rather than in one swoop. As I said earlier, it does not penalise in the medium term the goodwill of the established lessee. It certainly serves notice on the existing lessees and incoming purchasers of what the future holds.

Mr Kerr:
I am of the opinion that it is not only the rental rate that is important but also both the value of the asset leased and the interval between reviews of rent. Generally the asset leased should earn the lessor about three per cent every year. The value of the land asset leased (LEI) should reflect the best use to which the land may be put under the conditions of the lease. Without the relatively long periods between reviews of rent, Crown leases would not always be good real estate.
Some pastoral lessees are discounting fairly heavily the relatively benign conditions that will prevail until their leases are renewed and that is a rational thing to do. That is the way the administration works at the moment so it is not unwise for somebody to capitalise on that. They just have to be careful and judge it correctly.

Comment
Mr T.D. MacKenzie, Lands and Survey Department.

A renewable lessee has, since 1948, had the opportunity to freehold on very favourable terms at any point in time and particularly since the Amendment to the Land Act in 1970 when lessee's goodwill was recognised. Now those people, (and many of them were advised by their consultants and their accountants, knowing the rent was so cheap, to let it run) are now caught. People have purchased within a year of renewal, knowing what the new rental would be, and still paid well above what the Valuation Department has very recently advised as the rent renewal rate. We see things quite differently to the pastoral lessee who is hooked to a lease which he cannot freehold. He has to face a change in the basis of rental and therefore is entitled, we believe, to the types of concessions that have now been recommended by the Board and are in the Amendment to the Act currently before the House. So we do not see any similarity.

Mr Kelland:

This business of the rent still comes back to the question of whether the runholder can afford the cash he has to pay out. At the moment, provided he can match it he need only pay one and a half per cent of the LEI. I think probably the majority of farmers can match one and a half per cent with capital and maintenance expenditure on the place, but there are others, at the moment I can think of one or two in our area that cannot spend anything on capital improvements. The other thing is that after 33 years
you pay three per cent of your LEI. In some cases by the time the 33 years is up presumably they will increase at the rate that they have done. If, in real terms, farmers net income is about the same, or up very little, how can he sustain the three per cent increase on the LEI at that time, which would probably be after the year 2000?

Mr Frizzell:

I think it is unproductive trying to pursue the thought of what is likely to be the situation in 33 years' time. For this reason I think we have to agree with the general concept that the Crown has a gilt-edged investment in the land which should be held in trust for the community, but bearing in mind that they should receive a real return, equating a riskless investment. I think probably the problem could be overcome if the terms between renewals was short, but that does not seem to receive much support from the high country farmers.

From all this discussion it would appear to me that the way the runholder is going to get more money in his pocket, is that relatively, for the value of that land must go down and this seems to be the crux of the matter.

Mr Kerr:

That would surely happen - it must happen if the rent is set at an economic rent level. It is really a political matter how much the Crown is prepared or not prepared to allow lessees to have an interest in the goodwill of the land. In real terms, in time, the rental value of pastoral leases must fall.

Mr McDonald:

Technically that is possible, but in practise I think we should see it stabilising rather than reducing.
OPPORTUNITIES FOR COMMERCIAL RECREATION

G.A. JOLL *

All are aware of how the traditional produce from the farm is sold. Whether the product is meat, wool or crops, the price obtained is set by the whims of demand, local or overseas, and the fluctuation of a few cents per unit makes the difference, between a good financial year or a rough one.

Allied to this situation of being at the mercy of an auction system for most farm produce, is the real problem of not being able to effectively budget, and having no way of passing on rising costs to the consumer, as so many other industries are so quick to do, and so farmers are told to diversify and intensify. Which in simple terms means, make less go further, work harder to arrive at the end of the financial year in a break-even, or worse, situation. So the treadmill continues, with the farmer ham-strung with lack of liquidity, and lack of finance to do those improvements which will make for higher production and thus a higher net annual income.

Diversify, diversify. Intensify, intensify, so the cry goes .......... 

Without doubt many farmers have diversified and intensified; they are working longer hours, and getting more ulcers, but in most cases they have diversified into traditional forms of farm production - sheep, cattle and crops.

People

I would like to suggest that thought be given to diversifying into

* Managing Director, Tourist Trophy Guides Ltd, Lilybank Station
people; people, their needs and desires. As the pace of city life quickens year by year, more and more city dwellers look to the countryside for release from the pressures city living creates. They look at the lakes, rivers, mountains, the wide open spaces, and envy those who live in such surroundings. Farmers, (and perhaps their fathers before them) look at the same scene, equating carrying capacity, production, improvements, - never thinking for a moment that the river, lake or mountain range, even the buildings, are all assets of value to be turned to financial advantage.

It is a simple and fundamental fact of life that where there are people, so too are their needs. They need feeding, housing, entertaining, servicing in all manner of ways.

At the farmers front gate, is a source of income which is not subject to sale by auction, market fluctuations; it is a source of income over which they have total control, where services can be provided at a price directly related to costs and inputs; services which can be proofed against cost escalation or inflation.

For simplicity let's call IT 'tourism'. At Lilybank, after five years of effort, income from tourism constituted 75 per cent of gross income; only 25 per cent came from the century-old and traditional sources.

Ways and means

Almost all farmers are personable characters who enjoy to chat, particularly if it is to tell about their way of life. Without being aware of it, farmers have always been great salesmen, as far as their local area is concerned, being full of folklore, history and local affairs.

We should attempt to clarify what IT might be.
There are two ways of becoming involved with local tourism:

1. By capitalizing on a local need
   or
2. By creating a unique service or attraction.

Local Needs

One of the simplest ways of gaining an income from other people's recreational needs is to rent shearer's quarters. Many are fortunate (as we are at Lilybank) and have a ski field nearby. Many have a lake or river on, or near, their properties, where there is good salmon or trout fishing. Could fishermen be encouraged by farmers assisting with information as to where the best fishing is? Or, if farmers are so inclined they could hire themselves out as fishing guides and capitalise on the local fishing knowledge gained throughout the years. The possibilities are endless if the imagination is allowed to run! Perhaps some farmers, or their wives, have a particular skill which in the past they have so often given free. Have they thought seriously about what this skill or ability might be worth on an hourly basis?

When we moved to Lilybank eight years ago, the old homestead was at a stage where a large sum of money would have to be spent on it if we were to make it our home. We decided to build a new house and renovate the old place to some degree, tidying it up sufficiently to let it out to ski parties and families on summer holidays. We are now at the point where the net annual income from this old homestead is equal to the valuation of the building when we took over the property, and that annual income is greater than that from the sheep and cattle operation.

Unique Service

Under this heading come those stations close to Queenstown where
highly sophisticated show is offered to the passing public, demonstrating all aspects of high-country station life in the span of an hour or two. In fact, they have not offered anything new; they show only life as it is in the area, yet, each year thousands of New Zealand and overseas visitors flock to such properties. Erewhon Station, closer to home, has done much the same.

Of the above two options, the second is the more difficult to develop and turn into a valuable asset. The attraction has to draw people into the area on its own merit, whereas the supplying of accommodation or meals, etc., in association with an existing attraction, means that the attraction virtually does the promotional work and the farmer gathers some of the spin-off.

And yet, for the farmer and his family with vision and imagination, the creation of a unique attraction with its allied development, promotion and advertising cannot only bring deep personal satisfaction, but also worthwhile financial reward.

I cannot suggest unique and imaginative ideas. However, thought should be given to the skills and abilities farm families have which may be turned to entertain others, give them enjoyment, or perhaps teach them a new recreational skill. Many stations have interesting landforms, old Maori campsites, caves or historic buildings. It takes a great deal of imagination and searching thought to make a go of such a venture, but historically it is proven that within the farming community we have a wealth of imagination. Remember the hum-drump of city living, the repetitive round of restaurants, theatre, T.V., the pub, afternoon teas, parties on Saturday night. The pure joy and excitement seen on the faces of city folk when they visit a farm should be recalled. To the farmer it is work - to them it is an experience they will remember for a long time, an experience they will want to repeat, an experience they would happily pay for ......
Camps

At Lilybank we run a summer mountain safety camp for boys and girls over the age of 14. Each group is with us for six days. We teach them rifle safety and shooting, trout fishing and aspects of mountain safety, such as river crossing. They learn how to select a good campsite, cook wholesome meals over an open fire, what food to carry on a trip and so on. This goes on for four days, then they go in their groups, pack loaded, under sealed orders, on a trek where they apply all their new-found skills. Each evening they go rabbit hunting, trout fishing or horse riding. All game shot or caught is brought back, taken care of and cooked the following day. At the end of the camp we give each boy and girl a small certificate of merit, and strangely, we have boys and girls coming back the next year for more of the same.

In financial terms the camps are not a great financial success, for our charges are solely to cover expenses, yet what the kids gain from such a recreational activity in the high country cannot be measured in terms of dollars. With very high intake levels the camps eventually will make a valuable contribution to income; meanwhile we feel we are fulfilling a real need in the community.

Two Approaches

The establishment of a financial recreational facility on a high-country run involves one of two basic approaches:

1. To provide a facility which is designed to service a large number of people at a low price per person.

2. To develop a service where a few customers are serviced at a high price per person.
This second choice is by far the most attractive, for there is not a high capital investment in service facilities; in fact the existing buildings, plant and vehicles will be all that is needed. Today, many gorge runs are looking towards an even bleaker financial future. And yet, by their very location and the associated rough terrain, they are the runs where the last few remaining game animals are to be found. Those remaining game animals are the most valuable animals on a farm in this country today. From these can come the financial salvation of our gorge runs, a dramatic improvement in our overseas funds situation, with additional spin-off being beneficial to the local community. Historically tahr, chamois and deer have been treated as noxious animals and have been destroyed in their thousands. In doing so, New Zealand has been deprived of millions of dollars in overseas exchange. Views may change in the light of the current high prices being paid for live deer - $8,300 a head a few weeks ago ... and what is a billy goat worth today if he is pure Angora? What price a buck rabbit next year? Surely it is time for us to take a new look at deer, chamois and tahr.

In June 1979 there was an international conference in the United States where over 70 nations of the world gathered to discuss the conservation of game species throughout the world. Of those 70 nations there was only one - New Zealand - not treating its game species as a highly-valued renewable, recreational financial resource. Can it be that one out of 70 proves the one to be wrong?

Other Countries

Mongolia is charging $18,000 for a ten-day hunt for one trophy of the sheep family, the *Ovis ammon ammon*. Afghanistan gets $24,000 a head for each trophy of *Ovis poli* shot - Canada gathers $9,000 for a 20-days hunt from every non-Canadian hunter. The State of Alaska earns over $20 million annually from sportsmen visiting that State to hunt and fish. And in New Zealand we smile smugly because 7-million dollars was earned from the export of venison a few years ago. In any country in Europe a
good quality red stag can cost a hunter about $7,000, and if it is an exceptional trophy, as high as $10,000. Yet, here in New Zealand, we used to shoot this same species and leave them to rot. Mrs Tirakatene-Sullivan, when she was the Minister for Tourism in the last Labour Government, publicly stated "that the overseas visitor hunter was our most valuable per capita tourist".

**Gorge Runs**

Those on gorge runs who are struggling financially, and who want to make a decent living from a hard day's work, should go into the tourist business and operate hunting safaris on their runs. For an additional annual investment of about $5,000, an additional $30,000 to $40,000 net can be made annually within a five to seven year period. How does that make the future economics of a gorge run look? The running of hunting safaris is not an easy way to make a living. But the game animals that are there to be harvested require no investment and at the same time they don't need mustering, drenching, dipping, shearing, winter feeding, fencing or sale by auction. While traditional farm produce prices might rise or fall, the income from hunting safaris can only increase. The farmer sets the price and increases it each year against inflation and rising costs. As game animals decrease in number, the price per trophy rises. I think we can accept current Forest Service statements which state that deer, tahr and chamois numbers in most areas are at an acceptable level. If they are not, we have the helicopters to manipulate the numbers to the satisfaction of all except perhaps the odd total exterminator.

A safari business based on a gorge run does not need large numbers of game; the present very low levels generally are sufficient to sustain a run taking say ten to fifteen hunting clients a year. They, therefore, would be basically controlling the game while at the same time making an excellent additional income.
We took over the Lilybank lease in October 1970 and since then much of our time has been involved with catering to a wide variety of people and their recreational activities. Our application to Lands for the transfer of the lease was as a basically non-farming company, and our application was successful. To me this shows that, even nine years ago, the Lands and Survey Department had the foresight to see that there were alternative uses for high-country lands. Today, those alternatives are even more apparent with the development of tourism, ski fields, deer farming and so on.

By 1975 our income from recreational servicing totalled 75 per cent of our gross income, making ends meet as they could never have had we been farming only. We worked eighteen-hour days, often for months at a time, having virtually no private life, BUT, we received a fair reward for our labours - something many on the land do not enjoy today. All our efforts were aimed at providing the highest possible standard of service, for we knew we were being compared with safari operators everywhere else in the world. It was a harsh field in which to compete. Yet, once established with a good reputation, customers don't have to be sought, they seek you out. This is the same for any enterprise you may enter into as far as servicing people is concerned. If they like what is offered they will do the promotion for you.

Laws

Attention should be drawn to the laws and regulations governing the activities I have outlined. There are County By-laws which must be complied with; County Clerks should be consulted. Buildings used for accommodation come under the Fire Service Act. The transport of paying passengers requires the vehicle to have a certificate of fitness, not a warrant, and both driver and vehicle must have Passenger Service Licences. With the Amendment to the Land Act 1975, legislation was enacted controlling commercial recreat-
ional activities on Crown lease lands. A Recreational Permit is now required to undertake any such form of activity. The amended Act should be studied very carefully for it is restrictive almost to the extreme. Yet within the requirements of this Act all types of commercial recreational activities are legally recognised. A word of warning. Under this amended Act it is illegal to operate any form of commercial recreational activity without a Recreational Permit. The penalty for breaking this law is not a slap on the wrist or a $1,000 fine: it is the confiscation of your pastoral lease without compensation.

Conclusion

It is important for the individual to decide whether an asset will be an attraction. Existing facilities can be capitalised upon and used to provide a service. It is important to decide whether the business will cater for a large number of customers at a low charge per head, or a few customers at a high charge per head.

The possibilities within the field of commercial recreation are endless and rewarding. There are, of course, obstructions, delays, red tape and total discouragement. The effort required to make a success of diversification is great, particularly if the venture is new or different. Sadly, anyone who attempts something different in this country is quickly labelled an agitator, a rebel or a "rocker of the boat". Yet, if that person finally succeeds he or she might be acknowledged as a pioneer in later years.
Mr Gresham:
Mr Joll is right. High country runs are often a valuable recreation resource and there is a good potential for runholders to make money from this resource. In contemplating the recreational potential of his run the runholder should bear in mind:

1. That managing the run for recreation will take time and money which may otherwise have been spent on farming activities. Some runholders have very successfully combined the two activities but my own studies indicated that there was good reason to suspect that the stock on one or two runs were, in the past, run-down because recreational activities consumed a large proportion of management time.

2. A condition of all pastoral leases is that the land be "kept free" of wild animals and although it is usually impracticable to apply this condition rigidly, runholders are expected to comply with the spirit of the condition and keep animal numbers low. However, if the runholders established a safari hunting operation on his run he needs wild animals for his clients. Furthermore, he may need a large number of wild animals on his land if he is to guarantee his clients a reasonable chance of a trophy. Whatever the number of animals needed, the establishment of a safari hunting operation gives the runholders a
vested interest in maintaining wild animals on his land. This vested interest runs contrary to the conditions of the pastoral lease, the intent of the Wild Animals Act and the wish of catchment authorities to remove all grazing animals, domestic or wild, from the severely eroded areas of high country. The point should also be made though that with helicopter hunting the opportunity now exists to readily control the number of wild animals on high country runs to acceptable levels and that the costs of any damage to water and soil values by wild animals need to be balanced against the economic benefits they provide as a recreational resource.

3. While in many circumstances a runholder can provide recreational facilities for services of benefit both to him (and his family) and the general public, it is possible that the commercial recreational interests in his land may make the runholder unwilling to permit the "free" recreational use of run country that has been a long-standing tradition in New Zealand.

Mr Yeoman:

Mount Hutt is on retired land. It was spelled from farm production some fifteen years ago, so it is producing its first type of income. However, we are looking for diversification, technically into other tourist-style facilities or with farming people in the Methven area - subsidiary activities to encourage people to stay in the area.

Skiing, for its part, is involved with the four and a half thousand feet level and above. I do not think that farmers would get much of an income above four and a half thousand feet. We operate on a lease and a permit from the Forest Service, and we have found that to be a particularly helpful system. Frustrations have come from local authorities, or from those using town planning systems with which we have become involved. Many farmers in the Methven or mid-Canterbury area have older farm houses or shearers' quarters lying idle most of the year. When I asked if I can use them in the winter season, some town planning fellow says "no, you can't, because that is not in the best interests of the community".
For a person in my situation, both professionally and businesswise, I tend to get on the farmers' side very quickly, because this is economic utilisation of an asset for him and the country by way of the tourist.

At this stage there are 22 ski fields in New Zealand, with six commercial ones in the South Island and two in the North Island. The Mt Hutt Ski and Alpine Company is owned by 1400 people with an average share holding of $365. We call it snow-farming and regard it as a cheap investment; it does not require any Government subsidy at this stage! It is a valuable earner of overseas funds. The income last year was about $900,000, but, as in most businesses, overheads eroded everything but $200,000 before depreciation and tax. It is only marginally profitable, but it has not discouraged us and I would not let it discourage you if you decide to go into the business as well.

With three-million people here, there are a lot of ideas not even thought of - the place is wide open.

Mr Usmar:
I am all for private enterprise moving into the areas Mr Joll has suggested, particularly guiding, providing accommodation, etc. I think there are one or two constraints that need to be put on some of these things because basically it is exploitation. You have to ask some questions. First of all - Whose rivers? Whose lakes? Whose mountains? Not the runholders!

The paper, to my mind, would have had far more impact in terms of the animal aspect if it had talked about the condition of the vegetation. All the things that are argued for there I find tolerable as long as the vegetation is either in good condition or being enhanced. If, in fact, there is deterioration in that vegetation then the money you are talking about taking from these animals has to be deducted from the cost of that deterioration. This may well outweigh the strict gain from the safari. Let us have commercial recreation, but let us also weigh up the consequences. You can have a situation where an over-supply of tourists can destroy the very thing that is the attraction. This can happen in any area where you develop rough tracks, huts,
etc. As it becomes more popular the tracks and huts build up and you end up with so many people there that the tranquillity (which is what the people originally came for) is destroyed.

Most of you will have seen, in places where there are a lot of tourists, the way the people who are there, theoretically, to look after them, are in fact turned off by the tourists and by the repetition of questions. You get a reaction against the tourists that is not evident to start with when you have small numbers. When you get the same questions repeated hundreds and hundreds of times, barriers get erected, sometimes even physical ones, to protect the people who are supposed to be telling the story, from those who want to hear it.

Regarding the new look for animals that Mr Joll proposed - I don't find it a new look - it looks pretty old to me. I don't know of anyone who has not been encouraged to have people shoot animals. The only argument really is this one of vegetation and of course we spend most of our time in Southland and Otago trying to stop the animals who get off Mr Joll's farm from coming down to Otago and getting into Mount Aspiring National Park! Mr Joll's paper was inspiring and progressive. I just add a little feeling of caution. Some of the things that appear to block progress are there because of what other people interpret as the nation's right and it is up to all of us really to decide what is the nation's right.

Mr Joll:

Many of you probably know the background to the problems and confrontations that have evolved from our occupying Lilybank. In preparing my paper I deliberately did not air any of those problems regarding the various departments with which we have had disagreements. I am sorry that Mr Usmar saw fit to make a barbed thrust at the paper, bringing forth old hackneyed forestry phrases such as "the animals that were left on Lilybank have spread to Southland". That remark is totally unfounded.

On the question of vegetation, I do not wish to create an uproar or a
controversy. Certainly, the mountains are of prime concern to everyone. Anybody involved with any activity on the high country which relates to people using vegetation for stock or game animals is a fool if he thinks he is going to have his place over-run with stock to the detriment of vegetation, because he cuts his own throat. If you are an entrepreneur, if you are thinking of going into safaris, or if you are thinking of taking people walking - decide - and in making that decision consider all the values. Decide whether you are going to have ten thousand people walking down a track at 50 cents a head, or 1000 at five dollars a head. The environment and damage sustained by it are factors to be considered in your decision.

I accept the fact that there could be a case where a person becomes so busy developing tourism that he neglects his run, but surely that person has thought very carefully where the money is going to come from. Which of these two diverse enterprises is going to put money in the bank, is going to house me, is going to feed me and is going to leave me with a small smile on my face at the end of the financial year? That is why I said - "diversify into tourism", and that five, ten, twenty thousand dollars you make will make you sleep a lot better at night.

I stressed the fact that on gorge runs it is difficult making the balance sheet, balance. One way of staying on a gorge run and making a reasonable living, is to diversify into tourism. Now it is entirely your choice as to whether you are going to make that five per cent, one per cent or 50 per cent of your gross turnover. If you want one tourist a year and you charge him $10,000 for some service that is worth $10,000, that's fine. You either have a lot of people at a low price or a few people at a high price rendering a service equivalent to it. Now I can't decide for you whether you are going to have half of Christchurch on your back door for the week-end or whether you're going to have one person a month. All I wish to do is lay a multitude of possibilities before you which you as individuals will tailor to your own personality, your own family circumstances, your own property and the credit or debit balance that you have in your bank account.
Is ski touring commercially possible?

Mr Joll:

A small company in Tekapo has a new aircraft equipped with skis and is currently in the infancy of developing ski touring. Cross-country skiing has taken on with Australians, mainly because they have run out of room for alpine skiing. In New Zealand we haven't run out of room nor do I think we ever will. I don't believe it will be economic for many people to run because you can't charge lift fees.

Where do the 400 000 registered firearm owners, our recreation shooters, fit in? They don't appear to have very much going for them.

Mr Joll:

I have been a recreational hunter for 25 years and I have very strong feelings about what has happened as far as the 400 000 firearm users are concerned. In a way I've had to be two persons; I am a person that supports recreational shooting at as low a cost as possible for the people who don't wish to engage in a professional service, and I am Managing Director of the Company that will sink or float on its ability to produce results for paying customers. Not every high-country run is going to be running Safaris. The problem that has arisen in the last five years for the recreational shooter came not from people running Safaris but from the price on the head of deer. Some recreational shooters can no longer hunt for deer on properties where they hitherto did because the property owner has given the catching rights to commercial catching companies. Within our society, within our mountain ranges, there must be space for the majority as well as the minority.

In the light of the knowledge which research has given us in recent years, does Mr Usnar think that there is a level of wild animals, or varying levels of wild animals, that can be tolerated on various classes of country today?
Mr Usmar:
The short answer is "yes". That is recognised within the Act which defines exactly what is necessary; that the animals will be constrained to the level considered necessary for the wise use of the land. It is recognised that recreational hunting areas have been declared in the Blue Mountains already but banned in other areas and there will be a great deal of areas where a number of wild animals can be condoned or even managed, but there are other areas where they can't. Of course one of the areas in conflict is within National Parks. The National Parks Act clearly states that they cannot stay there. Our policy is not extermination; we haven't been exterminating for many, many years.
What a great country we live in. As one jets from Invercargill to Christchurch at this time of the year the geography and landscape changes, but the attitude seems the same.

A look across the Southland Plain. The very tight mobs of sheep, fore and aft of electric fences - rotating daily at 300 to 400 per acre, a minimum of brassica crops, stock carried at seven per acre on spring grass - a climbing lambing percentage, very enthusiastic farmers who are adaptable to change and who want to get on with the job of farming.

As the climate changes so do the soil types and hence the farming patterns. In the Canterbury area with its good cropping soils and climate, there is evidence of irrigation, new breeds of wheat giving higher yields and better quality, bigger tractors and implements that get the job done a lot faster, new crops and more efficient rotations. Again a population of very enthusiastic farmers who are adaptable to change, and who want to get on with the job of farming. Hill and high-country farmers are really no different.

If all this innovativeness and enthusiasm that I observe is in the farming industry, then what is going wrong? Why is our national output more or less stagnating? Why are many farmers reluctant to push things too hard? Why do we meet here today to discuss new livestock opportunities as a form of land use?
Scope

New Zealand's greatest asset is its large area of country side, coupled with the combinations of legumes, atmosphere and superphosphate that will fix nitrogen, which in turn helps sustain vigorous pasture to sustain an animal population.

The millions of acres of hill and high country provide ideal livestock farming opportunities. The land is there, the options are present, it just needs enthusiasm and manpower into the mix, and we are in business.

Ownership

Perhaps a few observations on hill farm ownership could be useful before we assess stocking alternatives. Through observation in my 12 years in business, I have noted that the late sixties and early seventies were rather a quiet time for the trading of hill country properties. Many of the units had tight family ownership, and were enjoying the second generation without much happening. Some of the more innovative became involved in the scramble for very high stocking in the late sixties. Two dry summers plus lack of basic management knowledge for the higher stock numbers saw quite a tail-off in stocking rates. When money inflation really got cracking in the early to middle seventies a move towards businessmen purchasing hill country properties became evident. Those families which had sat still for a long time had an opportunity to sell at what looked like excellent values. Up till the start of this year, I was not aware of any property in the South Island which sold for over one million dollars being purchased by a farming family. The businessmen farmers brought with them a new philosophy of borrowing to the hilt and really getting stuck into development. Mr. Muldoon's 1978 budget again plotted a new course, with his generous development handouts - land development encouragement loans (L.D.E.L.) and the like. A quickening of interest in hill country took place, and the inflation rise was severe as a result. It is now common for a property with development potential to sell
for in excess of $100 per stock unit.

Without doubt, the vendors of today are getting a very fair share of the L.D.E.L. monies added to the purchase price. Not bad, especially when you don't have to do any work!! Syndicates of farmers, flush from the last two quite good years, are presently showing good interest in purchasing development properties. The generosity of the Rural Bank to pick up the tab for an entire development programme has certainly boosted confidence.

This scramble for development monies, and the desire to capitalise on the various handout scheme has meant a lot of extra work. To date I have completed 52 livestock incentive scheme forms. These moves are providing farmers with very powerful incentives to get stuck in. It just seems a real shame that this is reflected in higher land values.

The development impetus that is currently taking place, has bought with it a fast-moving management change of sheep and cattle systems.

1. As rough blocks are shrinking in size, so are beef cow numbers.
2. The use of bagged nitrogen has allowed reasonable brassica crops to be grown first time out of rough. It pays to put the areas through crop, as the better consolidation and the extra working seems to reflect well in the new grass.
3. The larger areas of brassicas has provided better wintering conditions for young stock, and an incentive to carry over calves to the more profitable spring markets.
4. The better hoggets are becoming bigger ewes that are giving better lambing percentages.
5. The use of electricity for cheaper fencing is resulting in closer subdivision. This is allowing higher mob concentrations, and pastures are benefiting. Stock are wintering better through more frequent shifts.
6. The mob stocking systems for ewes on hill country is proving very
easy to manage, and quite a saving on winter feed. Mobs of six or seven, thousand ewes are now quite a common sight in a tight winter rotation.

Booroola blood is starting to make a impact. A very enthusiastic breed society has generated much interest, and this blood must have the capacity to improve per head performance. Closer selection within existing breeds must also provide a great opportunity for a low cost production improvement.

I am really enthusiastic about the development that is taking place on our hill country areas. A combination of the guaranteed minimum prices, land development incentives, the infusion of new blood from businessmen with their non-traditional outlooks, have all added up to give these large areas quite a kick in the pants.

I really don't believe that things are going too far wrong with attitudes and output from the hill country. I think what is giving everyone the jitters is the lack of co-operation from some servicing sectors. Its difficult to have the confidence to produce when you are not sure if products will be processed or not. Actually the processing industry for meat seems to be a real grey area. One could be really cynical and suggest that some factions seem content to see the whole thing destroyed. This critical area of uncertainty is the one factor that most concerns farmers today. Their efforts are seemingly being torpedoed by a chaotic meat-processing industry.

I believe that, quite apart from anything else, an emphasis on developing unproductive areas and becoming more efficient and stocked up on the already developed acres, with sheep and cattle must offer the best livestock for our hill and high country farmers.
Deer

I suppose that the excitingly rapid rise into prominence and profitability of deer has been the main motivating influence for this part of the programme. Without doubt, deer offers a very profitable alternative form of land use. Deer have always seemed too expensive in terms of capital value per animal, when this has been related to product price. I note with interest the result of the recent Criffel sale where the well-presented hinds averaged $2,000 per head. If the tax rate is 60 per cent and these animals were written down to a $200 standard value, net capital outlay would be $920. If the market for store stock stayed about where it is for the next year, with weaner hinds selling for $1600, and weaner stags for $1200, an 85 per cent fawning of 50/50 sex would return a gross of $1190 before direct expenses and tax. This is indeed an excellent return, and when it is considered that four or five hinds per acre could be carried on better country, the returns seem quite fantastic. Remember the good old days of the early exotic cattle, where you could buy a cow for $30,000, sell its calf for $25,000, and still have the cow left!! If I recall correctly, beef was then selling for about 60¢ per kg.

With venison selling for about $1 per lb, it is quite obvious that the deer market has moved far past the holding of any relationship to the meat price. All that is left is velvet. I can recall that in the first deer farm study I undertook back in 1972, velvet was budgetted to return $15 per lb. Just last year we saw the deer farmers pool returning $102 per lb for A grade, and David Yerex at the Deer Farmers Conference in Te Anau made a prediction that it could rise to $130 per lb next year. It is reasonably difficult to get all the velvets grades as 'A', so allowing - say 3.5 lb average per head at $100 gross less say $15 direct cutting costs, velvet could return $335 per stag. If that stag has a value of say $1500 per head today, and was written down to $200 by someone who was paying 60 per cent tax, the net capital outlay would be $720 for the animal, and this would show the gross return of $335 for velvet (46 per cent on net capital outlay). By carrying four or five
stags per acre on better country about $1500 per acre can be made from velvet. I wonder how many people who are buying deer are really on a 60 per cent tax rate. On a large property qualifying for Rural Bank development finance, the chances are the net taxable profit could be kept in the 33 per cent range. I believe that it would be a very poorly planned and managed development programme that would not return more competitively. Would it be fair to ask about the deer boom - 'What's really short-land or capital?' If it is land, buy deer, if it is capital borrow from the Rural Bank and develop to raise sheep and cattle numbers. The velvet market is a real oriental mystery to me - either we have been getting ripped off for years, or the orientals have new wealth and have acquired a new taste, or we have new markets - I wouldn't know, but it seems quite fantastic that the price would rise by more or less doubling each year for the last five or so years. Who am I to sound notes of caution? The best I can do is to interpret to my own satisfaction the symptoms and knowledge available, and pass those conclusions on. One thing that seems clear to me, however, is that if the sole motivation to go into deer farming is to make a fast buck, one would have to be quite careful that one didn't lose the lot! Deer are very beautiful and interesting animals. They are sensitive and highly strung. They require very special management, and very special handling techniques.

Goats

The latest of the high fliers have been the billy goats gruff - smelling, nimble-footed creatures that would sooner eat matagouri than clover; the animals that could be bought for five dollars per head a couple of years ago that now sell for near $50. Without doubt, the prospects for the sale of goat meat on the overseas market must be every bit as good as sheep meat. More people eat goat meat than eat sheep meat on a world scale. I guess it has been the interest in the Angoras that has really triggered off the interest in goats. With Mohair selling for about $15 per kg on a world market, the sums are quite easy to do. With twice a year shearing an Angora would gross about $100. They
seem very sensitive creatures, which require good shelter for at least three weeks after shearing, and who often have trouble bearing kids. They need intensive shepherding in dry climates.

Goats have a nasty habit of testing even the most experienced fencer's skills, and if feed pressures come on a herd, they could easily change camp in a most unplanned fashion. One could possibly see a place for a good-sized herd in a well-fenced environment, grazing blocks that have become choked up with weeds. A harvest of meat every now and then would provide some revenue. I am afraid I can't really see a place for goats in a developing hill or high-country situation. Ladies who like spinning and weaving and knitting would seem the best customers for Angoras.

**Pigs**

It wasn't so long ago that domestic pork was selling for $1 per kilogram, while wild pork was making $1 per pound. Wild pigs do very well in certain areas, and they have a major phobia against electricity. Wild pigs are easily contained behind electrified netting. They breed at a rapid rate, and if one was able to maintain the expected confirmation, gamey flavour, and lack of fat, carcasses suitable for export to Germany must be able to be produced. How on earth you would muster and handle the animals to facilitate the carcass harvest would have to be left over to Kiwi ingenuity.

**Rabbits**

A lot of "hoo ha" seems to be being talked about rabbit farming lately. I am inclined to think that the antagonists to the idea are visualising hillsides crawling with rabbits; with farmers moving around putting a pet ferret down burrows to flush out those rabbits present, so that he can wring their necks and send them off to the market. Rabbit farming has got to be "all go" in New Zealand. It is a logical form of land use, that requires intensive
labour, and the prospects of converting easily grown feed into a high quality product with a world demand. The feed conversion factor looks excellent as well. I don't feel that rabbit farming would have a place in our hill or high country set up. It must be more suitable to intensive units on better soils handy to a labour and processing source. I guess it will prove to be similar to the broiler chicken industry.

I was absolutely astounded to hear on our local radio from a University staff member who had gained some knowledge of rabbit farming that he felt the development of the industry would be best left to the guidance of a Government department who could sift through and select the best breeds suitable for those interested in farming them. I thought it was quite clear to everyone, that if we want to develop an industry fast and efficiently, it must be left over to private enterprise to operate, with the least number of regulations as possible. If someone makes a big profit - so what - caveat emptor - "let the buyer beware" must be everyone's motto. We don't need the shelter, the slowness and inefficiencies that seem to be traditional hall marks of departments. The punters need the opportunity to get their fingers burnt as well as to be able to make a fast buck. The deer farming experience is a good example of very little Government influence and control. It must rank as an outstanding example of Kiwi ingenuity and enthusiasm that has put our country to the rank of leaders in the world. I can't see that rabbit farming is likely to be any different.

Fish

I am not sure if the use of our water resources falls within the scope of this talk. In case it does, brief mention must be made of the prospects for the production of eels, fresh water cray fish or trout. I understand that if Mr. Muldoon could be convinced, there would be a good chance that trout farming could be legalised tomorrow. Why shouldn't it be? This would further utilise resources we have. It would not spoil them, and it would not hinder
the recreational opportunities. The same could well apply to ponds suitable for the production of freshwater crayfish. This European delicacy has an unsatisfied market.

**Bees**

If bees are animals within the scope of this paper, the planting of suitable trees, and the development of our land must increase the feeding opportunities for bees. Our honey is beautiful, and it can be packed and presented in so many different ways. The opportunity for bee farm expansion must be great indeed.

**Innovation**

I observe that it is a certain kind of man who is an innovator. To be successful one must have a bit more than a burning conviction. A reasonable supply of spare dollars is necessary. Any new venture brings with it unknown and hidden problems. These usually take time and money to solve. To attack a venture from an under-capitalised position is asking for trouble. If it looks like being successful there is seldom any problem finding a sleeping partner looking for a slice of the action, but if it looks a bit shaky or long term, capital support can be very hard to find.

One is very unwise if one lets the new development interfere with the 'bread and butter' operation. It must involve capital that can be risked, and time that is spare from the normal efficient running of the enterprise.

**Summary**

The excitement and high returns from deer farming have sparked a national quest for alternative forms of land use. The deer prices offer high returns per acre, but low returns on capital. All prices seem to be related to velvet value and not meat.
Goats seem to be a bit of a flash in the pan, and if farmed would present management problems, and low returns. Efforts to farm wild pigs could be a rewarding and interesting idea. Rabbit farming would be best left to factory-type systems closer to town. Fish farming alternatives such as eels, fresh water crayfish or trout could well prove to be ideal stock for our water-ways. Bees could well use the flowers of clover on developed land and special trees planted to extend our honey production. I didn't mention opossums in the main body of my talk. They fight and scratch each other and so harm the pelts, while their breeding ability is a bit slow. These factors combine to make the farming of these a bit doubtful except perhaps on a rabbit farming type system of factory production.

I observe that the sort of farmers who are the innovators are usually quite financially secure, and have a well run and oiled bread and butter department. They are usually not shy to call on help - people to discuss the risks and do the calculations, people to talk about processing, and people to talk about marketing. At all times, as a producer, the farmer must be aware. He is the only one without a cost-plus mentality, so naturally enough, he is where the buck stops!

I must re-emphasis the lead the Rural Bank has given to stimulate the development of our hill and high country. I would suggest that with known technology, sheep and cattle numbers could rise by at least 25 per cent on existing development. If this is the case, a farmer should be careful when embarking on further development to ensure that he is not spending unnecessarily. Before looking at any new form of stocking, a farmer should be very sure he is maximising returns from his existing regime. Breeding and feeding are the two things that give us meat and wool. We should not be dispirited with sheep and cattle. More efficient management of these must still be the best prospect for utilising our hill and high country.
As Mr Newson has admirably illustrated, the livestock opportunities for the hill and high country are many and varied and, before I comment on deer farming aspect of these opportunities, I will first comment on my limited knowledge of some of the other livestock opportunities Mr Newson discussed.

Firstly, I personally agree with Mr Newson's summary that goats seem to be a 'bit of a flash in the pan' in that they don't have the three-pronged high income potential that we see in deer i.e. the velvet, the by-products and skins and the meat. Goats have mohair, which may be subject to the same type of fluctuation we find with wool; they provide milk which surely will not achieve a universal appeal, and they provide meat.

We, ourselves, sell only wild goat meat which we process and pack similar to lamb carcasses and for which we achieve between 99 and 114c per kg (45 - 52c per lb). Prices for goat meat are often adversely influenced by Australian suppliers selling at 10-15 per cent below our prices. Apparently goat meat processed through freezing works sells at not much more than the prices already mentioned. When we deduct 27c per lb for processing, cartage, selling commissions etc., the farmer is looking at approximately 35c with skin per lb return, not so attractive, and interest in goat farming can only be based on the price for mohair.

* Edmonds Game Packers Consolidated Limited, Christchurch.
I was most interested to hear comments from Mr Newson on wild pig farming as most people appear not to have considered this a possibility. The market for wild pork is extremely strong, with strong interest in France (not so much Germany) and from the Japanese (who do in fact require a fat carcass or cuts). Indicative prices for a farmed wild pig could possibly be $1.10 - $1.15 per lb on carcass weight. However, there are problems among which are the retention of the 'wild' taste (as you know, the taste of pork is very much influenced by what the animal is eating) and the growth rate. (It could take 18 - 20 months to achieve a 120lb carcass). However, there is no doubt that this farming diversification must be tried.

Mr Newson mentioned the 'hoo ha' being talked about rabbit farming, and frankly I could not describe the situation better. Exporters of rabbit meat (and the industry should obviously be based as an export industry) will find that they strike some tough competition in the market place from East block countries and China. It is certainly not going to be backyard activity and must be tackled by individuals or companies with a good supply of funds to create farming facilities (similar to the broiler chicken facilities Mr Newson mentioned) to buy the production expertise and to employ top marketing techniques.

Frankly I know nothing about bees other than that one or two people I know in the business complain that they are hamstrung by the Honey Marketing Authority in their efforts to export their product at improved prices. These monopoly selling organisations often fall short of what other marketers can achieve and therefore what suppliers should rightly expect for their product.
Before commenting on deer farming, I want to pay tribute to the high-country deer farmers such as Malcolm Prouting of Mesopotamia, Arthur Urquhart of Erewhon and the Burberys of Glynn Wye who were at the forefront of deer farming development. Unfortunately, many of these men who contributed tremendously to the industry with their early experience and with their availability of stock for the starting of new farms, are often neglected when deer farming scribes make comment on the history and development of this business. There is no doubt that these high-country innovators played an extremely important part in the establishment of the current deer farming industry, and should be so acknowledged.

Some of Mr Newson's inputs, I feel, are a little inflated which, in turn, distort the percentage return on capital figures. All hinds are certainly not $2,000 each and it is possible to purchase very adequate animals ex helicopters for as low as $1,350 (a suitable insurance cover will take the initial risk out of stocking with these untrained animals), and $1,500 is too high a price to pay for a stag cutting 3½ lb of velvet). An animal producing this type of weight should cost today between $800 and $1,000 and of course when it is sold for meat the farmer could expect $1.30 per lb based on the carcass weight, and not the $1 mentioned by Mr Newson.

However, his point is well made that the market has in fact passed the point of holding any relationship to the meat return, and really, in the circumstances, why not? Income from velvet is a very valid part of the overall deer products production and an income from this source cannot be discarded as if it just weren't there.

However, my own opinion is that the price of stock is in fact too high and reflects a scarcity value, a value which says it is fashionable to be in deer farming, and the value of a tremendous long-term potential. Unfortunately, it also reflects a reliance on uninformed speculations from so-called experts which is not seen to the same degree in most other
industries. For instance, the prediction by Mr Yerex that velvet could rise to $1.30 per pound can in no way be based on fact, and it does little to assist in bringing prices to a more realistic level. No doubt people in the forefront of the Deer Farmers' Association administration must take a totally responsible attitude towards such advice.

In his comments on velvet, Mr Newson uses the phrase "getting ripped off" with reference to the increase in velvet prices over the last three years. I think, and I hope, that he means by "we", we as New Zealand exporters of velvet and not "we" as deer farmers as it is sometimes indicated by other sources. If he does in fact mean "we" as exporters of velvet, he is correct. If he means "we" as farmers, he is not.

Mr Newson said that deer are "sensitive and highly strung" and this too is correct, but experienced deer farmers with well-designed yards and an ability to handle stock will choose deer any day over the handling of sheep and cattle.

Finally, just a quick resume of how I see the industry at present. Sales of velvet should continue to make this product a very viable earner. Contrary to Mr Yerex's view, my belief is that the price will not in fact escalate to $1.30. New Zealand velvet is considered to be a top-quality product in an ever-expanding market and the long-term sale for velvets in - mainly - Korea is most encouraging.

Like all developing businesses there are anomalies in our industry, and one which concerns me considerably is a gap which is developing between the deer farmers and their association and the game industry as we know it. There is little doubt that farmers, and probably with some cause, have become mistrustful of the commercial enterprises they have had to deal with, and Mr Newson of course refers to this. It is understandable too that this attitude could prevail in their approach to the commercial involvement in the deer farming industry. However, they fail to take note of the fact that
if it had not been for commercial interests involved in game recovery, there would be in fact no deer farming industry today, and that all companies involved in the game industry are also heavily involved in farming and therefore vitally interested in ensuring the well-being of this new aspect of the industry.

Because of this rather unfortunate attitude which emanates mainly from the deer farmers, we could be in danger of losing the opportunity of creating a new farming venture where, from the outset, communications and understanding between farming and commercial interests are directed at achieving benefits for both sections, and not one at the expense of the other.

Regrettably, the Deer Farmers' Association and particularly some of its Council members seem, through their various writings and attitudes, to be engaged in a conscious effort to depreciate the game industry in the eyes of their members and to me it is a most unfortunate trend in this brand-new industry.

Farmers obviously realise that, like it or not, there is in fact going to be a commercial involvement in the overall game industry, and much better results are going to be achieved for all parties if there exists an attitude of co-operation and understanding rather than if the parties become alienated.

This industry has far too much potential for both those involved in it and for the country as a whole, to be sectionalised by ambition and posturing. We, as an industry, just cannot afford to create a situation akin to that existing today in the freezing works industry.
DISCUSSION

Q  What class of the Korean community uses deer velvet and for what purpose?

Mr Morrissey:

A  All people in Korea want to use deer velvet from high school age upwards. Velvet probably has an unfortunate reputation of being an aphrodisiac. That is not the situation at all. When Korea had deer, the people noticed that the deer lived a long time. Deer were the only animals producing velvet, and this was equated with longevity.

Q  Would you expect that markets for speciality products will start to decline?

Mr Morrissey:

A  In most countries, people are becoming sick and tired of eating beef, sheep and chicken. They are looking for diversification in their diet.
I intend today to put up a few ideas on the place of trees and forests in the high country. In doing so, I recognise that many farmers are opposed to trees of any shape or form and cannot see any value in them at all. This attitude will inevitably change and in my view trees must be looked on as another farm crop, which can be used on different soils for different purposes, and which must be considered seriously in new developments in the high country.

Before discussing the place of trees, I think it is worthwhile giving brief attention to the condition of the soils and vegetation that we have on what is commonly called "high-country". In many areas the soils have developed under beech forests over long period of time, and conversion of these forests to tussock grasslands by burning has occurred over the last few hundred years.

It is not generally recognised how much nutrient capital is retained or cycled in a stand of beech forest.

If we assume in a forest burn that all the nutrients in a mountain beech stand go back as ash, the following quantities of nutrients, in their fertiliser equivalents would be dumped on the soil surface (ha): nitrogen (16 bags urea), phosphorus (14 bags superphosphate), calcium (50 bags lime), potassium (18 bags potassium chloride) and magnesium (36 bags Epsom salts).

* Forest Research Institute, Christchurch
These large quantities of nutrients could either have been taken up by newly formed grasslands, or they could have been leached, washed, or blown from the site.

The grasslands that developed on the previously forested areas produce total crop weights of around one tonne/ha for fescue, to three-six tonne/ha for snowgrass, both of which are well short of the beech forests at 150-250 tonnes/ha. The snowgrass sward generates a large amount (25 tonnes/ha) of dry litter over the years which is more important than herbs and small grasses in giving ground cover.

I have quoted these figures to emphasise the fact that our grasslands did not necessarily develop under low-fertility conditions, and that they are not now high producing even although they may give the appearance of being vigorous swards. Their apparent standing crop is mostly litter and, for the tussock grasses in particular, their two-year cycle of leaf production imposes limitations on the extent of defoliation they can stand without a long-term loss of productivity. In short, increased grazing pressure on our higher grasslands is likely to lead to decreased productivity and increased nutrient loss, unless it is counterbalanced by the introduction of exotic grasses and legumes which will tolerate the grazing pressure. In most cases this also means adding fertilisers to maintain the growth of the introduced species.

This brings me to the point of questioning whether extensive grazing without fertilisers, typical of most of the high country grasslands, is
sustainable in the future. Increased utilisation of the standing crop of grassland may only hasten a shift to less productive grasslands or \textit{Hieracium} dominance, and a consequent fall in nutrient capital. It seems to me that there are sound reasons for developing the better soils for agricultural use, and fencing them in small enough blocks that the benefits of nutrient returns in dung and urine are more uniformly distributed over the improved pastures.

If we assume that increased animal numbers in the high country are going to be managed more intensively, then I think we have to consider SHELTER for stock protection and possibly better grassland production, PRODUCTION FORESTRY in its widest sense as an alternative form of income, and PROTECTION FORESTRY as the only effective form of long-term stabilisation on eroded soils.

I will take each of these facets of forestry and try to put them in the context of a high-country farm.

**Shelter**

The first point to make in regard to shelter is that it is unlikely to have any beneficial effects on the farm unless a grassland improvement programme is underway.

It is doubtful if high shelter belts have any effect on the production of unimproved tussock grassland, and it seems a fair bet that animal production will not be increased.

In the improved pasture, shelter will probably have most benefit on the legume component, mainly by modifying the drying effect of the wind in summer, and may encourage more even grazing of the pasture. The north
side of the shelter belt will be relatively warm, and the south side
cold, particularly in winter and spring. There should be positive gains
in animal production from better lamb survival, better pasture utilisa-
tion, and better utilisation of supplementary feed over winter.

If we look on the shelter belt as an integral part of pasture develop-
ment in the high country, some of the costs can be offset against poss-
ible increases in animal production, or they can be offset against the
management of the shelter belt as a small production forest. In regard
to the latter, very narrow shelter that is suitable for a horticultural
unit in the low-lands is not necessarily the best for the higher country.

I believe there is much more scope for the use of wide shelter belts
which combine the better aspects of forestry management with pasture
development. These shelter belts may be more than two chains wide but
they are at least wide enough between fences to allow for a rotation of
felling and replacement.

If one assumes that the shelter will reduce winds roughly eight times the
tree height out into the paddock, this leaves about 200-300 metres of
pasture that is affected.

At first sight these shelter belts may not seem to be a very large timber
resource. However, it has been estimated that if five per cent of the
farmlands of New Zealand were planted in suitable shelter belts, the
total wood resource could be as large as the present resource of exotic
timber in our planted forests. While this may seem a large proportion of
trees on a high-country property, there are farmers in the high country
who already have about 10 per cent of their farms in shelter belts and
who are convinced of the value of trees solely on the grounds of their
protection to stock.
Even if we are talking of the best soils on high-country properties being developed to pastures, the associated shelter belts will represent a large timber resource for the future. The fact needs emphasising, though, that if they are to be useful they must be managed as a forest and will require a rotation of felling and re-planting as part of the farming scene.

Production

If the combined development of shelter and pasture was limited to the better soils, it still leaves a potential for large-scale production forestry in most areas of the high country. The scope for production is limited by present-day economics rather than by the biological opportunities.

In favoured areas of the North Island where radiata pine can be grown fast over short rotations, it can be more profitable to grow trees than to run six stock units/hectare. In the South Island high country the trees that are suitable for the usual types of log production are slower-growing and require a longer time to reach milling age than radiata pine. Under these conditions a figure of about two stock units/hectare may be comparable with timber production.

It is worth commenting that the value of a stock unit on the paddock is roughly comparable with the value of a cubic metre of Douglas fir on the skid, and many areas on high-country farms are capable of producing 15 cubic metres of wood or more in a year. The arguments in favour of either pasture or high-quality log production depend largely on estimates of markets up to 70 years from now.

It is not my intention to discuss all the different options of production
forestry. However, it is worth noting that the selection of better provenances of Ponderosa pine, Corsican pine, lodgepole pine, Douglas fir, Scots pine, European larch, Eucalyptus and redwoods, all suitable for production use on the high country, is well advanced, and the establishment of these species presents no major problem.

The single largest problem is how farmers can derive an income from the land taken up by the trees, and cover the expenditure involved in establishing the crop. The obvious answer is to develop systems of grazing under the trees. This sort of development is in its infancy in the high country, and it is too soon to predict how it might work as a management system. At first sight, the fertility-building processes of legume introduction, topdressing and grazing would seem to be of benefit to the trees, while concurrently returning an income from the land, but it is doubtful that the system will produce as much herbage as open-grown pasture. Any damage to the trees would also need to be offset against possible benefits of grazing.

In other words, specialist production of trees or pasture on different parts of the farm may in the end be the most satisfactory form of integration.

**Liquid Fuel**

At least one of the options for the use of trees in the high country is the production of liquid fuel. Most people are by now aware of the decreasing supplies and increasing costs of fuel and of the need to develop alternative sources of supply in the near future.

The most important replaceable energy source in the future will be trees.
Over the last couple of years the Forest Research Institute has been felling, drying and weighing stands of trees in the Craigieburn Range at altitudes up to 1 200 metres (4 000 ft). Basically, we have found that the fastest-growing plant is lodgepole pine and it is producing about 10 tonnes of oven-dry biomass/hectare/year.

These stands were established up to seventeen years ago, using unselected stock, and have not received fertilisers.

Considering the soils and the altitude of our trial plots, it seems reasonable to expect that forest production on easier country below 1 000 metre altitude will be similar or better than that we have measured.

Based on our results, we can expect a 20-year-old crop of lodgepole pine to contain 200 tonnes of oven-dry wood and foliage per hectare. The foliage amounts to 15-20 tonnes/hectare, and the new needles produced each year remain on the tree for five to seven years. This gives the pine a tremendous advantage over other plants in that it does not need to develop all its new photosynthetic tissue in one season and, further, the nutrients taken up can be used very efficiently for growth. This mass of needles generates about 40 tonnes/hectare of litter under the trees over the 20-year period.

During this time the lodgepole pine would accumulate nutrients amounting to approximately 800 kg nitrogen, 100 kg phosphorus, 350 kg calcium and potassium, 40 kg magnesium and 100 kg aluminium - in the needles, branches, wood and bark. Clearly, all the useful nutrients must be returned to the site if we wish to maintain productivity.

Of the systems that are available to produce liquid fuel from trees in the high country, the pyrolysis system involving burning some wood to produce heat to power the conversion, seems most suitable. The carbon,
hydrogen and oxygen components are incorporated in the fuel, and the ash containing most of the nutrients is available to go back into the ground.

Each hectare of 200 tonnes of trees should produce approximately 70,000 litres, or 350 44-gallon drum equivalents of liquid fuel, and at least two tonnes of ash containing most of the nutrients.

This ash could be returned to the site as is. On the other hand, if it were possible to extract the aluminium and make new fertilisers, it would be possible to control the return of nutrients to match uptake. Let us assume that some sort of procedure like this is possible, and make the assumption that a 500 tonne/day plant is required. This would require 2.5 hectares to be harvested each day. Assuming 330 work-days in the year, 825 hectares would be required to keep the plant operating for the year, and 16,500 hectares to keep it operating over a 20-year rotation. The minimum-sized forest would therefore have a radius from a central plant of about 7.2 kilometres or 4.5 miles.

However, in an integrated farming scene it may be better to consider an area of 40,000 hectares with pasture development in between the blocks of trees to provide fire breaks on one hand, and to get the benefit of the shelter on the other. This larger area of 40,000 hectares would have a cartage distance to a central plant of up to 11 kilometres or about seven miles.

The trees would contain about 50 per cent moisture at the time of harvest, so that roughly 1,000 tonnes/day would need to be shifted unless we can find ways of allowing the crop to dry standing in the field. However, assuming a green crop is chipped on site and loaded directly into bulk trucks with a 20-tonne load, 50 trips/day would be needed and would
probably require a fleet of four or five trucks.

In a year this plant would produce 58 million litres of synthetic petrol of which some 10 per cent might be needed for the harvesting and transport. That leaves about 50 million litres as the annual yield of the forested area.

Coming back to the farming scene, a 40 000 hectare area would have about 40 per cent of its area in trees and 60 per cent of the area in pasture. The biological opportunities arising from this form of production are intriguing. Firstly, the possibility of depleting a soil in aluminium by using lodgepole pine means that there is the possibility of removing an exchangeable element which is detrimental to many plants. Secondly, the phosphate in the trees could be returned to the soil in a relatively available form. Thirdly, the clear ground, available after complete harvesting, allows the introduction of a legume, like Maku lotus, which is slow to establish and which might be grazed for five years but is capable of increasing soil nitrogen markedly over a few years after planting the trees. There is a potential for controlling the return of ash, or its fertiliser components, to balance either the growth demands of the trees or the associated legume. In short, it should be possible to build and maintain soil fertility in the forest by the judicious use of legumes and possibly grazing for 25 per cent of the time the tree is growing.

This form of energy production using a short-rotation species does not preclude the use of the slower-maturing species which might be used for saw-log production. The latter species would be grown near the fences to provide the long-term shelter.

The system suggested does not displace farming from the high-country scene - if anything it will add a new dimension to the opportunities open
to the high country. I would see the proposed system as being much less disruptive to existing agriculture and our present export requirements than any other form of energy-producing enterprise, including mining.

Protection

I do not intend to cover the need for protection forests in the high country in any depth, but I think it is important to recap that many of the slopes in the mountains that were once in beech forest now exist under low-producing grasslands. Most of these grasslands have less than 10 per cent of the weight of roots of trees on the same site, and it seems inevitable that trees will be needed on the least-stable slopes.

The latter case becomes even more real if one looks at the revegetation of eroded subsoils. We know that the use of superphosphate and legumes can lead to a dramatic improvement in the vegetative cover on these soils, and in their fertility. However, this production, even after adding 3 000 kg superphosphate/hectare over 14 years, does not now exceed one tonne/hectare/year. Nearby we have trees with 200 tonnes/hectare above ground and with 25-70 tonnes/hectare of roots, which have never been fertilised, i.e., annual production is 10 times greater than grassland.

If the country wishes to have a more stable landscape, and protect soils from erosion, it will have to face up to more trees. I see no reason why we should not use suitable exotic pines to act as a nurse crop for beech in certain areas of the high country.

Over and above the slope stability problem is the fact that carbon dioxide levels in the atmosphere are increasing at an accelerating rate to the point where, in 50 years, they could be twice the levels they are at present.
The only feasible way of locking up this excess carbon is in increased soil organic matter accumulation and in trees. In the high country, where temperatures are relatively low, there is the potential to fix and retain large quantities of carbon in the soil/plant system. This potential is about 200 tonnes of carbon per hectare on eroded soils.

Conclusion

The use of trees in the high country has never been a major enterprise in New Zealand. In the next few years (or months) we have to make major decisions on future energy supplies. The potential for forest production in the high country, using the fast-growing pines, looks promising. Above this, the need for forests to protect the soil resource and soak up some of the world's excess carbon dioxide is becoming an ecological priority.

We should not forget that while our high country at times seems bleak by lowland standards, its climate is more suitable for sustained growth than most areas of the world. There are good and urgent reasons for developing this potential, and I think the combination of protection forestry, production forestry, and intensive grassland development, provides the key to the future of the high country.
COMMENTARY

W.A.N. BROWN *

Agricultural development in New Zealand is dependant on innovative and progressive ideas. Gone is the time when we could remain complacent and contended, confident that continuation of past practices and movement along the long term trend line would preserve a healthy agricultural sector, and therefore a healthy economy. We must now actively search for new ideas and directions, promoting a climate of confidence and progressiveness in agriculture. Such a change necessitates that we all, collectively, consider new opportunities, evaluate development options, and constantly be on the lookout for diversification opportunities, no matter how small.

I stress the need for collective action, for in the past it has appeared as if we have abdicated responsibility for much of the initiation of development planning to "researchers" both at Lincoln and at other institutions. But there is no substitute for collective action, whereby the industry identifies new opportunities and encourages their evaluation.

It is in this light that I welcome the opportunity to comment on Mr Normeyer's paper which suggests that energy farming is another high country land use option worthy of more consideration. I propose to consider both the technical and economic implications of his proposal, and then draw some conclusions.

 Provision of an indigenous supply of liquid transport fuel is

* Agricultural Economics Consultant, Christchurch
Zealand's major energy problem - some would say our number one national priority. Rapid expansion of provision of CNG to high mileage urban vehicles in major North Island Centres, and of LPG to similar vehicles in the South Island will cater for a small section of the market - but even at maximum market penetration, this will account for only 18 per cent of fuel use. As for liquid fuels from Maui gas, methanol or synthetic gasoline could satisfy a significant proportion of our requirements by the late 1980's and during the next decade. But even though this does make a major contribution, the long term supplies of transport fuels from these sources are restricted. Gas off-take from Maui will have to be reduced after the year 2000, and other options come on-stream to make up the shortfall. The two alternatives which offer some hope are methanol or synthetic gasoline from coal, and energy farming; i.e. alcohol fuels from wood and agricultural crops.

Mr Nordmeyer has suggested that an alcohol fuels plant deriving its feedstock from Pinus contorta grown in the high country could be one option. Let us now study this more closely.

Wood can be converted to ethanol by acid hydrolysis and a pilot plant is currently operating on this technology at the Forest Research Institute in Rotorua. The alternative option is production of methanol by gasification of wood, and research by Dr Brian Earl at the University of Canterbury suggest this to be the lower cost route (1) - a conclusion confirmed by overseas research(2). Gasification involves the thermochemical decomposition of the feedstock, producing a synthesis gas which can be converted to a number of fuels such as hydrogen, methane or methanol. Gasification of wood or straw is not yet proven on a large scale continuous commercial basis, although a similar process is involved with gasification of garbage by the Purox (R) method, gasification of coal using the Lurgi route, and Cousins at DSIR in Wellington has successfully gasified sawdust on a small scale. The conversion achieved is approximately 0.47 t of methanol per ODT (oven-dried tonne) of wood, and so a 500 ODT/day
plant would produce just under 100 million litres of methanol annually. 1 Dr Earl is confident that this technology will be commercially proven within the next decade.

So what would forestry energy farming in the high country involve? Let us take the Waimakariri Catchment as an example. Plantations would need to be of a minimum size of 30 ha, but preferably larger. They would be densely planted - around 2000 s.p.h.2 compared with normal planting densities of 1000-1200 s.p.h., and would remain completely untended until felling at around year 20. Some grazing within the stand area would be possible after the trees were well established, and before the cover developed too densely - say between years five and ten of the rotation.

At the end of the rotation, all trees would be clear felled, and the total above-ground biomass delivered to the plant. A typical whole tree harvesting system is shown in Figure 1. The tree is sheared close to the ground and assembled in piles by the feller-buncher. The bunches are picked up and dragged to the roadway by tractors equipped with hydraulic grapples. The trees are then fed individually into the chipper and the chips blown directly into vans.

Clearly such a harvesting system is not suited to very steep country, but slopes up to 18° can be accommodated easily. Where slope exceeds this, an individual felling operation is necessary, with the logs either shoted or sky-trained to the chipping point. This latter operation is, however, more expensive than mechanised whole tree harvesting.

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1 The conversions assumed here are significantly different from those used by Nordmeyer, but agree with research both at F.R.I. (4) and overseas (8).

2 s.p.h. = stems per hectare
The chips would be transported by road to the centrally located gasification plant - situated at Cass for instance - and methanol produced on-site, being railed to Christchurch for blending at the Woolston depot into the Canterbury motor-spirit pool.

After clear felling, the land could be replanted again to start another rotation. The ash from the methanol plant would need to be returned to the area to prevent loss of nutrients and fertiliser applied to maintain adequate nitrogen and phosphorus levels.

As Mr Nordmeyer has stated, the minimum size of gasification plant needs a feedstock input of approximately 500 ODTPD (oven dry tonnes per day), or an annual harvesting of 165,000 ODT. This would require a supply area of 16,500 ha of productive forest (at an annual average production of 10 ODT/ha), or an area of forest of 20,625 ha, assuming an average utilisation of 80 per cent (Table 1).

Data from Hayward's 1967 study suggests that there is suitable land of this area in the Waimakariri Catchment (3) - refer Tables 2 and 3. The area required represents 34 per cent of the land classed as terraces and/or rolling lands and hills, and is roughly equivalent to the 19,636 ha of land classified as suitable for productive forestry in the Waimakariri. Whether this land would, of course, be available is another matter, and one which depends principally on the profitability of alternative land use options.

The factory output would be just under 100 million litres of methanol - this represents 15 per cent of the fuel used in the South Island if it were blended.

So, technically, the concept is workable. What about the economics? The critical factor in this exercise is the price at which the wood can be delivered to the processing factory, for 35 per cent of the final product
TABLE 1
Productive Forest Stand for Methanol Plant

<table>
<thead>
<tr>
<th>Feedstock</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of productive forest (ha)</td>
<td>16,500</td>
<td></td>
</tr>
<tr>
<td>Rotation length (years)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Area harvested annually (ha)</td>
<td>825</td>
<td></td>
</tr>
<tr>
<td>Yield of harvest (oven dry tonnes (ODT/ha)</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Annual harvested yield (ODT)</td>
<td>165,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processing</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory capacity (ODT/day)</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Operating period (days)</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Annual feedstock requirement (ODT)</td>
<td>165,000</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2
Topography of Waimakariri Catchment

<table>
<thead>
<tr>
<th>Topographic Class</th>
<th>Area</th>
<th>%</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>River beds &amp; lakes</td>
<td>16,512</td>
<td>4.5</td>
<td>-</td>
</tr>
<tr>
<td>Terraces</td>
<td>26,052</td>
<td>7.1</td>
<td>&lt; 5°</td>
</tr>
<tr>
<td>Rolling lands &amp; hills</td>
<td>34,491</td>
<td>9.4</td>
<td>&lt; 15°</td>
</tr>
<tr>
<td>Steeplands</td>
<td>289,870</td>
<td>79.0</td>
<td>&gt; 15°</td>
</tr>
<tr>
<td></td>
<td>366,925</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Source: Hayward (1967): 3

TABLE 3
Suitability of Land for Productive Forestry Waimakariri Catchment

<table>
<thead>
<tr>
<th>Subclass</th>
<th>Area</th>
<th>% of Catchment</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Slight Physical Limitations</td>
<td>19,636</td>
<td>8.4</td>
</tr>
<tr>
<td>T2 Moderate Physical Limitations</td>
<td>22,456</td>
<td>9.6</td>
</tr>
<tr>
<td>T3 Severe Physical Limitations</td>
<td>28,292</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>70,384</td>
<td>30.1</td>
</tr>
</tbody>
</table>

Source: Hayward (1967): 166-7
price of methanol ex plant is attributable to the price of the feedstock material.

Recent costing studies by Mr Tom Fraser and Mr Gerard Horgan at the Forest Research Institute (4) at Rotorua suggest that Pinus radiata can be delivered 20 km to a mill for $11.41/green tonne, a charge which covers harvesting, chipping and transport. This compares well with recent U.S. researchers who have estimated figures between $11.80 and $15.00 / green tonne (5,7).

If we allow a margin of 25 per cent to cover more difficult operating conditions in a high country catchment, the cost of harvesting, chipping and transport rises to $14.30/green tonne, $28.60/ODT. To this must be added the stumpage price paid to the farmer, any fertiliser costs associated with maintaining a sustainable rotation, and discounted growing costs. A stumpage price paid to the farmer of $550/ha is used in these calculations.3

Discounted growing and fertiliser costs amount to $1800/ha, which includes an allowance for planting ($160/ha), administration ($11/ha/year) and fertiliser ($180/ha). 4 Total delivered cost of wood is therefore approximately $41/ODT 5

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3 This represents the value of compounded net revenue foregone over 20 years from grazing 0.75 SU/ha at a gross margin of $15.00/SU. Allowance for grazing of 80 per cent of maximum is made in year 5, reducing to 10 per cent in year 10.

4 No allowance for site preparation, blanking, weed control, dothistroma control or opossum control. Although relevant to production of Pinus radiata in the North Island, they were not considered necessary in this context.

5 This compares with estimates by Oeler (8) of NZ$ 34-46/ODT, and by Mitre (8) of NZ$ 20-40/ODT, and includes an adjustment for a non-productive forest area of 20 per cent.
If this feedstock price can be achieved, the economics of the processing operation are detailed in Table 4. The estimated methanol product price is just under $18/£ petrol equivalent in blend ex factory, which probably translates into $21/£ blend petrol equivalent delivered to the blending point, using current day costings. The cost of premium grade motor spirit imported into New Zealand (currently 30 per cent of our requirement) is now $19-20/£ and expectations are that this will climb rapidly, so the methanol product prices appear very competitive.

From a foreign exchange point of view, the position is also very attractive. Although nearly 60 per cent of the capital cost of the plant would be imported ($21 million), the net savings in foreign exchange total $18 million annually, or over $850/ha of land allocated to forestry. This is considerably in excess of the current foreign exchange earnings from traditional land use patterns.

**TABLE 4**

*Methanol from Wood Processing Factory Costing*

<table>
<thead>
<tr>
<th>Plant Size</th>
<th>500 ODTPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating period</td>
<td>8000 hours year$^{-1}$</td>
</tr>
<tr>
<td>Capital Cost ($1977)</td>
<td>$35 million</td>
</tr>
<tr>
<td>Conversion</td>
<td>0.47 t methanol per ODT wood</td>
</tr>
<tr>
<td>Production</td>
<td>$99.7 \times 10^6$ pure methanol</td>
</tr>
<tr>
<td>Delivered Cost of feedstock</td>
<td>$41/ODT$</td>
</tr>
<tr>
<td>Product price</td>
<td>17.6/£ petrol equivalent in blend</td>
</tr>
<tr>
<td>Delivered cost of feedstock as a proportion of final produced price</td>
<td>35%</td>
</tr>
<tr>
<td>Employment</td>
<td>40 shift</td>
</tr>
<tr>
<td></td>
<td>18 permanent</td>
</tr>
</tbody>
</table>
One final comment relates to the employment creation aspects of such a project. The factory involves a workforce of 58 people, and the felling and transport operation at least another 12, or a total labour force of 70 persons. This represents a community of over 200 people, a very significant base for community development in sparsely populated areas of the high country.

In the time available I have not been able to adequately address other aspects of the proposal – conflicts in land use patterns for instance; whether 'suitable' land is, in fact, 'available'; the dangers associated with spread of seedlings from large areas of \textit{Pinus contorta}; and other environmental issues. But, I hope to have shown that Mr Nordmeyer's proposal exhibits technical and economic sense and certainly warrants further investigation. We should always be willing to receive, consider and evaluate all proposals for diversification, in a positive comprehensive fashion. Some will warrant further investigation, others will need to be discarded. I suggest this proposal of Mr Nordmeyer's is in the former category, and I commend it to you for further study. Remember, it takes over two decades for forestry plantings to come on stream, so there should be no delay.
REFERENCES


DISCUSSION

A stumpage price of $550 a hectare will give the farmer about $12 a year gross. Is that correct? In other words he will be worse off with trees than he is with sheep.

Dr Brown:
It depends on the exact substitution. The $550 used is the gross price that would be paid as a rental for that piece of land for the period of twenty years. What figure would you rather was put in its place?

Comment:
I suggest you should multiply that by a factor of five to make any sort of economic sense to the producer.

Dr Brown:
If the stumpage price was five times the figure I have used, that would be a return to the farmer equivalent to grazing about four ewe equivalents per hectare with an annual gross margin of $15 over that period. If high country land is currently grazing four equivalents, it wouldn't be worth putting it into trees for energy farming.

Comment:
If you did multiply the price by five the resultant change in the value of the final product would be insignificant. Would that be a fair assessment?

Dr Brown:
Well it depends on what you call insignificant. About 35% of the farm product price depends on the delivered cost and so instead of talking 18c a litre petrol equivalent blend, you would be taking maybe 22c a litre petrol equivalent in blend which could well be what the gasoline price is in a short time.
Could a factory such as this not be put into a plantation such as Balmoral in a year or two?

Dr Brown:

The first thing would be to put in a small pilot plant where there was a lot of waste wood. The next stage is to either put in a commercial plant at, say, Balmoral, or in the high country. If you had a large return of wood available from wind throw, that is the obvious first source of cheap wood.

Mr Nordmeyer:

I would like to see an integrated system for the high country where the farmer has a number of opportunities. Improved pasture development is only possible with good shelter to make the increased production on the flat safe. Much flat land can be improved, but it's risky country if it's prone to snow. Low country farmers have the possibility of producing logs for a reasonable return; high country farmers by comparison have few opportunities because of transport costs. However, with the production of liquid fuel, transport is not an important issue, because a third of the gross weight comes off as fuel. I would hope that all the ashes available would go back on the ground to maintain site productivity. I would also point out that I am not assuming all the high country will be taken over by this form of enterprise because I wouldn't like to see the high country taken over by trees in any way. I think however, it is an alternative particularly for those areas of high country where the rainfall is above 30" - 40" per year. It would not be a satisfactory alternative for very low rainfall areas of Central Otago.
The level of grass production appears to be very low.

Mr Nordmeyer:

What we were faced with in many eroded soils was trying to build up fertility by introducing legumes with very liberal quantities of superphosphate. We achieved a very low order of production after a very heavy input of fertiliser and although fertility has increased this has not come through in terms of increased grass production on these very low fertility soils. However on those same low fertility soils we can get tree production. Perhaps some of these eroded soils are the place for putting the trees for a certain amount of biomass to hold those sites together. It is a sort of package deal which goes with the integration with farming. I think it has to be looked at in that light.

What does the site look like after you've cut across the lodgepole pines? Have you done any strata tests of the soil properties and their productivity after the removal of one of these crops?

Mr Nordmeyer:

It looks like a layer of litter over the surface of the ground with the stumps cut fairly close to the surface. If we left it at that and simply took off all that material without returning the nutrients, the result over the long term would be disastrous. I have no pretence that we could possibly operate this sort of system unless we put the ash back at the same time. That's basically why I am suggesting that the pyrolysis system could be the one to chase because we do get the ash. Now I don't know anything about the formation of fertiliser from the ash material. I'm not sure if it is technically feasible to remove aluminium. What we are suggesting is burning the forest by pyrolysis, sowing Maku lotus, and grazing after the trees grow to a certain height. So we don't necessarily forego the use of the land as a grazing system.
Has an ash-pelleting system been considered to avoid major leaching problems?

Mr Nordmeyer:
No.

Have any comparative studies been done between liquid fuel production in the high country and production from waste woods from forests in low-land situations?

Mr Nordmeyer:
No. High country farmers can share in what is going to be a future energy demand; low country farmers have a number of cropping alternatives open to them. The only option for high country farmers in the energy field is to grow trees.

Dr Brown:
If we are going to make substantial contributions to New Zealand's liquid fuel in the year 2,000 we would need 36 beet ethanol plants which is one of the options mentioned. We would need in addition to that 50, 500 tonne-a-day plants, of the type being discussed here. It is possible to have about seven to ten of those on waste wood. They would eliminate all the waste wood so there is still a need for another 40 plants somewhere. Clearly some of these would be at Kingaroa, some would be at Balmoral, with some in the high country. One plant isn't a big deal in the total energy scene.
How do sawn logs for export compare?

Dr Brown:

Studies at Kringaroa show that if sawn logs or pulp wood can be exported at reasonable market prices it is far better to do that and buy in the oil, even if the oil price continues to escalate at recent rates. If wood has little or no alternative use, large areas of *Pinus concorta* growing in the high country would be better converted into methanol.

What prospects does Mr Nordmeyer see for high quality timber production from wide shelter belts and what are the possibilities for within-woodlot winter shelter and feeding?

Mr Nordmeyer:

I think there is considerable potential in this sort of approach but only if it is integrated with increased grassland production. I cannot see it working in a system where we have large scale grazing over extensive areas of native grasslands. Of the species we have in the high country the main one would certainly be Douglas fir. *Ponderosa pine* has always had a bad reputation as a milling timber in N.Z. possibly because it has been handled much too young. Many of the trees that are logged in the United States are 70 years of age or more. I wouldn't like to say what would happen in the event of one exceptional storm once every 40 or 50 years or after very heavy snow falls. So there are if's and but's about log production in the high country which I don't think necessarily apply to the fuel option because that is a short rotation system, one in which, if damage occurs, utilization is not lost.
Would I be right in suggesting that it is for government to decide what their intentions are regarding the production of synthetic fuels and what incentives they are likely to offer farmers to produce the necessary crops? The first move must come from them. When is government likely to make the move?

Dr Brown:
Any energy policy decisions will have to be made within the next six months on use of Maui and within a year as to what happens after Maui. We don't want to sit back and wait for the lead to come from government. I think it is essential that we create a climate in which we are prepared to look at these various options, evaluate them and in fact consider how much we would need to be paid for a hectare of land devoted to lodgepole pine for twenty years. These are the kind of things we can think about, so that when government asks how much we need to be paid, we can at least have some of the answers ready and speed up the whole investigation process.

What happens in twenty years'time when technology has superceded your type of fuel; will we have trees in the high country we cannot use?

Mr Nordmeyer:
When you plant trees you're not necessarily foregoing the use of that land in the future. I think we are at the stage where we can look on trees as another farm crop.
UNDERSTANDING THE HILLS

JOHN A. HAYWARD *

Had this seminar been held ten years ago it might well have concluded with a "wish list" of research topics. Such topics would have emphasized on site and off site impacts of land use in the hills and while the list would have included many topics, erosion and land use hydrology would have been prominent.

Research requests would have been based on the proposition that we had a good qualitative understanding of the hills. The object of research would be to provide quantitative support to that understanding. New information would, for example, allow us to establish the costs and benefits of a proposed catchment control scheme. It would not question the need for such a control scheme.

In 1941 when the Soil Conservation and Rivers Control Act was enacted there was in New Zealand, a handful of scientific papers, a considerable volume of general writing and the stark evidence of depleted New Zealand landscapes. At that time action was more important than research. Thus the cover of the Soil Conservation and Rivers Control Council's Bulletin No. 4 identified "Research" as the 10th of 10 "First steps in soil conservation".

When you read the writings of the New Zealanders who first promoted a concern for soil conservation you come to the conclusion that our "understanding" was profoundly influenced by North American attitudes and experience. They knew of Horton, Lowdermilk, Bennett and others, and of the "black dusters" of Colorado, Oklahoma and Kansas.

Exploitive land use led to a deterioration in plant cover and consequent increases in erosion and flooding. This proposition was regarded as a fundamental truth. If it needed the support of research findings, then such support could be found from the European and North American literature.

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A few New Zealand surveys (for example Zotov 1938, Committee of Inquiry 1939) and a depleted New Zealand landscape gave support to the view that good plant cover was a desirable watershed feature.

In 1940 this was the fundamental premise on which our understanding of the hills was based, and on which policies of the Soil Conservation and Rivers Control Council would depend.

The achievements of the soil conservation movement in the 1950s and 1960s are well documented in Lance McCaskill's book "Hold this land". But to understand the division of attitude that these achievements created you have to read between the lines or talk to those who were intimately involved. The problem was that "conservation farming" demanded a new approach to the use of land.

Tradition dies hard, and many runholders and civil servants openly disputed the worth of soil conservation practices.

In response, the staff of catchment authorities repeatedly called for research. The minutes and accounts of the many meetings held in the 1950s and 1960s make interesting reading. A reader is left with the distinct impression that research was not needed to establish an understanding of the hills but to determine the extent to which that understanding was "true".

In the 1960s research programmes began to emerge and the South Island hills became host to scientists from many disciplines and agencies.

The vegetation and soil surveys of Gibbs et al (1945), Barker (1953) and Wraight (1960, 1963, 1967) established that much mountain land was in a severely eroded or depleted condition. In response O'Connor (1962, 1967), Dunbar (1970, 1971) and Nordmeyer (1976) and others found species that would be suited to revegetation and established the fertility needs of a wide range of sites.
Work by Gradwell (1955, 1957, 1960), Soons (1968, 1971) and Butterfield (1970) confirmed that frost and wind were active agents of erosion. Notwithstanding these studies, soil surveys and soil process studies. Cutler (1962) reported that although erosion in South Island high country had long been a controversial and frequently acrimonious subject of debate there were no valid data on the stability of soil and steep slopes. Subsequent work by Molloy (1962) showed that instability had been a periodic feature of at least one New Zealand mountain range (the Torlesse range).

Geologic mapping (for example Grindley et al (1961) provided much information about New Zealand's complex geologic history. However, the emphasis on mapping time-stratigraphic units has not been particularly useful in understanding rates and mechanisms of erosion. O'Loughlin's study (1969) of the geology and geomorphology of a mountain catchment was an important contribution towards such understanding. From his investigations he concluded that a modern phase of accelerated erosion associated with the depletion of land cover, had substantially modified stream bed forms. He suggested that the morphology of the stream bed and channel was controlled by infrequent catastrophic events, and called for longer term studies to verify his findings and provide more information on sources of bedload.

In the decade before 1970 there was information about sediment loads in only a few lowland rivers and Johnson's (1970) study in the Craigieburn range was the only contribution to the understanding of mountain stream sediments.

In the decade prior to 1970 rapid advances were made in understanding the character of mountain climate and of the variability of temperature and rainfall. The studies showed that above about 1500 metres snow made a significant contribution to total precipitation.

In 1970 Toebes reviewed hydrological research relating to land management and noted that because experimental basins, begun in mid-1960s required three to four years for both calibration and evaluation, few results were
available. Although some results of the hydrologic impact of land use were available for Moutere and Makara, there was no comparable information for high country.

Some information was available about some hydrologic processes. For example, studies of interception had been made by Jackson 1973, Blake 1972, Fahey 1964, Kellar and other. Work by Mark and Rowley (1969) led them to conclude that a natural undisturbed cover of tall tussocks provided for the maximum yield and control of water from low alpine snow tussock grasslands.

Infiltration studies by Nordbye and Campbell (1951), Gillingham (1964) confirmed earlier findings from the United States that showed that infiltration rates decreased with an increasing intensity of land use.

The fate of water which infiltrated into the soil and the significance of soil water to a mountain catchment's response to flood rainfalls were largely matters of speculation.

When you read the pre-1970 literature, you must come to two conclusions. The first is that we imported an "understanding" of our hills from Europe and North America. The second is that the early research efforts served largely to reinforce that understanding.

The comparisons of prior land conditions with early photographs and the significance of the work of Molloy and O'Loughlin was either ignored, or accepted for those aspects which fitted out conventional wisdom.

Jack Holloway in 1954, in his major work on forests and climate in the South Island cautioned

"hypotheses themselves are not facts, although they may sometime be proven to be substantially founded on fact."

In the 1960s, our understanding of the hills, and our approaches to high country management were based on a large number of hypotheses.
Since 1970 there has been an explosion of information about "the hills". In the field of erosion and hydrology alone, there have been four to five times as many papers written since 1970 as in all the preceding years.

Some of this information forces us to stop and re-examine many of our cherished beliefs. We are developing a new understanding of the hills.

For example:
In an extraordinary Ph.D. thesis, John Adams established that the South Island mountains were a balanced system. That is the rates of uplift and erosion were comparable.

Dr. Andy Pearce and Colin O'Loughlin have established that, with the exception of the Kaikoura mountains, erosion rates in the South Island mountain forests are generally low.

Dr. Paul Mosely has questioned whether the noxious animal populations of the Ruahine Ranges have played a significant role on the apparent increase in erosion rates. He offers instead convincing evidence of former erosion in pre-animal times and the proposition that much of the present slope instability may be due to changes in channel and stream behaviour.

Trevor Chinn has established that many scree fields are both old and stable.

Since 1966 the Tussock Grasslands and Mountain Lands Institute has been involved in a wide range of studies in the Torlesse Mountains to better understand the behaviour of the mountains.

I would like if I may to now outline some of that work as a contribution to a better understanding of "the hills".

Most of our work has centred on the Torlesse Stream catchment. This is a 385 hectare sub-catchment of the Kowai River. The basin rises steeply from about 750 metres to about 2000 metres in just over 4 kilometres. Most slopes are between 26 and 30 degrees. The mean altitude is about
1300 metres. About 80 percent of the catchment is described as "severely eroded and depleted".

The basin is part of a block that was traditionally used for summer sheep grazing. However, in 1971 the North Canterbury Catchment Board prepared a soil and water conservation plan for the property. This plan was based on a land capability assessment and called for the area to be retired from sheep grazing between 1971 and 1975.

Prior to 1971 the basin was grazed for about two months each year by a wether flock. However, in 1972 a change in policy saw the area grazed by a half-bred ewe flock for about two months each summer. Sheep movements were recorded for the next three years. Sheep were not found above about 1300 metres and there were few stock above about 1100 metres. This ewe flock behaviour was in marked contrast to the wethers that moved freely to the tops of the mountain. More than half of the lower altitude area on which ewes were found had a stock presence of less than 1.5 sheep per hectare for the two month grazing period. Almost all of the sheep presence in excess of 1.5 per hectare was on land with a ground cover of more than 80 percent.

During the first recorded floods in 1972 it appeared that the stability of some riparian land was strongly influenced by flows in the stream channel. Subsequent field and laboratory investigations showed that:

1. The Torlesse Stream channels are generally well ordered sequences of pools and riffles.

2. This steps and stairs shape of the stream channel is a most significant mechanism for dissipating stream energy.

3. When the pools are inundated by high flows or by gravels, stream energy is sharply increased.

4. Although streams such as the Torlesse have been loosely described as mountain torrents this description is only accurate when the pool riffle (steps and stairs) morphology is submerged by higher flood flows.
Stream sediments

1. A vortex tube sediment trap was built to allow us to measure bedload sediment during floods. Between 1972 and 1977, 81 flood events were recorded. These floods shifted a total of 560 tonnes of gravel. The average annual sediment yield was 30 tonnes per square kilometre of catchment. Although the Torlesse Stream catchment is commonly described as severely eroded these yields are amongst the lowest values recorded for New Zealand and overseas mountain lands.

2. Bedload yields vary greatly between storms and are more dependent on the supply of sediment than on the transport capacity of the stream flow. Results show that the stream could transport a greater sediment load if there was sediment available to be transported.

3. Bedload sediments were found to move wave-like downstream.

4. Conventional methods for predicting sediment yields were found to over-estimate by several orders of magnitude.

5. Major flood events have a dominant influence on long-term sediment yields. For example, in April 1978 four days of floods moved nearly twice as much sediment as was moved in the proceeding five years.

Sources of sediment

1. A majority of bedload sediments were derived from the disentegration of small areas of intensely faulted exposed rock.

2. The spectacular and visually dominant scree field of the upper catchment were found to be comparatively stable during the study period.

Suspended sediments

In major river systems suspended sediments account for almost all sediment yield. In this small headwater catchment, suspended sediments were found to contribute less than 10 percent to the total annual sediment yield.
Low flow

Lowest stream flows occur during the summer and winter. Recession flow constants vary between 0.87 and 0.99. This means that in the lowest flow periods the stream flow would halve in about 70 days. The rainfall study showed that rain falls about every 7th to 8th day.

The implications of this understanding for land management

Land management for water yield

Our attitudes of the influences of land management on water yield derive from North American experience. However, there are marked differences between North America and the Torlesse Stream catchment. It is difficult to conceive of any high country management practice which could significantly alter water yields in the order of 80 percent to 90 percent of precipitation. Water yield was found to be heavily dependent upon precipitation. Therefore minor variations in yield due to vegetation and management can be expected to be masked by the more dominant variations in rainfall.

Land management for low flow regulation

The impact of land management on low flows will be greatest in catchments which have thin soils overlying bedrock of low hydraulic conductivity. Although the soils of the Torlesse catchment are frequently shallow, the scree deposits are believed to be deep and primarily responsible for sustaining low flows.

Land management for flood control

The impact of land management on floods was once a lively topic of debate but it is now generally recognised to be greatest in small catchments and in small storms. In addition to these constraints an understanding of the partial contributing area concept allows probable responses to be more clearly stated.

The concept postulates that a catchment can be divided into hydrologically active and passive zones and that run-off is generated from a relatively small active zone. For flood flows I postulate that the active zone is
the stream channel and adjacent riparian land. The impact of land management on floods will therefore depend on the changes brought about in the hydrologically active zone. For example, practices such as roading which increase a catchment's drainage density are liable to produce significant increases in flood flow although they only disturb a very small proportion of the catchment's surface. On the other hand, practices such as afforestation of eroded land in the hydrologically passive zone can be expected to have no influence on flood flows.

Land management for sediment control
It has been implicitly assumed and sometimes explicitly stated that a reduction in stream sediment yields should be an objective of high country land management. However, four findings call to question the validity of this objective in at least the Torlesse Stream catchment.

1. Sediment yields were found to be less than historic or long term rates and were amongst the lowest recorded values for mountain catchments.

2. Major floods were found to dominate long term sediment yields. Management practices such as the rehabilitation of eroded land will be less effective under these conditions than in smaller or more moderate events.

3. There has been a popular view which assumes that the spectacular scree fields contribute sediment directly to stream channels. However, in the Torlesse Stream catchment the scree fields were found to be coarse textured and stable. Of this 385 hectare basin only 0.5 hectares contributed bedload sediments to the stream over the five year study period. These sites were found to be finely shattered exposures of bedrock which would be difficult, if not impossible, to rehabilitate. Nevertheless this study has shown that the majority of stream sediments could be denied access to the stream system if treatment of less than 0.1 percent of the total catchment could be effected.

4. Such treatment may not, however, reduce stream sediments. It was found that in the absence of adequate sediment loads the streams tended to cut down and derive sediments from their own beds. Where such downcutting produces over-steepened banks there is an increased risk of riparian slope failure and a new supply of sediment to the stream channel.
Sources of stream flow
Observations made during a storm in 1972 led to studies which have altered our understanding of the hydrologic responses of this catchment to rainfall. In that storm 135 mm of rain fell in 36 hours. However, water which was poured by hand on to an eroded subsoil was observed to soak directly into it. This experience confirmed the findings of many hydrologists, that overland flow can be a rare phenomenon in mountain soils. An infiltration study showed that infiltration rates varied with the degree of surface cover depletion, but the lowest recorded values were still in excess of almost all rainfall intensities. This finding raised the question that if overland flow did not exist by what mechanism were floods generated. A partial contributing area study assessed stream channels and the adjacent riparian land as more important source areas of flood flow than has generally been recognised. That study also showed that some erosion features are associated with bedrock which is close to the catchment's surface. This finding led to the conclusion that from a hydrologic point of view vegetation is important on sites where water emerges from the soil. It is less important on sites where water enters the soil.

Water Yield
From rainfall and stream flow records it has been possible to estimate the proportion of catchment rainfall which is yielded as stream flow. That study has shown:

1. That between 80 percent and 90 percent of catchment precipitation is returned as water yield.
2. From published North American data land management influences on water yield have been recorded where 10 percent to 60 percent of precipitation is yielded as stream flow.
3. Preliminary results from three other South Island catchments suggest land management for water yield might be more realistic in areas other than the Torlesse Stream catchment.
Management for sediment control should be put into effect only when the implications of such management are understood. Sediment transport is a natural river function. Management schemes which alter this function may induce downstream instability and create a more serious problem than they attempted to control.
REFERENCES


DISCUSSION

What are the finest sediments that you measured? Are you measuring soil or stream sediments?

Dr Hayward:

We measured both suspended and bedload sediments. While soil particles may give a stream spectacular colour, I suspect that their total mass is quite small. The vortex tube trap measures only bedload. The suspended fraction was sampled with a DH 48 suspended sediment sampler. The suspended sediments were found to account for only about ten per cent of the total sediment yield. In lowland rivers suspended sediments are the dominant sediment form, but they become progressively less important in small headwater catchments. Most bedload were within the size range of one to three centimetres.

What is the proportion of suspended sediment in downstream rivers and where does this come from?

Dr Hayward:

In the lower reaches it is probable that 80 per cent to 90 per cent of the total sediment is in suspension. I believe that almost all of that material comes from the grinding and pounding of debris in the stream channel. In the upper catchment the relatively unimportant suspended sediment fraction probably comes from the rapid breakdown of softer rocks and from direct soil erosion. For many years we believed that if we could deny suspended sediments access to a stream channel we could reduce downstream suspended sediment yields. Our observations of downstream channels convince us that they are important source areas for suspended material.
Therefore, although rehabilitation may reduce suspended sediment concentra-
tions in upstream channels, this affect will become progressively lessened
with distance downstream. We believe that it is the channel itself which
becomes the dominant source area for suspended sediments.

Can the results from the Torlesse area be applied to other areas?

Dr Hayward:
I don't know. I would be cautious in applying our results anywhere
other than in the Torlesse stream catchment. I think that they probably also
have application to the Eastern Canterbury hill and high country. I believe,
however, that the principles have a very much wider application.

Cuff's survey of the Upper Ashburton River shows the areas which are
contributing sediment to the stream channel. It also proposes corrective
action to prevent aggradation of that river. Will this work be successful
in reducing stream sediment yields and rates of aggradation?

Dr Hayward:
That depends on where you want your response. If you want a response
in the coastal reaches of the river, then I believe that you will probably
be disappointed in the results from rehabilitation of mountain sites. If,
on the other hand, you want a response immediately downstream from a treated
area, then I think there is a fair chance that you will see a marked improve-
ment. However, the solution to one problem may be the cause of another.
If you deny sediments access to a stream channel and if, on consequence, the
channel begins to degrade, you may increase the risk of failure of bridge
abutments, flood protection works and the like. For stability, channels
must be allowed to transport their natural sediment loads. If we reduce the
natural sediment loads by conservation treatment or gravel extraction for
commercial purposes, we can expect a new series of problems.

_How important is time in studies such as yours? For example, had you commenced studies in 1956 you would have had a spectacular storm in 1957. Would a period longer than five years alter your results?_

Dr Hayward:

Low frequency events certainly dominate long-term sediment yields. We were lucky with our study in that we had a large number of small events before we got a very big one. If this had been the other way round I think we would have been very confused. The problem would have been that a large event in, say, the first year of study, would have swept all sediments from the catchment and for perhaps the next two to three years there would have been little sediment left to measure. It might have been a frustrating and unrewarding study. As it was, things worked out pretty well. In the five year study period most of our storms were manageable. However, in 1978 a major event delivered nearly twice as much sediment in a few days as we had recorded in the preceding five years. Sediment yields in the five year study period are an order of magnitude less than what we estimate long-term sediment yields to be. The 1978 storm suggests that if we extended the study to include a greater number of low-frequency events, then contemporary sediment yields might be in about the same order as long-term or natural rates. We believe that the system we have observed is behaving in about the same way as it has for a long, long while.

_Have you compared your results with other areas, for example, the Ruahine Ranges?_

Dr Hayward:

Yes. Sediment yields from the Ruahines are perhaps a hundred times
greater than yields from the Torlesse stream catchment. This in itself is not a problem, for the Ruahine streams are for the most part about a hundred times more effective in coping with sediments than are rivers like the Kowhai. Problems occur when you try and match a river such as the Kowhai with a mountain system such as the Ruahines. We have come to understand that a mountain and its river are part of one system and that so long as the system remains balanced the absolute amount of sediment being discharged is relatively unimportant. It is imbalances in sediment supply and transport which are more important than the differences between systems.

Are you suggesting that we should not maintain or improve the density of vegetation on our mountain slopes?

Dr Hayward:

No. I believe that we must both improve and maintain the quality of vegetation. Our studies quite clearly show that where erosion exposes shattered underlying bedrock, a new cycle of erosion is initiated which is impossible to arrest. It is important that we do not initiate new cycles of erosion. Therefore we must be concerned to maintain the existing cover. Further to that I believe that we should improve cover, but for productive reasons. It was commonly held that our mountain systems were fragile. Our studies would suggest that they are somewhat more robust than we had at one time thought. Therefore I believe we can look afresh at questions of production from mountain lands.
"REGIONAL RESOURCE PLANNING"

THE PROCESS OF SELECTING OBJECTIVES

M. DOUGLASS*

Synopsis

The view that Catchment or Regional Management Plans would assist in clarifying water and soil objectives and lead to more efficient Catchment practices, river control and land management has been around for some time. The difficulties of interpreting these respectable ideas are much greater than might be at first imagined. These difficulties have led to apprehension and at times resistance to the introduction of such planning measures.

What follows is a summary of the application of regional planning techniques to the preparation of a Water and Soil Regional Management Plan (WSRMP) for the Waitaki River Catchment. Several quotations are included to give more detailed background for those directly involved in this type of work.

1. PLANNING CONFIDENCE

1.1 Legislation

The skills and experience associated with catchment management are being developed with experience gained over many years but somewhat cautiously. The physical knowledge on catchment behaviour began with a prime concern for the control of water and prevention of needless flooding. While soil conservation was included in the 1941 Act its

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prime thrust was towards the protection of property from damage by floods.

The short title of the 1967 Act was introduced the additional need for the establishment of a national policy making provision for conservation, allocation, use and quality of natural water and for the promotion of soil conservation and the controlling of multiple uses of water for primary and secondary industry. In water statutes N.Z. Legislature has generally taken advantage of overseas forward thinking and patterns of experience. New Zealand is fortunate in having had legislation which was generally ahead of the ability of the community to perform in these areas. The current review of legislation is largely to ensure a smoother institutional pattern of responsibilities that will encourage more effective implementation of these broader policy matters.

1.2 Movement toward planning

The catchment movement during the first 30 years of its existence has relied heavily on intuition and personal assessment of the obvious needs and urgent actions which have been required. As it moves into the 1980s and many of the more obvious problem areas have been tamed, it becomes necessary to have a more rigorous and rational approach to selecting policies and implementing plans which will bring greatest short and long run benefits.

Effective planning should bring with it greater confidence and a more purposeful application of resources including human effort and investment. It does involve, however, eliminating matters of less importance and emphasizing key issues. This selection process is painful and may not emerge from the convenience of agreement by consensus.

The selection of objectives will remove some options. To some this will be seen as a loss of flexibility. It should be remembered, however, that complete flexibility probably reflects great uncertainty.
Planning confidence is reflected by the ability of an organization or group of individuals to move to a position of relative certainty. The knowledge that the policies which have been selected are relevant to the problems in the region, and that their priorities are correctly ranked both to meet the problems of the area, and have some chance of successful implementation.

1.3 Regional management planning

In several areas of the country, different agencies and groups have been addressing themselves to these issues. In the Waikato, the joint Scheme prepared by the seven councils in the region relied heavily on the Waikato Valley Authority interpretation of land use inventory and other information.

The attempts to save the East Coast from excessive erosion through a universal acceptance of the objectives of afforestation is another example. Work in the upper Waitemata Harbour Catchment brings these water and soil regional management plans into closer contact with a variety of urban issues.

We have been addressing ourselves to the situation in the Waitaki Catchment, commencing with the Lower Waitaki and subsequently extending the work throughout the MacKenzie Country area.

The greatest obstacle to development of WSRMP's is the lack of confidence in planning and the apprehension shared by a large proportion of the participants to expose their judgements and experience in a rational way to the implications of a public planning process.
2. **THE LOWER WAITAKI RESOURCE STUDY**

2.1 Preliminary studies

During 1978, the opportunity was taken to bring the accumulated knowledge of the Waitaki Catchment Commission together in a lengthy report which was seen as a Preliminary Resource Study of the Lower Waitaki river.

A. Terms of reference

At a meeting of the Waitaki Catchment Commission held on 4 April, the general brief for this study was approved. The report is a summary of the water and soil resources and the objectives of an Outline Management Plan for the Lower Waitaki and Hakataramea.

The purpose of the study is briefly to:-

(i) Formulate objectives and prepare a summary statement on appropriate uses of the water and soil resources.

(ii) To include a summary of the present pattern of activities and foreseeable changes consequent on the combination of events including power development, improving use of the land and recreational activities associated with the Waitaki River.

(iii) The study is confined to the area east of the Waitaki dam and is intended as a preliminary statement of the issues involved, leading to recommendations as to future investigations and actions required.

At a meeting on 5 April, representatives of the Mackenzie, Waitaki and Waimate Counties were acquainted with the intentions of the study and general agreement was reached as to its Terms of Reference and the necessary assistance that would be required. Some doubts were expressed as to the short
time allowed for completion of the study and the Counties also reserved their position to comment independently on the Report when completed.

B. Role of study

The study considers the range of objectives and consequent working policies which might be available to the Waitaki Catchment Commission in its influence on management and development of the Lower Waitaki River Catchment.

The Outline Management Objectives do not supersede the planning functions of the territorial local authorities within the Catchment District. They are confined to issues of soil and water use and conservation in the area and provide basic information in these respects.

Issues such as urban development, population trends, settlement patterns and tourism are not of prime concern in the study. However, in so far as the water and soil factors are affected by or affect these activities, they must of course be considered concurrently.

The study and objectives included here could form part of a future Regional Planning Scheme. While not being comprehensive as a basis for regional planning, many of these catchment objectives are a pre-requisite to successful regional development and any Regional Planning Scheme for the area.

C. Preparation of report

The Report has emerged through a logical process of sorting information held by the Waitaki Catchment Commission. A lengthy process of discussion then followed with many individuals and agencies during the period when the Objectives and Working Policies were being prepared.
Consideration has been given to the guidelines suggested by the National Water and Soil Organisation and other references on Catchment Management Planning.

This study does not result in a group of specific proposals for control or development in the Lower Waitaki. It provides the intermediate step, however, between the purposes of Water and Soil Conservation as set out in national legislation and the practical working policies necessary to their implementation.

The study provides a link in the chain of thought from the general to the particular and from theory to practice. It comes at a time when isolated and random works and activities are no longer adequate as a means of the Catchment's management. It re-states the Commission's Objectives in a comprehensive way suited to the multiple use of the water and soil resource and exposes them for open discussion amongst the multitude of interested parties.

D. Contents of report

Section 1 of the Report establishes the statutory responsibilities and general guidelines.

Section 2 describes the general situation in the whole Catchment and the present policies of the Commission.

Section 3 summarizes the equivalent situation in the lower Catchment and present proposals that will bring changes in the future.

Section 4 describes the role of the Commission and its relationship to other organisations.

Section 5 sets out the Objectives and Working Policies against which future proposals in the Catchment can be considered.
Section 6 identifies the major issues facing the Catchment and recommends areas for future investigation.

E. Distribution of report

The Commission proposes to adopt the Report for distribution to all interested departments, agencies, organisations and individuals seeking comment and submission. By this process, it will then be possible to gain support for and critical comment on the Objectives and Working Policies with a view to their refinement and subsequent confirmation.

2.2 Relationship to other organisations

The Report emphasized that the Commission is only one of several agencies contributing to the management and planning of the Catchment. While it is an agency with statutory responsibilities, it is possible to identify three major areas of contact:-

(i) It reflects the national water and soil conservation responsibilities delegated from the National Council.

(ii) It has close affinity with the other local authorities in the area, and has opportunity both formally and by way of discussion to influence activities in the Catchment.

(iii) A major part of its endeavours have been related to an advisory role on soil and water management matters, largely at an informal and at a property level.

It is apparent that all these activities are important, and most of them result in fruitful and useful improvements. However, without any system of ranking of relative priorities and importance, it is possible for an agency such as the Catchment Commission, to fill its year with what might be considered a useful programme of work and contact, and not actually make any
significant movement towards the achievement of any long-term objectives.

2.3 Definition of objectives and policies

For the purpose of this Lower Waitaki Study, the definitions that follow in the extract from the Report have been used. There seems no reason, at present, to amend the general pattern, and these are also being used in the preparation of the Management Plan for the whole Catchment.

2.4 General and Specific Objectives

In summary, the General and Specific Objectives are as set out in the quotations from Pages 85 to 87 from the Report. These in turn are complemented by Working Policies which can be regarded as the administrative working out of the objectives into practical standing orders for use by personnel both in the office and in the field.

2.5 Integration of Objectives

The Preliminary Resource Study also laid considerable stress on the need to balance the objectives and the need to integrate them and select them by a process of open discussion and feedback from parallel agencies.

5.0 LOWER CATCHMENT OBJECTIVES AND POLICIES

5.1 Definitions

In this study, a "GENERAL OBJECTIVE" is a goal which remains constant over time. The general objectives have evolved over many years and may be considered as the goals generally accepted by the community and reinforced by legislation.
"SPECIFIC OBJECTIVES" indicate in more detail the Catchment Commission's interpretation of its resulting responsibilities.

"WORKING POLICIES" are guidelines for achievement indicating ways in which the Commission and all other agencies can, through their administrative, technical control and construction activities, implement the objectives.

The underlying philosophy is to encourage the attainment of multiple objectives and uses in the Catchment. These objectives and working policies must be ranked and reconciled in any management or resource development programme.

Throughout the objectives and working policies, the stance on implementation varies depending on the Commission's role, i.e. whether it is mandatory, advisory or simply assistance and encouragement.

Where the words "ensure" or "require" are used, the Commission has statutory powers to exercise control or implementation.

Words such as "undertake", "design", "construct" and "identify" indicate that the Commission has statutory discretion and an active roll in implementation.

Where the word "assist" occurs, the Commission has established an advisory or consultant role which has become accepted by other agencies.

The word "encourage" is used to indicate concern and, if requested, an opinion that can assist in the formulation of regional planning decisions.
For convenience, the objectives have been grouped:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Commission responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Water and Soil Conservation</td>
<td>Statutory Discretion, Advisory</td>
</tr>
<tr>
<td>2. Flood Control Works</td>
<td>Statutory Discretion, Advisory</td>
</tr>
<tr>
<td>3. Water Quantity Management</td>
<td>Allocation, Statutory Control</td>
</tr>
<tr>
<td>4. Water Quality Management</td>
<td>Classifying, Statutory Control</td>
</tr>
<tr>
<td>5. Land-use Potential</td>
<td>Advisory, Assistance</td>
</tr>
<tr>
<td>6. General Catchment Planning</td>
<td>Assistance Only.</td>
</tr>
</tbody>
</table>

The general and specific objectives are included in Section 5.3 and are repeated with the more detailed working policies in Appendix 4.

5.3 General and specific objectives

The following General and Specific Objectives have emerged. In addition, there are Working Policies which are included in Appendix 4.

1.0 Water and Soil conservation objective

To promote the conservation of water and soil in the Catchment.

Specific objectives

1.1 To ensure land management practices consistent with land-use capability and which result in soil protection and a minimum of degradation and loss of the soil mantle.

1.2 To ensure that the vegetative cover is, as far as possible, preserved and land-uses are developed that retain and conserve the water resource so that the Catchment gains increased water retention, sustained dry weather flow, enhanced productivity, reduced damage by flooding and more modest flood control.
measures.

1.3 To assist in identifying the interaction of soil quality, land-use, water yield, local climate, irrigation potential and location within the Catchment in order to encourage the formulation of optimum plans for land-use and catchment development.

2.0 Flood control works objective

To prevent damage from flooding and ensure that flood control schemes are comprehensive and appropriate for each part of the Catchment.

Specific objectives

2.1 To ensure the lands abutting rivers and streams are protected from erosion, flooding and high ground-water levels resulting from peak flows and seasonal flow characteristics in the river and its tributaries.

2.2 To undertake works and river training activities to a comprehensive plan for each of the tributaries and the Lower Waitaki River that secures steadily improved flood protection and control.

2.3 To ensure, as far as practicable, that the design and planning of flood control measures are compatible with the wildlife and recreational potential of the river-beds and the productivity of adjacent farmlands.
3.0 Water quantity management objective

To ensure that the existing and future demands for water in all parts of the catchment are identified and to achieve a balanced policy of water allocation.

Specific objectives

3.1 To ensure that water allocation recognizes the multiple objectives for its use including the national, regional and local demands, and these are assessed at regular intervals in the context of the Commission's objectives.

3.2 To provide adequate water for the existing and future needs of rural and urban residents, stock and fire fighting requirements.

3.3 To ensure that water for irrigation receives high priority and in those rural areas having a potential for both large communal and small private irrigation proposals, encourage the establishment of new and expansion of existing irrigation schemes.

3.4 To ensure that in allocating water for power generation, due regard is paid to the full social/economic costs and benefits from competing water demands and appropriate weight is given to balancing all aspects, including those benefits that cannot be measured in economic terms.

3.5 To encourage the establishment of farm-fishery for salmon and, as the opportunity permits, for trout having regard to the potential social/economic costs and benefits from this use of
the river waters.

3.6 To encourage a recreation system taking full advantage of the water areas and water resources of the Lower Waitaki and its tributaries consistent with the allocation of water for domestic, fire, stock irrigation and power purposes.

4.0 **Water quality management objective**

To sustain the highest practicable water quality in all parts of the catchment.

**SPECIFIC OBJECTIVES**

4.1 To ensure that all water bodies are maintained in a condition suited to the life systems they support and the aesthetic qualities they possess and avoid any needless significant deterioration in the quality of receiving waters.

4.2 To ensure that at all times desirable water management and control practices are pursued so that the quality of the total water system in the Catchment is sustained free from any needless deterioration.

4.3 To encourage a pattern of land-uses, activities and management practices which takes into account the desirable quality of receiving waters.

5.0 **Land-use potential objective**

To encourage an increase in the productive use of land
consistent with protection of the soil resource and conservation practices.

SPECIFIC OBJECTIVES

5.1 To assist in achieving the potential for and the continuance of arable and pastoral activities in all those areas where these land-users are most appropriately located.

5.2 To encourage the establishment of shelter belts and selected planting and the establishment, where appropriate, of productive forestry consistent with other soil, water, recreation and wildlife objectives.

5.3 To encourage the development of multiple use of land in those areas where supplementary activities are appropriate alongside traditional arable and pastoral uses.

3. SUBMISSIONS ON THE LOWER WAITAKI STUDY

3.1 Period for submission

The report was adopted on 14 August, 1978 and the Commission allowed six months for submissions to be received until 23 February 1979. From the 450 copies distributed, about 50 submissions were received. It was disappointing that while many commented on the descriptive sections of the Report, few addressed the objectives contained in Chapters 4, 5 and 6 as outlined in Section 2 above. The establishment of objectives was, of course, the purpose of this exercise.

3.2 Next steps

In a Report called "Comments Report", covering the submissions received addressed to the Commission in March 1979. The extract that follows
Figure 1

STEPS IN PREPARATION OF WATER AND SOIL MANAGEMENT PLANS

This Report

GENERAL OBJECTIVES

SPECIFIC OBJECTIVES

DEFINITION OF FUNCTIONAL AREAS

APPLICATION OF FUNCTIONAL AREAS

WORKING AREAS

POLICIES TO TOPICS

PROPOSALS OF THE COMMISSION, GOVERNMENT, OTHER AGENCIES AND INDIVIDUALS ARE ASSESSED AGAINST THE OBJECTIVES AND WORKING POLICIES AND IF NECESSARY MODIFICATIONS MADE PRIOR TO THEIR APPROVAL OR IMPLEMENTATION

IDEAS FLOW -- FROM OBJECTIVES TO IMPLEMENTATION

Periodic Review

Specific Commission Reports

STEP 1

STEP 2

STEP 3

STEP 4
summarizes the next steps and also re-interprets the necessary steps to be
taken in the preparation of a Water and Soil Regional Management Plan.
This is also illustrated in Figure 1.

3.3. Our own criticisms

The chief criticism we have of our Report is its undue emphasis on the
descriptive aspect of the Catchment (72 pages) in contrast with the
section dealing with objectives (15 pages). Asked to do the task again, we
would make the descriptive sections a supporting report or appendix, and
concentrate on the OBJECTIVES and setting out an adequate reasoning for them
at the beginning of the Report.

Another criticism was that the objectives tended to cover the whole
catchment, but were arbitrarily applied only to issues in the Lower
Catchment. By the same token, the emphasis on working policies would vary
in different parts of the Catchment and in different functional areas of
catchment activity.

The Commission is sensitive to this criticism and as a result, a Water
and Soil Management Plan for the whole Catchment, including both Upper and
Lower segments, is now in hand. This will lay greater stress on the
application of working policies to specific functional areas of concern.

2.0 Next steps

2.1. As a result of the submissions, corrections have been made to the
descriptive part of the text, and some objectives and working policies
have been adjusted. The adjusted objectives and working policies and
corrections which change meaning substantially, are attached to this Report.
(Attachment 1,) (Corrections to spelling, other facts and figures have been
made into an Errata sheet which can be obtained from the Commission).
2.2. It must be stressed that the Report is a preliminary resource study only. Initial objectives and working policies have been formulated. The submissions have not revealed any major deficiencies in the matters covered. Many of the questions raised relate more to the application of the objectives and policies; in particular, how these would affect other departments and agencies, or specific areas of the catchment.

2.3 The making of a water and soil resource management plan is best seen in four steps:

**Step 1: Preliminary Resource Study and Statement of Objectives**

The Preliminary Resource Study outlines the objectives and working policies for the whole catchment. (To be complete, a similarly preliminary resource study must now be done for the Upper Waitaki. Many of the objectives and working policies will be the same as those for the lower catchment).

**Step 2: Definition of Functional Areas**

This next stage will examine critical issues and likely areas where changes may occur or, by policy, should be encouraged. This functional subdivision of the catchment will enable the selection of priorities and working policies for the specific areas. In the Waitaki, examples of such subdivision are, amongst others,

- the high country of the Mackenzie,
- the major productive valleys and fans that could be irrigated,
- the Ahuriri Valley,
- high country retirement areas,
- the Maerewhenua downlands,
- the lower plains,
- the riparian lands (river bed) of the Lower Waitaki, and
- the lakes and recreation areas
These functional subdivisions are drawn so that the objectives and working policies outlined in the Preliminary Resource Study can be applied in practice and in a meaningful way.

**Step 3: Functional Area Working Policies and Management Plans**

The third stage is the preparation and implementation of detailed management plans for conserving the resources and development proposals in the functional subdivisions. While lying within the total resource objectives, these area management plans give a positive programme of control (policies and limitations) and management (development programmes, flood control, soil improvement etc).

**Step 4: Review**

The review of objectives, functional areas and management policies in the light of the success and effectiveness of their application must be undertaken at regular intervals, say five years. At this time, objectives may, if the need is shown, be adjusted. Through the review process, working policies can be refined and programmes of investigation, control, management and works reassessed in the light of performance and experience.

**Step 5: Specific Reports:**

The preparation of specific reports on management plans, works proposals, advice and submissions to water allocation plans. These specific reports are, and always have been, part of the regular technical and administrative work of all Catchment Authorities. However, in future their basis and their recommendations will have to be shown to fall within the agreed catchment objectives and working policies.
2.4 The next step is, therefore, to establish the functional areas and determine appropriate working policies and management proposals. In the context of the Lower Waitaki, these will include:-

(i) Flood control within the Lower Waitaki river-bed and adjacent terraces.

(ii) The uses and future administration of the riparian or river-bed lands.

(iii) Assessment of water availability and allocation.

(iv) Water harvesting and irrigation for the Hakateramea.

3.4 Assessment of proposals

Section 6 dealing with the major issues had, of necessity, to come at the end of the Report. Until that stage it was not possible to rationalize our judgements on such matters as:-

- irrigation extensions,
- intensive agricultural production,
- fish farming,
- Lower Waitaki Power Development,
- minerals and quarrying,
- multi-purpose use of river-bed lands,
- additional recreation, and
- Council's Town Planning Scheme

This assessment of the major issues against the objectives, provided an opportunity to test in a robust and working situation, the validity of selecting objectives and policies in a Catchment situation.
Figure 2

WATER AND SOIL REGIONAL MANAGEMENT PLANS?
DIFFERENT PEOPLE DIFFERENT VIEWS!

- Government
- Catchment Members
- Engineers
- Local Authorities
- Other Politicians
- The NWASCO Organisation
- Soil Conservators
- Farmers
4. Attitudinal Hurdles

4.1 Different people, different views

The number of times water and soil objectives and Catchment management plans have been renamed and redefined, clearly indicates that there is still little agreement as to the form, significance or consequences of regional management planning.

Taking the concept diagram already described, it is possible (somewhat facetiously), to identify several different attitudes depending upon the institution or group which is involved.

Figure 2 is an attempt to indicate the areas where there is confidence and uncertainty for eight of the more significant roles in the 'cast' of decision-making participants.

4.2 The need for statutory recognition

Until such time as the Water and Soil Legislation requires that appropriate Regional Management Plans be prepared, this lack of a concerted view is likely to continue. I am not one who supports the view that the water and soil management plan should be of the same detail as the ordinances and maps of council district schemes. It is necessary, however, for the objectives and policies which might be embraced within a WSRMP to go through some recognized process of -

- proposal or recommendation,
- their criticism and amendment, and then
- adoption and subsequent review

This process must involve all public agencies affected, and should also be open to members of the public. Once the objectives have been refined by the catchment authority for the area, they could possibly be confirmed by the
National Council as the basis for inclusion in the Regional Scheme under the Town and Country Planning Act, 1977.

4.3 Relationship to Regional and District Schemes

By the same token, I do not consider that the Regional Scheme should embody specific detailed provisions that might have to be administered either by the Catchment Authority. Once the general principles have been adopted by the Catchment Authority, included in the Regional Scheme, then it would seem that implementation would follow in the following manner:-

(a) Through the zoning provisions of District Scheme which are made compatible with the regional policies, the local authorities will automatically be involved in administering some of the broad land use working policies.

(b) Parallel with the zoning provisions, the Catchment Authority will be involved in making submissions from time to time to the councils in respect of changes to the District Scheme and by way of evidence at the hearing of applications made by individual owners and developers.

(c) Parallel with these District Scheme land use operations, the Catchment Authorities will naturally be involved in administering their statutory requirements under the Act, introducing complementary bylaws to control the management of land at a detailed level appropriate to that legislation.

(d) The Catchment Authorities will also, of course, be undertaking their own investigation and works which have now become a well-established part of Catchment operations and planning.
5. CONCLUSIONS

Within a period of one year, the Waitaki Catchment Commission has explored the possibility of the selection of objectives for catchment planning purposes.

The exercise may appear to some to be somewhat hypothetical. For those directly involved it may be an additional task added to an already overcrowded day. However, without such "sorting of priorities" their days will always be overcrowded, perhaps with unimportant trivia.

I believe that attitudes are changing and through a sympathetic and helpful approach, it is possible for planners and applied scientists to help the existing and established Catchment Authorities over the planning hurdle into a more productive and worthwhile era of catchment work in the 1980's

Copies of "Lower Waitaki Preliminary Resource Study" are available from Tussock Grasslands and Mountain Lands Institute or the Waitaki Catchment Commission, Kurow.
Mr Knowles:
Mr Douglass dealt very succinctly with the finer points and ramifications of WSRMPs. One definition of a WSRMP (Water and Soil Resource Management Plan) is a long-range guideline statement prepared by a catchment authority to facilitate the most effective future management of land and water resources, allowing the authority to demonstrate its knowledge and expertise in the specific fields over which it enjoys statutory responsibility for administration. When the proposal for legislative backing for WSRMP was first put forward, the national organisation declined to support the concept of legislative backing, believing that there was adequate opportunity for comment and participation by voluntary means. Mr Douglass has explained the structure of a WSRMP quite clearly, and I think that no further comment is necessary, other than to say that it seems to be an assessment of the total actual and potential uses of the soil and water resources of a region, the risks and consequences of maximum utilisation, and a combination of management policies necessary to secure long-term use and development of these resources.

Our organisation is interested in soil erosion, bearing in mind the fact that the soil layer is relatively thin. The screes, larger forms of historical erosion, are of lesser interest and one would venture to suggest that these should not have attracted the degree of attention they may have received in the past. They do, however, play a major role as a sediment source.

The increasing demands on our land and water resources from both the urban and rural sectors have reached the stage where the best use and full potential of these resources cannot be realised without a properly coordinated long-range plan. There are many examples of a decline in quality and the increasingly wasteful use of resources. WSRMPS are designed to overcome these particular problems. There are adequate ways in which these objectives can be enforced. Existing water and soil legislation is quite powerful in
its own right. However, if proper coordination and adequate joint management of these resources is to be obtained, cooperation and understanding will be vital. Consequently, the national organisation has opted for a cooperative approach.

There is a particular advantage in providing a broad water and soil management policy in a regional planning scheme, with the opportunity this affords for public consultation and, if necessary, objection and appeal. At the same time, other matters can be discussed. We are hopeful that resource management plans, on the district scheme/town planning level, can form an integral part of the overall management of regional resources.

Mr K. Ackley:
I identify completely with the perspective Mr Douglass has presented to us and yet the enormity of the challenge of water and soil resources management plans raises some doubts. He has presented us with a view consisting of a physical side and a political side. Perhaps this is an over-simplification of the situation.

We have authorities who tell us with complete confidence that we can model the universe, and engage in rigorous and comprehensive planning. I think an ecologist would not go quite so far. He would argue that we may attempt to model the universe in a useful way by extracting the most important details, if we can identify them, and in that way construct a much more simple model that we can still understand and utilise in trying to make decisions about land use and all its related problems and possibilities.

On the other hand, there are those experts who look at the political picture. Some say that it is impossible to model the universe. Of course, they are looking essentially at the political universe and saying such things as - "We can't possibly be comprehensive because we don't have the mental capacity", or "we can't specify objectives because we don't know what we can get and we don't know what we want" and implying that we can't be systematic and must stumble from decision to decision. We make disjointed and incremental decisions, and therefore reach a state of
political compromise, a source of dissatisfaction to all concerned. The problem and the enormity of the challenge is therefore to ascertain how we can bring these two models together and achieve some degree of comprehensiveness in our planning. I don't think that there is any future in adhering to the stumbling crisis-oriented problem-solving approach as opposed to a much more systematic approach. It is the only choice available to us. Systems are very much in vogue, while common-sense and intuition are not, so it will be necessary to adopt the systematic approach and to adapt ourselves to it.

My concept of a WSRMP requires a double R. In my lexicon, 'regional' is not a dirty word; we can say Water and Soil Regional Resource Management Plan because we should be thinking on that scale. That does represent, in a nutshell, the difficulty for each of us as individuals to relate our own particular interests to the whole region.

There is another enormous problem; we will need to recognise, as we model the system, that we are going to have to consider very carefully how the various functional areas interact with each other. What happens upstream affects the areas downstream and what happens on a political level affects the physical level. All of the inter-relationships relating to coastal areas will have to be integrated if we are to achieve a comprehensive planning approach by determining our objectives and setting down policies for future action.

Mr Elworthy:
I have been sceptical about planning since the days of the National Development Council, which took part in particular planning with certain targets. These targets lost credibility because they were inflexible and could not be met. The planning process affects us, I think, in three areas:

1) The individual is affected by decisions.
2) The local elected, or appointed, authority is making decisions on a local basis (the territorial authorities and the regional development councils).
3) In the legislative realm, the main concern lies with the Local Government Act and the Town and Country Planning Act. As a result of this, the planning process is in a state of confusion.

The Waitaki Catchment Commission, the example under consideration, is surrounded by a variety of other organisations; the Mackenzie, Waitaki and Waimate Counties, with their District Schemes, lie on the north and south banks of the river. In some cases, five year District Schemes have been instituted. In others, no move has been made beyond the planning stage. The Waitaki Lakes Committee has no statutory rights, but certainly has some influence in the area of recreation planning.

On both sides of the river, water flows through the boundaries of the North Canterbury Catchment Board and the Otago Catchment Board. The Ministry of Works and Development and the Department of Lands are administrated on the north bank from Christchurch and on the south bank from Dunedin. There is a Regional Development Council on the north bank, the Southern Canterbury Regional Development Council, and on the south bank, the Otago Regional Development Council. There are plans to introduce a Regional Planning Scheme, and there are estimates from the Water and Soil Conservation organisations through the Capital Works Committee and Cabinet. In addition to this confused situation, the Public Works Act is under review; the most important aspect of this Act, in my view, is the right of the Crown to take land under certain conditions and with certain safeguards. The soil and water legislation is to be reviewed.

In the area of legislation, speakers have correctly said that the acceptance of objectives is crucial. In the case of the Waitaki, the task of legislating to resolve the conflicting interests of energy, conservation, irrigation and recreation seems almost impossible; it must be done by consultation and agreement. These four major conflicting interests illustrate the human side, the effect on the individual, in addition to the
effect on the local authority and the appointed authorities and the effort to integrate the activity at a local level with a national development scheme. We now have a Minister of National Development, with the task of coordinating on a national basis, setting national objectives and sending them down the line to have them implemented at grass roots level.

The formation of united councils by the second Local Government Commission will be finished by the end of this year. Having set the boundaries, the next logical move may be to ask not only united councils, or regional councils, to proceed with ten-year regional schemes which will bind the district schemes in each local authority, but also to require government to move departmental offices so that they coincide with the united councils' boundaries. Following this, the catchment commission could then be asked to rationalise the ad hoc organisations into those boundaries and possibly to take the next step and rationalise local authority boundaries as well. In 1896, primarily for reasons of efficiency, regional government was abandoned and central government took on legislative power. I believe that in 1979 and through the eighties we are going to move back to where we were in the 1970s. I would like to see united councils move into other areas of activity, apart from regional planning by agreement, and the law of the moment will allow individual authorities to opt out if they do not want to get into other activities beside regional planning and civil defence. Once we have those areas with the central government departments centralised, using common boundaries, there will be a greater degree of autonomy in decision-making in districts outside Wellington.

Mr Douglass:
I was rather horrified that you did not challenge the objectives in the general structure of the plan which I have been discussing because this is the interesting point. When we issued that book for comment, we received various comments about the fact that the rainfall was wrong in the Tara Hills and so on, but nobody commented on the basic structure of the objectives and working policies proposed. It is a new area where very few people have confidence to come clean and say ..."It is a lot of rot and it should
be turned upside down." There is no reaction like that at all, and it leaves terrible responsibilities for people like myself and Mr Knowles because we must hope that we are perpetuating a scheme which is a real thing; one that has a chance of survival in the face of unknown factors. I would insist that legislation require this operation to be carried out parallel with regional planning, but I don't think the exact requirements need to be set out by regulation.

As far as the confusion in the legislation is concerned, we know that it is in capable hands and we are sure that it will be sorted out in the long run.

Even with the greater simplification of boundaries, local authorities and art councils, and the rationalisation of legislation, this exercise must still be carried out. We hope it will be a little simpler in the future. It is just as important to know where the confusion is as it is to know where the simple relationships are and I agree with you entirely about the increasing rationalisation in order to achieve stronger regional decision-making. I hope that this sort of exercise is of some assistance in that on-going journey.

**Question**

Q I would like to challenge you on the statement that objectives derive from the legislation. I think that is the wrong way to look at objectives. Objectives, in fact, come up from vested and other interests. That is where we have to look for them. There will be conflicting objectives. All that legislation does is to try, in a very broad way, to capture some of these objectives.

Mr Douglass:

A I agree entirely. Naturally, I can be easily accused of oversimplifying these relationships in order to present a coherent story. Jonathan Elworthy raised the matter of reconciling the use of water in the Waitaki. It would not be done by legislation.
Nevertheless, the tenets of national concern should, if possible, reflect the kernel of the idea. National water and soil legislation demands that the kernel is enshrined there and requires us, as I said earlier, to put our gumboots on and get involved in the field. In the absence of that legislation, I think many agencies, certainly many sections of the community, would do nothing.

**Question**

Q Let us get to a thorny but fundamental problem - the Lower Waitaki. Is that river bed maintained as a river bed in some way, or is it abandoned as a river bed? Is it abandoned as a river bed and just used as an occasional flood? Your statement of objectives would probably be acceptable to a large number of residents of the Waitaki. There are 22 species of birds dependent on the Lower Waitaki river bed for their habitat. According to the Internal Affairs Survey, there were approximately 22,000 counted in three days reported in our Waitaki report. Now whose interests are those? I think that these are probably our grandchildren's interests. The decision that is made on the quality of the river bed is not, in fact, provided for in the objectives that you state. How do you reconcile (i) who you are working for, and (ii) whose interests you are to serve?

Mr Douglass:

A The working out of objectives and policies against proposals and design is an issue of balancing judgments, factors, planning, engineering, soil conservation and community consideration and awareness. Following this, we cover the aspects to which you referred. When these are written down and numbered, it is then possible to start looking at proposals and to start switching the numbers back again to the individual aspects of the proposal. In my discussions of power designs for the Lower Waitaki Scheme, for instance, I think we have introduced a group of restraints which are no less real now than the graded river and waterflow
were to those concerned when they began their power scheme. Because they know that they have a continuous canal and disregard some of the elements we are talking about means that objective number 5.3, working policy number 15.2 and all of the other written policies have to be refuted. There comes a point where even the project architect, with his single-minded judgment, has to acknowledge that he could not overturn matters. Until policies are written, however, he can over-turn everything. Once they are written down it is possible to go through the check-list and mark them off one at a time, identifying where the differences of opinion are. I did not describe the chart indicating our suggestions for the Lower Waitaki, which include a combination of lakes, weirs and canals and cover the ecological, fishery and other aspects.
POTENTIAL PASTURE PRODUCTION IN HILL AND HIGH COUNTRY

D. SCOTT*

1. Introduction
Land cannot always be simply classified as lowland, hill or high country, since many factors vary between regions or even within one farm. However, by considering three environmental gradients it is possible to show the similarities and differences between these areas.

This paper first described these gradients and how they may be recognised from topography, soil types and native vegetation. Following that, the associated trends of fertiliser requirements, pasture yields and seasonal variation are given, together with discussion of appropriate pasture species and the integration into farming systems.

2. Environmental Gradients
The three environmental gradients which are important are:

* Grasslands Division, DSIR, Lincoln.
(i) **Temperature**

The reduction of mean annual temperature with increasing altitude allows subdivision into low, hill and high country, with further subdivision of the high country into montane, sub-alpine and alpine. While farmers have no control of temperature, it is important to realise its significance in farming different regions.

(ii) **Soil Moisture Availability**

Sites can be compared by using annual rainfall and soil moisture characteristics. Except with irrigation, or to a limited extent with some management practices like fallowing, soil moisture is also a factor beyond farmer control.

(iii) **Soil Fertility**

This is the most easily managed factor, either by selection of appropriate sites with good natural soil fertility, or addition of legumes and fertilisers. As with temperature and moisture, there is a continuous gradient in soil fertility, but Figure 1 only shows the contrast between low, moderate and high fertility soils.

3. **Land units, soil types and native vegetation**

In any locality there will be a range of characteristic landforms, e.g. flats, fans, slopes, knobs, etc. Usually each of these occupies a unique section of the three environmental gradients, and because of this each type of site will have a different pasture potential and growth pattern. Landscape units can be further defined by soil type, with each soil spanning a smaller part of each environmental gradient. Figure 2 shows the approximate position on these gradients of a few soil types. These are for the soils in their natural state, and it will be noted that by the standards of agriculture very few would rate as
moderately fertile and none as highly fertile.

However, by fertiliser application their fertility rating can be changed, while retaining similar temperature and moisture characteristics.

The potential of particular soil types under various fertility levels is known from farming experience and trial work, and from their position on the environment gradients we can probably extrapolate to other soil types.
The influence of these environmental gradients can be illustrated by a description of the pre-European vegetation (Figure 3). In the natural state there were very few high fertility sites with associated plant communities, the nearest probably being the silver tussock and *Agropyron scabrum* communities of the drier high country, and the fuchsia shrublands of the low country.

On low to moderately fertile soils in the high country, fescue short tussock occurred on warm (low altitude) dry soils, but these grasslands have now been extensively modified or replaced. Snow tussocks occurred up to and above the timberline with *Chionochloa rigida* in drier soils and other species towards the wetter forest zone. The red tussock (*C. rubra*) of the wetter soils of some hill and lowlands has now been largely replaced by pasture. *Celmisia* herbfields occurred on the lowest temperature sites. The wettest sites were forested with podocarps on the warmer sites at lower altitudes, and beech forest at cooler temperatures at higher altitude. Shrublands formed the transition between forest and grasslands.

Most of the lowland pastures, particularly in the North Island, and in much of the wetter hill country, which are the basis of most New Zealand farming today, were once forest or shrublands with greater potential for plant growth because of warmer temperatures and moister soils. The general characteristics of the New Zealand native vegetation are slow growing perennial evergreen species, with often appreciable bulk but low annual increment, e.g. short tussock grassland with standing dry matter of 3-6 t DM/ha but annual increment of less than 1 t DM/ha.

4. Soil fertility and fertiliser requirements

Of the three environmental variables, soil fertility is the variable that can most easily be modified. As the native species are generally low yielding, and not very responsive to fertiliser, there is a need to introduce higher yielding species as fertility is increased. In the hill and high country the most deficient elements for plants are nitrogen, phosphorus and sulphur, with selenium and possibly iodine for animals.
In New Zealand, nitrogen deficiency is overcome by the introduction of clover and other legumes, together with associated rhizobia, and the application of phosphorus and sulphur, rather than by applying nitrogen fertiliser.

**Figure 4  Fertiliser Requirements**

<table>
<thead>
<tr>
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<th>P Initial (kg/ha)</th>
<th>P Maintenance</th>
<th>S</th>
<th>Mo</th>
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<tr>
<td>dry</td>
<td>100</td>
<td>30</td>
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<td>200-400</td>
<td>100</td>
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<td></td>
<td>600-2000</td>
<td>200</td>
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<tr>
<td>wet</td>
<td></td>
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<td>√</td>
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</tr>
</tbody>
</table>

The fertiliser requirements to change the original soils to high fertility soils vary with soil moisture status because of past and present soil development and leaching. For example, in the high country, phosphorus requirements vary from initial rates of 100 kg/ha superphosphate and annual maintenance rates of 30 kg/ha on brown grey earths, (BGE) through to 600-2000 kg/ha initial, and 200 kg/ha annual maintenance on podsolised yellow brown earths (Figure 4). Sulphur is more deficient than phosphorus on the brown grey earths. On wetter soils the sulphur requirement is probably satisfied by superphosphate application. Molybdenum is more deficient on the wetter leached soils. The temperature (altitudinal) influence on fertiliser requirements has not yet been established.

5. **Pasture Production**

From trial work on particular soil types and their position on the environmental gradients, it is possible to estimate the annual dry
matter productivity of a wide range of sites (Figure 5). These estimates are probably within twenty to thirty percent of the long term average, and are unlikely to depart by more than fifty percent. Figure 5 shows:

Figure 5 Annual Pasture Yields (t/DM/ha)

(i) That productivity from high fertility sites is about four to five times that of the equivalent lower fertility sites.

(ii) The marked decrease in productivity with the lower temperatures at higher altitudes.

(iii) The marked decrease in productivity at low soil moisture levels.

(iv) The productivity of the moist to wet sites is about two to three times that of equivalent dryland sites, and is the magnitude of the likely response to irrigation.

Most of the pasture plants are alike in that they can survive over the full range of the temperature, moisture and fertility conditions of areas likely to be used for agriculture and achieve at least fifty percent of the potential yield on most sites. In this sense, the difference between species is not as great as might be anticipated, e.g. between browntop or ryegrass in low and high fertility situations, or between pasture and forestry.
However, only one or a few species will realise the full potential of a site having a particular combination of temperature, moisture and fertility. Thus to farm close to the biological potential there must be consideration of the pasture species used. The environmental gradient approach incorporated in Figure 5, enables estimation of the potential productivity of all land units making up a particular farm.

Pasture growth rates vary during the year and Figure 6 shows the approximate pattern for lowland, hill and high country sites under both dry and moist conditions, and of a similar fertility level. Figure 6 illustrates that:

(i) With the decrease in temperatures associated with altitude there is a decrease in growth rates. This difference is probably greater between hill and high country than between lowland and hill country.
(ii) In particular, winter temperatures drop below the threshold for plant growth in the high country. Thus there is the possibility of pasture growth for all-grass farming in winter in the lowlands. This contrasts strongly with the three to five months period of no growth in the high country necessitating the use of conserved feed.

(iii) Lack of summer rain causes depression of growth rates in dry areas and there is also great year to year variability.

Variation in topography generally increases with altitude, with the consequent increase in variability of temperatures, moisture and pasture growth patterns.

6. Pasture Species

Figure 7 Species Range

While it was indicated earlier that most species can grow within a wide range of temperature, moisture and fertility conditions, each is probably only the better of alternatives
Figure 8 Pasture Species

LEGUMES

low fert.
- haresfoot
  - sweet clover
  - crown vetch
- subterranean

low fert. cold
- BIRDSFOOT
  - caucasian
- sweet clover
- LUCERNE
  - white
- subterranean

mod fert. warm
- sweet vernal
  - brown top
- bluegrass
- FOG
- danthonia
- COCKSFOOT
  - phalaris
- dogstail
- paspalum

grasses

mod fert. tall fescue
- phalaris
- COCKSFOOT
- TIMOTHY
- ANNUAL RYEGRASS

high fert.
- dry
- wet

HERBS

low fert.
- H. PRAEALTUM
  - Hypochaeris
  - Crepis
  - TARAXICUM

mod fert. h. pilosella
- chicory

high fert.
- dry
- wet
for a given management on one type of site. For example, Figure 7 contrasts browntop and perennial ryegrass under close grazing management. Browntop (horizontal hatching) is probably the most suitable grazing species on low fertility soils, in the mid moisture and temperature range, and to a lesser extent on moderate fertility soils. In other situations there are probably more productive alternatives - though where these are absent, browntop could fulfil a role on a greater range of sites (dashed line).

By contrast, perennial ryegrass (vertical hatching) is the most productive grass for high fertility soils, on all except the driest soils, but probably with an altitudinal limitation related to the frequency of frosting. Perennial ryegrass has a lesser role under moderate fertility conditions, although like browntop, would be used in a wide range of sites if there were no alternatives.

There is a range of possible pasture species and Figure 8 shows where each is the best alternative, although, like browntop and perennial ryegrass, this is broader than the space taken up by the wording on the diagram. A distinction is made between those suited to close grazing (lower case) compared with lax grazing and those suited for hay (in capitals) and between those currently available or adventive species (underlined) and those in an advanced stage of testing (others). While reasonable discrimination between species in terms of moisture and fertility tolerance can be made, the discrimination based on temperature is less accurate. Notes on the individual species are given in the appendix.

Clovers and other pasture legumes are mostly grown for their nitrogen-fixing ability, and in that context the associated rhizobium is as important as the host legume. Because there are no native clovers, both legumes and rhizobia have to be introduced. Thus in the development of hill and high country, rhizobium inoculation of seed should be carried out as a matter of course, with as much attention given to the selection of the most appropriate rhizobium strain as to the host legume cultivar. Legumes also
have an important feed quality value and this may be their chief use in intensive fertility situations, e.g. lamb fattening.

While most pasture legumes are perennial, introduced annual legumes fulfil a role in the drier regions. There are several new legumes which show potential for fulfilling a role in the low to moderate soil fertility range.

In contrast to low fertility situations, no new legumes are suggested for the high fertility soils. Improved nitrogen fixation and growth are more likely to be from selection and management of red, alsike and white clovers, and lucerne than from new species. Legumes are mostly spring and summer growers, with nitrogen fixation approximately proportional to growth. Thus pastures should be managed to let the legumes flourish.

Grasses are more cold tolerant or retain their food value under frost and can be used to overcome winter feed limitations in the hill and high country.

The number of adventive broadleaf herbs already present in the hill and high country indicates the suitability of the environment for these types of plants.

Finally, it must be re-emphasised that what Figure 8 attempts to show is not where a particular species is most productive (as this will generally be moist, warm, high fertility situations), but rather the approximate temperature, moisture and fertility conditions under which that species is more productive than alternatives. Also, due regard must be given to the specific attributes and management requirements of that species.

Some characteristics of pasture species, such as frost tolerance, are more important in the hill and high country environment than in the lowland. Some of these characteristics and the ranking of different species for some of those characteristics, follows:
(a) **Tolerance to low soil fertility** (Figure 8). Of the grasses, the native tussocks, browntop and sweet vernal are the most tolerant, followed by cocksfoot, Yorkshire fog, tall fescue, phalaris, timothy, bromes, and then the high fertility requiring ryegrass. Of the legumes, suckling is the least fertility demanding, then haresfoot, zig-zag, lupins, lotuses, alsike and red clovers, with the most fertility demanding being white clover and lucerne.

(b) **Frost tolerance and feeding value in relation to frosting** Grasses are more tolerant than legumes. Within the grasses, tall fescue and cocksfoot are the most tolerant, and Yorkshire fog the least.

(c) **Growth at low temperatures** Again grasses are better than legumes, with the best grasses being cereals, annual ryegrasses, bromes and timothy.

(d) **Palatability in the rank state** (as in autumn saved pasture or under conservative stocking). Legumes are generally more palatable than grasses, with clover being the most palatable, followed by red clover, lucerne, alsike, lotuses, suckling and haresfoot in that order. Within the grasses the order is timothy being the most palatable, then the ryegrasses, tall fescue and cocksfoot.

The characteristics of different species, given above and in the appendix, has been principally on the relative yields of established stands. There are also differences in establishment characters under particular conditions, e.g. the rapid establishment of ryegrasses and many legumes as compared to the slow establishment of browntop, timothy and zig-zag clover. There is also the general difference in rate of establishment related to potential for growth in different environments, with long establishment periods required in sites with low growth potential (Figure 5). Thus in the dry lower fertility high country it may be necessary to spell for 2-5 years following oversowing to allow good sward establishment.
7. Pastures and Livestock Production

If an area is to be farmed close to its potential, it is necessary to closely match feed supply with animal requirements. Where the annual pasture growth curve approximates animal requirements (Figure 6, dotted line), the emphasis in management will be on matching animal use with current pasture growth. However, when the pasture growth patterns differ markedly from animal requirement patterns, the emphasis will be on methods of carrying feed over from periods of surplus to periods of demand. In New Zealand standing feed can be saved for later consumption in situ through subdivision fencing. Because of the greater disparity between seasonal pasture growth and animal requirements, this requirement for subdivision is greater in the high country than in the lowland. But historically most of the lowland pastures were developed from bush and tended to start with small subdivision. By contrast, the original settlement of the South Island, and the present high country, is based on extensive grazing with conservative stocking to allow for winter cessation of growth. Based on the differences between annual pasture growth and animal feed requirements, the differences between annual pasture growth and animal feed requirements, the differences between lowland and high country in scale of subdivision should be lessened or even reversed. The strategy for such subdivision should:

(i) Place initial emphasis on the potentially more productive sites, which will generally be the moister soils at lower altitudes (warm) either with high inherent fertility or responsive to economic fertiliser application.

(ii) Aim for landscape units or soil types as these will respond in a uniform manner to a given management, e.g. subdivision into north and south aspect slopes.

(iii) Establish areas small and numerous enough to allow rotational mob stocking.
The last point is from consideration of the plants rather than stock. A plant is relatively fixed in its growth response to changes in the seasonal environment, whereas stock by weight gains or weight losses are more flexible in their responses. For example, not enough use has been made of the trial work which shows that hay use can be minimised by autumn saved pastures fed off in early winter, and retained as body weight reserve for later in winter.

The objective of pasture management should be to allow the pasture to grow to its full potential without grazing, with due regard to the legume component and nutritive value, and then graze off rapidly before the cycle is repeated. Again the implication is that if grazing off is to be rapid the paddock must be small (e.g. sufficient for one week's grazing), with several small paddocks, rather than one medium sized paddock.

By starting with small paddock subdivision, high stock concentrations can be achieved with existing flocks for short periods, under 'starvation' conditions if necessary, to bring the paddock into control. Remaining sections of the larger blocks provide the feed reserve during the transition phase to ensure no long term deleterious effects on the stock. Ultimately such small paddock systems imply high capital fencing costs. But during the transition, the cost of obtaining another 'stock feed/management unit' is less for a small paddock than a large one. Also fencing, in contrast to fertiliser, has a low maintenance/initial cost-ratio, so can be done in good economic years without incurring high maintenance costs in future years.

Within an extensive high country run there is initial justification of these small paddocks for special purposes:

(i) To conserve winter feed, e.g. hay, silage, brassica crops, feed grains, etc.
(ii) For critical feed periods, e.g. lambing, flushing.

(iii) To save autumn pasture for in situ winter feeding in high country, or spring saved pasture for in situ summer feed in dry hill country.

From such beginnings there could be a gradual transition to total small paddock farming, with the possibility of deferred grazing of some of the remaining native grassland blocks for a year or so, to allow reseeding and improvement of cover of either the native or introduced species.

8. Other Crop Options
While the discussion has been mainly in terms of pastures for grazing animals, the environmental gradient approach has also applicability to other options like cropping, horticulture and forestry (Figure 9). As stated earlier, the growth potential of different types of plants is approximately similar under particular conditions of temperature, moisture and soil fertility, so that the annual growth potential for pastures given in Figure 5 is close to those of farming options based on other plants.

As indicated earlier, irrigation is a means of extending the growth potential of moist sites to otherwise dry sites and would normally only be contemplated with associated fertiliser to raise them to the moderate to high fertility status. Irrigation would only be applicable to the naturally drier sites and would also be limited to topography (Figure 9, dashed lines).

The term "cropping" means any form of direct harvest of plant material. Conventional cropping of cereals has probably limited applicability to the high country in the short term because the soils lack structure and are prone to erosion. Topography limits use of machinery, and out-of-season frost is a problem which
increases with altitude. There is a need for development to improve soil structure. The probable limits of environmental conditions for dryland cropping are indicated in Figure 9, with the principal one being the need for high fertility.

The intermontane valleys and basins of the hill and high country tend toward a semi-continental climate with greater contrast between summer and winter climate conditions than the oceanic type climate of much of the lowland. Thus there may be a long term advantage in searching for cropping options for these regions, to make use of favourable summer conditions and avoiding the winter growth limitation inherent in the use of these areas for pastoral farming.

The difference between forestry and pastures as crops is probably not in annual increments of growth but in the accumulation of the growth, i.e. wood and stem materials, for a number of years. Trees are more limited than pastures species by temperature and drought (Figure 9, dotted lines). Within the applicable zone there are also limitations for timber production, through tree form and a long rotation period needed relative to other areas of New Zealand.

Figure 9 Alternative Uses (Possible environmental zones shaded)
8. **Conclusions**

The purpose of this paper has been to show that differences in pasture potential between lowland, hill and high country can be related to the environmental gradients of temperature (altitude), soil moisture and soil fertility. Further, it has been shown that this concept can be used to characterise the potential of the various sites and soils within a particular farm, the best pasture species for each condition, and the implications of these for animal utilisation.
APPENDIX
DESCRIPTION OF SOME PASTURE SPECIES

1. Legumes

Haresfoot clover, suckling clover, striated clover
These are adventive, annual clovers of low fertility situations, with suckling clover preferring wetter sites, and the other two, drier sites. They all probably make some contribution to nitrogen fixation and make good growth in spring and early summer. Haresfoot is relatively unpalatable in the rank state.

Subterranean clover
This species, a common annual once extensively used as the initial legume in the moderately fertile lowland situation, has, as fertility has increased, now been largely replaced by other legumes. Its range is probably limited by low temperature or frost in New Zealand. It is not suitable for the high country, but is suitable in parts of the hill country, particularly on the warmer dry north faces. It is a winter-active annual used during winter and spring for nitrogen build up and lamb fattening feed before being allowed to reseed, for a repeat performance in subsequent seasons. It has oestrogenic properties.

Sweet clover
This is a newly available biennial species for use in the dry zone at low to moderate fertility. It has a possible role as a temporary species for nitrogen fixation and honey production while more permanent oversown species are establishing. It makes some growth in the first year and yields similarly to lucerne in the second season. Bred cultivars have good palatability, unlike the wild form. It could be used for a hay crop following the initial cultivation of tussock country.

Crown vetch, zig-zag clover, Caucasian clover
In trials these three perennial legumes have shown ability to survive on moderate and low fertility soils. They spread extensively by underground rhizomes or stolons. All need specific rhizobia, are slow to establish, winter dormant and make moderate spring/summer growth under moderate fertility. Seed is scarce.
Lotus species
There are two perennial species released or in an advanced stage of testing. One is best suited to wetland (Grassland Maku) and the other to dryland (birdsfoot trefoil). The hybrid between the two is also being tested. Their place in agriculture has yet to be determined, but their likely role will be as non-bloating pure stands in dairy or cattle farming and as the legume component in the oversowing of unimproved grasslands where the inter-plant competition is likely to be low. They also have a likely role as the legume component for high altitude revegetation, or in grass grub prone areas. Present indications are that birdsfoot trefoil will be more suitable for moderate and drier areas as a "poor land lucerne". Both species require a specific rhizobium, are slow to establish and are probably best in open tussock as pure stands. They make most of their growth in late spring. Their spread by seeding is good. Not commercially available.

Vetch
This large-seeded spring annual legume is presently under evaluation. Like sweet clover it could be used as temporary oversowing species or in mixed sowings with oats for hay. It too needs specific rhizobia. One variety available has good ability to regenerate annually from subterranean seed pods.

Red clover
This is a taprooted perennial clover, which although short-lived, is one which establishes and produces well under a wide range of conditions. It does best under fertile moist conditions and is used for grazing or hay, or as an oversowing species at low stock densities. Of the high fertility legumes it is the least drought tolerant but the most tolerant to frost. It is bloat forming and oestrogenic.

Alsike clover
This is one of the principal legumes in the high country used for oversowing tussock country and in developed pastures both for grazing and hay. It requires moderate to high fertility. A taprooted short-term clover, it is hollow stemmed and a prolific seeder in initial years. As a hay component, it conditions more rapidly than red clover and is more frost tolerant than white clover. Not extensively tested or used in other areas.
White clover
A spreading perennial and the principal legume on the fertile soils of intensive or semi-intensive grazed areas, white clover will grow in all conditions except the very dry where it can be killed by drought. It requires intensive rotational grazing to express its full potential and this may be a limitation in the hill and high country. It is capable of spreading by stolons and seed. The least temperature tolerant of the high fertility legumes, it loses its feeding quality with winter frosting.

Strawberry clover
This is a suitable clover for the specific condition of saline, moderately fertile, wet soils.

Lucerne
A taprooted persistent legume, requiring moderate to high fertility and used for hay or grazing, lucerne is the most drought-tolerant of the perennial legumes and responds well to irrigation. It is winter dormant. Best production is had from pure stands but, at least in lowlands, can be overdrilled with winter active grasses to even out the yearly growth cycle. Lucerne is suitable as an oversowing species in the dry hill and high country of moderate fertility.

2. GRASSES

Sweet vernal
An adventive already widespread in dry to moderate moisture and low fertility areas, sweet vernal seldom forms dense swards like browntop. While it is a useful grazing grass at low soil fertility it responds poorly to fertiliser.

Aira and Vulpia spp
These are small adventive annual species of dry low fertility situations. Because of their frequency they probably make a contribution to the total herbage available during the spring, although they become relatively unpalatable once seeding starts. The success of these two adventives, along with several annual legumes, suggests that there is a role for more productive annual grasses in the drier zones.

Chewings fescue
This is a small grass for low to moderate fertility dry soils. It has not actively been used or advocated in recent decades.
Kentucky bluegrass
An adventive occurring occasionally on dry low fertility hill and high country. Kentucky bluegrass grows underground stolons and forms swards. It has shown no potential under moderate to high fertility conditions, as is the case overseas.

Brown top
A sward forming adventive abundant on most grazed, unimproved, moist areas of low to moderate soil fertility, browntop is probably the most suitable grass for such situations. Although less acceptable to stock when rank or with seed heads, it is used for long-term revegetation and slope stabilisation, and as an amenity grass.

Yorkshire fog
This grass is suited to low to moderate fertility moist soils. Productive but generally regarded as a weed under high soil fertility, it requires lax grazing management as it is intolerant of trampling. Peak growth occurs in the summer and feed quality is greatly reduced by frosting. It is also used as first year cover in revegetation sowings.

Danthonia (Notodanthonia)
This is a group of several native and introduced species which have shown good adaptation to low to moderate soil fertility and close grazing. They are common in drier regions. They show some response to increased fertility, but release a toxin which inhibits establishment of legumes and other grasses.

Cocksfoot
The most suitable of the productive pasture grasses for the hill and high country because of its tolerance of a wide range of temperature, moisture and soil fertility conditions, cocksfoot grows well under moderate to high fertility conditions. An important species for oversowning unimproved grassland, or as a component of improved pasture, and along with timothy and red clover for meadow hay, its best performance occurs under lax grazing management.

Tall fescue
A cultivar recently released (Grasslands Roa), this is very similar to cocksfoot in many of its growth form and agricultural characteristics. It has very good spring growth, good summer drought tolerance, reasonable
autumn growth, and very good retention of feed quality in the winter. It could rank with cocksfoot as the main high country grass because of its better growth under high soil fertility and its better winter feed characteristics. It is more frost tolerant than ryegrasses. Bred varieties do not cause animal disorders. It is slightly less acceptable to stock than ryegrasses.

**Crested dogstail**
This is a tufted perennial grass suited to moderately fertile and moderately moist soils. It is used on sheep properties as it can tolerate hard grazing.

**Phalaris**
A perennial with good winter growth where temperature permits and a reputation overseas for very good drought tolerance, phalaris could be important for New Zealand drier soils of moderate to high fertility. However, it has not been extensively tested or used in hill and high country as yet.

**Timothy**
Along with red clover Timothy is the main grass component in moist or irrigated high fertility, high country hay pastures. Used as a minor component of oversowing mixtures for high rainfall tussock grasslands, it can tolerate low to moderate soil fertility providing it has enough moisture. Suited to lax cattle grazing, it is highly palatable.

**Paspalum**
A warm temperature species, so only applicable to the lower altitude north facing slopes of the North Island hill country. Paspalum is productive on wet fertile soils.

**Prairie grass**
This is a tall perennial grass usually used in high fertility, wetter soils under lax grazing. In warm conditions it produces throughout the year with particularly good winter growth. Palatable in rank state, indications are that Prairie grass may be productive in fertile high country situations under both irrigation and dryland.
Annual ryegrass
This is a high soil fertility requiring grass which is winter active at moderate temperatures and is used for winter and spring feed. It can be managed either as a pure stand or overdrilled into lucerne or pasture. High country soils are generally not sufficiently fertile for this grass.

Perennial ryegrass
The main grass in lowland high fertility intensive sheep farming, therefore perennial ryegrass is considered for equivalent situations in the hill and high country. It requires high fertility and is susceptible to frequent frost, so has an altitudinal limit.

3. HERBS
Catsear, hawksbeard, dandelion, hawkbit
Adventive broadleaf species already widespread in the high country and to less extent in the hill country. Herbs are among the preferred species for sheep and have high mineral contents.

Sheeps burnett
This plant was introduced into the high country half a century ago and has been notable for its persistence and early spring growth in dry areas. There are more productive lines than the common one, and some are suitable for wetter conditions.

Hieracium
Eight species have inadvertently been introduced into New Zealand and two or three have reached weed proportions in the high country. *H. pilosella* establishes in moderately fertile undisturbed topsoils where grazing is absent or slight. Its dense mat formation and drought tolerance suppress other plants. *H. praealtum* is a coloniser of disturbed low to moderately fertile soil in open situations, where it can increase under nil or low grazing, either as open mats or in combination with other species.

Chicory
This is a perennial species presently under test and showing potential for high fertility lowland situations.
DISCUSSION

Q. Is there technology to establish the species suited to the different regions:

A. Yes - though the search for more efficient methods continues.

Q. How do you establish tall fescue?

A. We have had only limited direct experience but would expect it to be similar to other species, i.e. hard graze the existing vegetation or otherwise reduce competition, overdrill or oversow, and then give time for the species to establish before subjecting to too much grazing pressure. As a plant's potential to establish and grow decrease with temperature and moisture limitations, we have to contemplate longer establishment periods in the dry high country - this might be four to five years.

Q. Is your distinction between the tolerance of different species very important and do we have to introduce new species as fertility is increased, e.g. like replacing Yorkshire fog and sweet vernal?

A. Most species tolerate a wide range of conditions and will approach the potential productivity of a site as fertility and other conditions change. But only one or two will reach the full potential of a particular site and what the diagram tried to show is what these sites were for the different species. Thus, if you only have small areas with better fertility or moisture, then the cost of changing species may not be justified if you are going to get much of the increase in potential from the existing species. However, if you have larger areas, the resources, or the need to farm close to full potential, then you should go directly to the species that suit these conditions and which are likely to be more productive than alternatives in the particular situation.
PROBLEM SOLVING ANIMAL RESEARCH IN THE HILL
AND HIGH COUNTRY

A J ALLISON *

Introduction

Production of meat and wool from the hill and high country contributes substantially to New Zealand's export receipts. There is already a great deal known about ways of improving animal production in these areas but levels of performance are much lower than is easily achievable. Low levels of total animal production can therefore be defined as the main problem and research in many areas has given leads towards greater efficiency and profitability. Principles of increasing production apply to both hill and high country but in this review more attention will be afforded the latter.

Many of the factors considered offer substantial advantages with little extra cost but have a low adoption rate for a variety of reasons - tradition, political - reasons and also lack of motivation. Attention will be drawn to available but un-utilised possibilities for increases in production throughout this paper. They are mainly involved with -

(a) increasing stock performance and
(b) the use of more productive stock.

Both of these factors necessitate improving animal nutrition which will mainly be achieved by agronomic techniques which will be discussed at this symposium.

Increasing stock performance - Selenium and Anthelmintics

One of the most dramatic increases in animal production in recent times has resulted from the discovery of lamb growth rate and ewe fertility

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responses to selenium (Se). Lamb growth rate responses occur over very extensive areas of the South Island and in some areas of the North on sand and pumice soils (see Figure 1, Robertson & During 1961). Decreases in the percentage of barren ewes can also be expected where there is a history of white muscle disease together with a barren ewe problem. Although there is no published evidence to show that Se administration affects the level of twinning recent work suggests that embryonic mortality in multiple ovulating ewes may be reduced. Late embryonic mortality 3 - 4 weeks after mating in Se deficient ewes is the cause of the barren ewe problem (Hartley 1963). Embryonic mortality at this stage post-mating means that the ewe returns to service outside the normal 51 day (3 cycle) mating period - hence they do not have a further opportunity to be mated and conceive.

Table 1. Effects of Se administration on the incidence of barren ewes (from Scales 1974)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Age and (number of ewes/group)</th>
<th>% Barren</th>
<th></th>
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<tr>
<td></td>
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<td>Selenium</td>
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<td>2</td>
<td>2-tooth (250)</td>
<td>17.3</td>
<td>5.4</td>
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<td>3</td>
<td>mixed-age (165)</td>
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<td>20.1</td>
<td>9.0</td>
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<td>5</td>
<td>4-tooth (180)</td>
<td>5.3</td>
<td>6.0</td>
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</tbody>
</table>
FIGURE 1. Areas of selenium response, weight gain of lambs.
Experiments where Merino ewes have been drenched with 5 mg Se two
to three weeks before the start of mating have shown 11 - 12 per cent
decreases in barrenness in three of four trials (Scales 1974, Table 1).
Furthermore, in one experiment (No 5, Table 1) three groups of ewes were
treated as follows:
(i) No Se
(ii) 5 mg Se premating
(iii) 5 mg premating and two weeks pre-lambing with half of the
lambs in each group receiving 2 mg Se at tailing.

Although Se administration prior to mating did not affect barrenness,
lamb mortality in the group of ewes drenched with Se pre-lambing was 10 per
cent lower at weaning in comparison with the untreated group. Lambs dosed
with Se at tailing (three to four weeks of age) had negligible mortality to
weaning in comparison with approximately 20 per cent in lambs not drenched.
Of particular interest was the fact that the pre-lambing treatment of ewes
which minimised lamb mortality up to tailing also minimised mortality from
tailing to weaning in lambs which were not dosed at tailing.

Table 2. Effects of Se administration to ewes and lambs on lamb weaning
weights (kg)

<table>
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<th>Ewe treatment</th>
<th>Lamb treatment</th>
<th>Control</th>
<th>Se</th>
<th>Difference</th>
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<td>19.0</td>
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<td>2.2</td>
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<td>18.9</td>
<td>21.3</td>
<td>2.4</td>
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<td>Se (mating and lambing)</td>
<td></td>
<td>20.9</td>
<td>21.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Lamb growth rates to weaning in this trial (Table 2) showed substantial advantages to Se treatment and treatment of ewes pre-lambing was almost as effective as dosing lambs at tailing.

Reports of growth increases in weaned lambs and reduced mortality rates following administration of Se are numerous with most areas east of the Southern Alps showing responses (McLean et al 1959, Robertson & During 1961). It must be emphasised that lambs which grow faster also grow more wool and that where white muscle disease may be prevalent the first opportunity to dose lambs is at tailing. I have the distinct impression that the practice of pre-lamb drenching with Se in the South Island is not as prevalent as it was in the early 1960's when all of the research was done and publicised. In fact data from the Hughes et al (1974) survey of all tussock runs in the South Island (Table 3) showed that 43.4 per cent of runs did not drench ewes at all and that 31.5 per cent drenched only once. (The time of drenching was not specified). Presumably most of the latter would carry out a pre-mating drench. Of the 137 properties which did drench ewes only 80 per cent included Se. Thus on less than half of the high country runs which have ewes Se is not administered at all to the ewe flock.

Table 3. Drenching frequency of ewes on High Country runs (data from Hughes et al 1974)

<table>
<thead>
<tr>
<th>Frequency of drenching/annum *</th>
<th>No. of runs</th>
<th>% of all runs surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>128</td>
<td>43.4</td>
</tr>
<tr>
<td>1</td>
<td>93</td>
<td>31.5</td>
</tr>
<tr>
<td>2</td>
<td>67</td>
<td>22.7</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>1.7</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>0.7</td>
</tr>
</tbody>
</table>

* 80 per cent of properties drenching ewes gave Se
Both pre-mating and pre-lambing drenching with Se warrants serious consideration on most hill and high country properties and should result in increased levels of production.

Se-responsive unthriftiness can also occur in beef cattle of all ages particularly in the autumn and winter months. In trials in the Mackenzie Basin Davis (1974) has shown a 15 per cent growth response in weaner cattle over a nine month period in comparison with untreated animals (drenches given in March, May and September). Treatment at the same times with an anthelmintic did not give a significant growth response.

The effectiveness of broad spectrum anthelmintics is well known and need not be further discussed here. In recent trials "farmer practice" of drenching lambs three to four times at four to six weekly intervals from weaning has proved as successful as management techniques using "clean" pasture and a reduced number of drenches. Problems with internal parasites are more marked on irrigated pasture than on improved or unimproved tussock (Scales, et al 1968).

**Nutrition and liveweight - sheep**

Increased levels of nutrition resulting from pasture improvement, irrigation or from more efficient grazing management all allow higher liveweights to be achieved in existing stock and/or more stock to be carried, or both. A great deal of research has been carried out to identify the liveweight/fertility relationship and also on manipulation of levels of nutrition to improve animal performance. The various factors are considered under separate headings although they are closely related.

a) **Effects of liveweight**

Relationships between pre-mating liveweight, twinning and barrenness in
FIGURE 2. Premating liveweight and litter size relationship—percentage per 5 kg increase in liveweight.
2-tooth and older ewes as defined by Coop (1962) are well known. Although these data were defined in lowland conditions they do have relevance to the hill and high country situation. Increasing lamb drop with increasing pre-mating liveweight has been observed in many sheep breeds in New Zealand and Figure 2 summarises the between-flock relationships derived from four sources (Allison & Kelly 1978). The incidence of triplet births in all flocks used in these calculations was low and thus estimates can be considered as liveweight - twinning relationships. Between-flock liveweight twinning increases were 9 per cent (Whatawhata), 14 per cent (Invermay survey throughout Canterbury, Otago and Southland) and 17 per cent (Ruakura stocking rate trial in comparison with the seven per cent figure per 5 kg from Coops work). This information increases the emphasis which should be placed on achieving high mating weights in sheep.

Variation between mobs of ewes is largely caused by feeding and management differences. However, genetic differences between mobs within a breed and between breeds will cause deviations above and below the regression lines. Thus flocks of ewes with higher twinning in relation to mean liveweight than the relationships shown in Figure 2 will invariably be more efficient than flocks below the lines. The level of twinning usually increases with age of ewe but Coop (1973) has shown that most of this increase can be accounted for by increased liveweight in older ewes. Information from flocks of ewes at Tara Hills (Table 4) supports this contention and also shows that at higher liveweights quite high levels of twinning can be achieved in Merino ewes.

Table 4. Premating liveweight and twinning in Merino ewes - Tara Hills

<table>
<thead>
<tr>
<th>Age of ewe</th>
<th>Premating wgt (kg)</th>
<th>per cent twins</th>
<th>Premating wgt (kg)</th>
<th>per cent twins</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-tooth</td>
<td>47.2</td>
<td>10</td>
<td>40.0</td>
<td>6</td>
</tr>
<tr>
<td>4-tooth</td>
<td>45.3</td>
<td>26</td>
<td>48.0</td>
<td>17</td>
</tr>
<tr>
<td>6-tooth</td>
<td>53.0</td>
<td>46</td>
<td>49.7</td>
<td>38</td>
</tr>
<tr>
<td>8-tooth</td>
<td>52.5</td>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Within groups (i.e., where ewes within a mob are grouped according to differences in pre-mating weight) the increase in twinning with increasing weight is approximately half that observed between flocks.

The only apparent exception to this relationship is in Merino 2-tooth ewes where twinning is at a low level (<10 per cent) irrespective of pre-mating liveweight (Allison et al 1974). In Merino ewes 4-tooth and older ewes show increased twinning with increasing liveweight. Whether or not the relationship is still linear at very high weights is not clear. Coop & Clark (1966) showed that barrenness in Merino flocks decreased an average three to four per cent for every 4.5 kg decrease in pre-mating weight. Their data were derived from flocks of 2-tooth and 4-tooth ewes in the Mackenzie country which were, on average, only 34 - 39 kg.

In low-liveweight ewes inadequate mating management may be implicated in the high levels of barrenness often recorded. Provided most of the low-liveweight ewes are actually mated they have a similar ability to bear lambs as do heavier ewes. In ram/ewe ratio trials large differences have been observed between ratios of 1/100 and 3/100. Approximately 60 per cent of the barren ewes were not mated at all and when animals in this category are removed from the analysis the liveweight/barrenness relationship largely disappears (Allison et al 1974).

Between-flock differences in liveweight usually reflect differences in nutrition and heavier flocks therefore usually have higher levels of wool production. However, within a flock the 2-tooth fleece weight is usually the heaviest and decreases occur as ewes get older in spite of their increasing liveweight. Coop & Clark (1966) showed a 6.9 per cent increase in fleece weight within flocks (same age ewes) for every 10 per cent increase in liveweight.
b) Effects of flushing and feed allowance

Moderate to low liveweights at mating are the major cause for the average lambing percentage being below 100 in New Zealand and of course the hill and high country area contribute to this low average. Improving nutrition prior to mating (flushing) is widely advocated and many farmers attempt to flush their ewes. Flushing is a relative term, with the exception of oestrogenic pastures, improved nutrition prior to mating even when ewes may still not be gaining in weight will result in higher twinning in comparison with ewes, initially of similar weight but declining due to poor nutrition prior to and during mating. In general terms a response to flushing can be divided equally between a "static" effect due to the increase in liveweight and a "dynamic" effect due to the animals being in a state where they are actively gaining in weight. There is much debate as to the relative contribution of these effects to the total response, but the main thing from a practical point of view is that responses to increased live-weight will occur. These responses are greater, the longer the period of flushing, and it seems that a 15 to 20 per cent response in lambing percentage should result from three weeks flushing before mating and for another three weeks during mating. (Wallace 1951: Coop 1966). It is important to note that it is not necessary to take weight off ewes after weaning in order to achieve a flushing response.

Recent studies have drawn attention to the concept of "feed allowance" - the amount of pasture (dry matter) offered to a particular class of animal each day and "pasture yield" - the amount of pasture per unit area. Initially field observations showed that the levels of feed offered to ewes and assumed to be adequate were often not sufficient to enable ewes to gain weight.

Table 5 shows data from an experiment where different levels of pasture allowance were offered for 60 days prior to recording ovulation rate (Rattray et al 1978). Liveweight gains were higher with higher allowances offered but at the higher pasture yield (i.e. 4 310 kg/ha) gains were considerably higher than at similar allowances offered at a lower yield of 2 710 kg/ha.
Table 5. Pasture allowance, liveweight gain and ovulation rate (from Rattray et al 1978)

<table>
<thead>
<tr>
<th>Pasture yield (kg DM/ha)</th>
<th>4310</th>
<th>2710</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture allowance (kg/ewe/day)</td>
<td>1.9 3.6 6.1 8.4 10.0</td>
<td>2.2 4.9 6.4 9.2 11.4</td>
</tr>
<tr>
<td>Liveweight gain (g/ewe/day)</td>
<td>-9 51 130 172 147</td>
<td>-68 -5 28 47 32</td>
</tr>
<tr>
<td>Ovulation rate eggs/ewe</td>
<td>1.22 1.63 1.73 1.81 1.81</td>
<td>1.29 1.45 1.60 1.88 1.55</td>
</tr>
</tbody>
</table>

This situation also occurred in a subsequent experiment suggesting that, at low pasture yields with a resultant low yield of green herbage, animals had problems of access in attempting to obtain maximum intakes. Ovulation rates were similar at allowances greater than 6 kg/head/day. The suggestion of a problem of access to sufficient levels of available feed at low levels of pasture yield is further illustrated in Figure 3 which shows the relationship between ovulation rate and the allowance of green herbage per ewe (i.e., little dead matter in the pasture is eaten by sheep). These data are from the experiments described above (Rattray et al 1978) in high yielding pastures (i.e., high amounts of pasture/unit area) the percentage of green matter was 51 to 57 per cent in comparison with only 34 to 40 per cent in the lower yielding pastures. The concept of feed allowance has also prompted investigations concerning the liveweight change of ewes during pregnancy and lactation and also growth rates in young weaned lambs (Rattray et al 1977, Jagusch et al 1979).
FIGURE 3. The relationship between ovulation rate and the allowance of green herbage per ewe.

In all cases the same type of relationship shown in Figure 3 has been shown but absolute levels of performance vary according to the class of stock and type of pasture offered. For example the amount of feed which has to be offered to young lambs to achieve optimal growth rates may be less than that necessary for breeding ewes and with predominantly clover pastures lower allowances for optimal growth may be necessary than is the case with ryegrass pastures. The logical extension of the above research is to educate farmers to recognise the high levels of available pasture necessary to achieve high rates of liveweight gain. This implies manipulation of grazing management to allow a bank of feed to be developed before the need arises for use of this feed.

Although the feed allowance work has been carried out on high quality pastures in lowland areas, the principles can be extrapolated to the hill and high country situation. The principles imply that pasture management
(i.e., grazing and fertiliser) must be manipulated to allow banks of high quality feed to build up for flushing, lactation or fattening lambs and other critical periods. The common practice of set stocking pastures for long periods of time is not conducive to high levels of pasture production and efficient pasture management. If only low yielding pastures can be offered to ewes then it may be that attempts at increasing nutrition prior to mating or at other times may be of limited success. This needs further clarification for hill country conditions. Thus additional subdivision, allowing greater pasture management and control must be a priority if greater levels of production are to be achieved from existing grazing areas.

c) Effects of nutrition during pregnancy and lactation

Most hill and high country farming systems restrict ewes during early and mid-pregnancy and endeavour to increase levels of nutrition in late pregnancy. This approach minimises winter feeding costs while not affecting lamb birth weights, mortality or subsequent growth. Wool production is however reduced by 0.3 to 0.7 kg in animals restricted in winter in comparison with those fed at high levels throughout the winter (Monteath 1971). It is worthy of note that the restricted nutrition in these trials which caused approximately a 16 per cent liveweight loss in winter also resulted in substantial differences in tensile strength and style grading of the wool. These differences were not, however, reflected in the auction price.

Studies on winter supplementation of Merino ewes at Tara Hills have shown that daily feeding of hay is not necessary and results were similar with twice weekly or weekly feeding (Lewis 1968). When equivalent amounts of hay were fed there were advantages of restricted feeding during mid-pregnancy with an increasing level in late pregnancy compared with a constant level throughout. The latter strategy eliminated sleepy sickness.

In contrast to minimal effects of sub-maintenance feeding during
pregnancy, restricted nutrition during lactation invariably results in reduced lamb growth and ewe liveweight losses. However, even in the poorest management systems feed supplies are likely to be more than adequate in the spring and thus poor feeding in lactation should be no problem. Of particular note for the future is that an increase in the percentage of twin bearing ewes may cause feed demand to exceed supply for the early part of lactation and supplementation or later lambing will have to be considered for best results. Further to this the adoption of all-grass wintering systems may shift the period of most critical feed demand from late pregnancy into the lactation period which is also of concern with higher fertility sheep.

d) Oestrogenic pastures; lucerne and red clover

In many areas which have access to irrigation or are liable to summer drought, lucerne and red clover are species that produce more feed than other pasture species about the time of mating. As early as 1960 Coop & Clark reported a 10 per cent reduction in twinning and a delay in conception in ewes mated on lucerne in comparison with ewes joined on grass pasture. There has been a considerable amount of recent research on this topic. Scales, et al (1977) in four trials showed small but non-significant increases in barrenness (0.7 to 5.1 per cent) but large decreases in the percentage of multiple births (13.7 to 32.3 per cent) in ewes mated on lucerne in comparison with animals on grass, in agreement with Coop (1977) who reported a 20 per cent decrease in multiple births. These differences are due to an effect on ovulation rate. None of the recent observations have shown any effects on the percentage of ewes mated.

The effects on reproductive performance are due to the presence of the plant oestrogen, coumestrol, in lucerne. The higher the level, the greater are the adverse effects. Immature lucerne invariably contains low levels of coumestrol and is thus safe to graze. However, mature crops are likely to
contain high levels of coumestrol seemingly because they are more likely to be infected with fungal pathogens (leaf spot) and the level of infection is related to the concentration of coumestrol. The grazing of lucerne does not cause any permanent effects on ewe fertility. The grazing of ewes on grass for two to three weeks prior to joining will often be sufficient to allow a return to normal levels of twinning.

Besides coumestrol, another group of compounds (isoflavones) of which formononetin is the most important can also affect reproductive performance in sheep. Formononetin, found in large quantities in red clovers and some subterranean clovers, causes temporary effects on both fertility and fecundity and can also cause permanent infertility. There is the possibility of the new tetraploid red clover, Pawera persisting for long periods in pasture and producing major proportions of the available herbage in the summer and autumn. Flushing on stands containing substantial amounts of red clover can be expected to decrease twinning (i.e. ovulation rate) and also increase barrenness. In a recent trial at Palmerston, ewes joined on red clover (Pawera) had a 20 per cent reduction in the percentage of ewes mated in the first 17 days of mating, a 31 per cent reduction in ovulation rate (1.13 versus 1.63) and 44 per cent more ewes returned to service compared with ewes joined on a ryegrass/white clover pasture. Grazing of pure stands of red clover only during pregnancy and lactation may also cause a decline in ewe fertility which increases with age (Barrett et al 1965). Hay made from red clover is harmless.

The dilution of oestrogenically-potent pastures by non-oestrogenic species reduces the severity of effects on ewe fertility. Thus Davies & Maller (1970) showed differences in the effects on ewe fertility when mobs of ewes were grazed on pastures containing 0, 30, 60 and 100 per cent of red clover - (Figure 4.)
FIGURE 4. Percentage of ewes lambing to ewes joined when grazed on pastures of varying percentage of oestrogenic clover.
This suggests that pastures containing as low as 20 per cent red clover may not be completely safe. In this respect the apparently greater persistence of Pawera, compared with other red clovers, is obviously important as this variety has similar levels of formononetin to that in other red clovers which have been sown in pasture mixtures for many years. It does seem unwise to graze breeding ewes on swards containing substantial amounts of red clover particularly around the time of mating. These swards will however, be ideal for fattening young stock and should have no effect on cattle fertility. Research at Invermay is establishing possible effects of grazing oestrogen-rich pastures during rearing (i.e. hogget stage) on subsequent reproductive performance. Oestrogenic pastures have little effect on the reproductive performance of males.

e) Hogget rearing

Coop & Clark (1966) studied liveweight fertility relationships in four high country flocks and concluded that once ewes entered the breeding flock that they did not gain weight in subsequent years. This emphasised the importance of hogget rearing to achieve high liveweights by the time of 2-tooth mating. Also on about half of the tussock runs in the South Island 2-tooths are not mated at all, presumably because they are considered too small for a satisfactory performance. Most 2-tooth ewes in the high country which are mated have a mean weight of approximately 35 kg and in some cases even lower. Suggested target liveweights of 50 kg for 2-tooth Merinos prior to mating (Thompson 1972) are unrealistic but should be achievable for ½ bred or longwool ewes on hill country. At Tara Hills, stocking rates, levels of feeding Merino ewes and overall production are higher than most high country runs but 2-tooth ewes have not reached 50 kg (see Table 4). The importance of Se and anthelmintics for young stock and the provision of adequate levels of feeding to achieve high growth rates is obvious. Again subdivision and improved grazing management of improved hill and high country will contribute to greater hogget growth and wool production. Thompson (1971) compared
wintering of hoggets on sunny and warm improved tussock blocks with various forms of supplement (i.e. lucerne hay, root crops or grain) and concluded that supplements were uneconomic providing there was no snow risk. Some form of supplementation is essential if there is snow risk or inadequate feed available on suitable blocks.

The effect of efficiency of hogget rearing on subsequent reproductive performance and wool production is a question critical to all sheep producers. In most areas where provision of winter feed is expensive producers rely on compensatory growth in the spring to make up for deficiencies in winter feeding. Detailed studies with both Romney and Merino hoggets have shown that difference in winter nutrition resulting in 7 - 10 kg weight differences at the end of winter had little effect on reproductive performance as a 2-tooth when all ewes were well fed post-winter. Animals fed on low planes of nutrition during winter had compensated for 60 per cent or more of their liveweight disadvantage by the time of 2-tooth mating and by the 4-tooth joining, weight differences had virtually disappeared.

Data from an experiment at Tara Hills (Table 6) shows that in animals fed well during the spring/summer period there was little difference in reproductive performance but that poor nutrition during winter caused a 0.3 - 0.4 kg depression in fleece weight.

Table 6. Effects of plane of nutrition on wool production and reproduction in Merino ewes.

<table>
<thead>
<tr>
<th>Feeding level</th>
<th>Liveweight (kg)</th>
<th>Fleece weight (kg)</th>
<th>% barren</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring/</td>
<td>October 2-tooth</td>
<td>Hogget</td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>12 months</td>
<td>mating 19 months</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>26.7</td>
<td>43.3</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>19.9</td>
<td>41.1</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>27.1</td>
<td>31.2</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>19.5</td>
<td>28.4</td>
</tr>
</tbody>
</table>
In this experiment ewes were also fed high and low planes of nutrition in the spring/summer period up to the time of 2-tooth joining when all animals were run together. It seems that poor hogget rearing during winter has resulted in some carry-over effect on 2-tooth fleece weights irrespective of whether animals were fed high or low levels in the spring/summer period. This experiment was repeated in two years with four lambings of animals differentially reared in both years. The experiment is now completed. Further analyses will define the magnitude of any carry-over effects of hogget winter nutrition on wool production. From my experience with recording liveweights and reproductive performance of high country flocks, many young ewes are 35 kg at mating and sometimes less which is obviously due to inadequate feeding in the spring/summer period. Poor winter feeding, when the costs of supplementation are high, may be tolerable but it is obvious that many run holders could do much to provide better levels of nutrition post-winter and would be well rewarded for such efforts.

Grazing of young stock on irrigated or improved pastures or lucerne will result in higher growth rates but in this situation greater attention must be paid to the control of internal parasites. If any class of stock is to be grazed on lucerne then they must have access to salt licks at all times. The average sodium content of lucerne is only 0.03 per cent of the dry matter compared with 0.15 to 0.30 per cent for most pasture species. Table 7 shows differences in production from young lambs grazing lucerne with or without access to a salt block during a three month period (Joyce 1975)

<table>
<thead>
<tr>
<th>Supplement</th>
<th>None</th>
<th>Salt Lick</th>
<th>Per cent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liveweight gain (g/day)</td>
<td>84</td>
<td>162</td>
<td>93</td>
</tr>
<tr>
<td>Carcase weight gain (g/day)</td>
<td>32</td>
<td>70</td>
<td>119</td>
</tr>
<tr>
<td>Wool growth (g/day)</td>
<td>7.4</td>
<td>9.3</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 7. Responses to salt (Na Cl) supplementation in young lambs grazing lucerne (from Joyce 1975)
Nutrition of beef cattle

(a) Cows

In any hill and high country situation cattle are expensive to feed over the winter period and studies at Whatawhata and Tara Hills have concentrated on the restriction of winter nutrition and the effects on subsequent production. In the South Island, high country cows are usually allowed to gain weight after weaning until mid winter when feed supplies run out. If unsupplemented they will lose weight until the onset of spring growth. This pattern of liveweight change has been compared with taking weight off cows post weaning as shown in Figure 5 (Scales & Stevenson 1976).

FIGURE 5. Liveweight change in beef cows on 3 different levels of nutrition post weaning.
These treatments had minimal effects on calf birth weights, weaning weights and the efficiency of re-breeding but there were slightly higher (three to four per cent) calf death rates in the winter restricted groups. Reduced levels of nutrition after calving will however cause reductions in calf weaning weight and often a reduction in pregnancy rate of cows at re-breeding. In contrast with the above results experiments where severe under-nutrition was imposed on Angus cows in winter have shown decreases in calf birth weights, survival and weaning weights (Hight 1968, Smeaton et al 1979). Following restricted winter nutrition, increased nutrition for the last six to eight weeks of pregnancy is sufficient to promote high levels of production.

Even though there has been a great deal of research on nutrition of beef cows, the relative costs of winter feed and/or the entrenched traditional management systems already operating combine to make such studies only marginally effective in promoting any change. In many cases carrying feed forward or concentrating supplementation in late pregnancy could result in greater total production.

b) Weaners

As with beef cows the costs of wintering weaners affects the profitability of any beef enterprise. In fact most producers make use of the phenomenon of compensatory growth which is the capacity of the animal to grow more rapidly after a period of restricted feeding than after a period of higher level feeding. Thus animals which have suffered a period of feed restriction in winter eat more in spring when feed supplies improve and in comparison with the previously better fed animals make up 15 to 65 per cent of their liveweight deficit at the end of winter, in the ensuing post-winter period. Scales & Lewis (1971) have reviewed three trials carried out at Tara Hills where differential levels of hay feeding cause 23-48 kg differences in mean weight between groups (Figure 6), $M^+$, ad libitum; $M$, maintenance; $M^-$, sub-maintenance.
FIGURE 6. Compensatory growth in beef weaners.
In these and other trials most of the compensation has taken place in the three to four months from the end of the feed restriction. There were no effects on carcase composition of the weaners.

The most compelling reason to increase the levels of nutrition of beef weaners is to attain liveweights sufficient to allow farmer confidence to join animals as yearlings.

Joining of yearling cattle

Joining of yearlings at 13 to 15 months of age is not commonly adopted in beef herds and, as with the practice of not joining 2-tooth Merino ewes, a simple and effective means of increasing production is ignored. Most commonly-heard recommendations for successful joining of yearlings are that British beef breed animals should average about 295 kg for heifers and 340 kg for bulls. Carter (1973) analysed results of some 10,000 matings of yearlings and older cattle in four herds run on high quality pasture and sought to answer the following questions:

i) how successful is yearling mating?
ii) does it prejudice subsequent cow performance?
iii) how critical is yearling joining weight?
iv) can yearling bulls be successfully mated?
v) should yearling heifers be joined with mature bulls?
vi) is yearling mating profitable?

Detailed calving results from one of the herds can be seen in Table 8.
Table 8. Calving data in cattle of different ages per cent (from Carter 1973)

<table>
<thead>
<tr>
<th>Age at calving</th>
<th>2</th>
<th>3</th>
<th>4+</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of cows</td>
<td>1184</td>
<td>894</td>
<td>2091</td>
</tr>
<tr>
<td>Barren</td>
<td>18</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Aborted or calf lost</td>
<td>12</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Calves alive at 6 weeks</td>
<td>70</td>
<td>79</td>
<td>86</td>
</tr>
</tbody>
</table>

With results like these mating of yearlings must be considered a success. Calves from yearlings were born one to two weeks later, were lighter at birth and were 15 to 20 per cent lighter at weaning than calves from mature cows. In one of the herds, heifers were first mated at 26 to 27 months but in subsequent years were joined as yearlings. Their performance (Table 9) gives no evidence that mating as yearlings has impaired reproductive performance at the next mating.

Table 9. Age of female and liveweight and effects on calving percentage (from Carter 1973) n = 362 - 791

<table>
<thead>
<tr>
<th>Age at calving (yrs)</th>
<th>Not mated as yearlings</th>
<th>Mated as yearlings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1957-62</td>
<td>Wgt kg</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>341</td>
<td>78</td>
</tr>
<tr>
<td>4</td>
<td>407</td>
<td>83</td>
</tr>
<tr>
<td>5+</td>
<td>442</td>
<td>82</td>
</tr>
</tbody>
</table>
These data have also been classified according to average liveweights of animals at the time of first joining. In one herd the lightest 25 per cent of the yearlings which averaged 238 kg had a similar calving and marking percentage to the heaviest 25 per cent of the animals which averaged 296 kg.

Two and three year old calving percentages in relation to yearling weights are classified in Table 10.

Table 10. Calving performance at two and three years classified according to yearling joining weight (from Carter 1973)

<table>
<thead>
<tr>
<th>Joining wt kg</th>
<th>No. of animals</th>
<th>Marking percentage 2 yr.</th>
<th>3 yr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 215</td>
<td>33</td>
<td>58</td>
<td>60</td>
</tr>
<tr>
<td>215 - 238</td>
<td>108</td>
<td>69</td>
<td>79</td>
</tr>
<tr>
<td>238 - 260</td>
<td>179</td>
<td>62</td>
<td>78</td>
</tr>
<tr>
<td>260 - 283</td>
<td>156</td>
<td>76</td>
<td>81</td>
</tr>
<tr>
<td>283 - 306</td>
<td>118</td>
<td>64</td>
<td>85</td>
</tr>
<tr>
<td>&gt; 306</td>
<td>28</td>
<td>71</td>
<td>68</td>
</tr>
</tbody>
</table>

Between 215 and 306 kg there was little apparent relationship between joining weight and subsequent performance. While these results have been achieved on more productive land areas than hill and high country, they do illustrate the substantial possibilities for increasing beef production which mating of yearling heifers offers. The liveweight data are useful indicators of expected levels of performance. Certainly most young cattle would reach a sufficient weight to be successfully joined. As is the case with mating ewe hoggets to lamb at 13 months, it is important to ensure that animals calving at two years are adequately fed to alleviate any problems which may be expected. Carter (1973) advocated the practice of joining yearlings and culling all those diagnosed as empty prior to the winter. In these studies no physical damage
resulted from joining yearlings with mature bulls and yearling bulls of 300 - 400 kg mated as successfully as did older bulls.

These data therefore indicate that for efficient beef production heifer mating should be widely advocated and adopted within industry. However, Hanly and Mossman (1977) have adopted precisely the opposite stance. Based on extensive surveys in hill country in the east coast of the North Island they consider that mating yearlings causes poor in-calf rates as second calvers and consider that critical mean weights should be 272 kg for Angus and 295 kg for Hereford yearlings which would allow an 84 to 95 per cent in-calf rate in a 42 - 45 day mating period. They present few data which allow discriminatory examination of the many contentions made and seem unable to accept that, although barrenness and calf losses may be higher in yearlings, failure to join these animals represents wasting of large slices of potential export income. Their efforts would be better directed to increasing management skills and farmer confidence so that this increased potential can be realised.

Mating behaviour in sheep

Changes in management strategies to facilitate ram/ewe contact are often necessary to achieve optimal reproductive rates particularly with young sheep. This fact, together with the possibility of using the most productive sires over many more ewes than is current practice, has prompted research on various aspects of mating behaviour.

An extensive series of trials on the hill country at Invermay has shown that conventional ram/ewe ratios grossly underestimate the sexual capacity of rams. With Romney sheep, ram/ewe ratios of 1/50 to 1/210 had little effect on the percentage of ewes mated, on returns to service and barrenness when groups of three rams were joined with varying numbers of ewes (see Allison 1975a). Table 11 shows the percentage of ewes mated in the first cycle and the percentage returning to service in two trials and also the number of ewes mated by each ram.
Table 11. Ram/ewe ratio trials - individual ram mating performance and returns to service (from Allison 1975 a)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Rams/ewe</th>
<th>Per cent mated 17 days</th>
<th>No. of ewes mated * by each ram 1st 17 days</th>
<th>Per cent returns to service</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/150</td>
<td>95</td>
<td>122</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td>3/450</td>
<td>95</td>
<td>297</td>
<td>16.3</td>
</tr>
<tr>
<td>2</td>
<td>3/210</td>
<td>81</td>
<td>144</td>
<td>14.6</td>
</tr>
<tr>
<td></td>
<td>3/630</td>
<td>83</td>
<td>365</td>
<td>12.1</td>
</tr>
</tbody>
</table>

* different coloured crayons in the harness of each group.

Different crayon colours in ram harnesses were used to estimate the number of ewes mated by each ram. Most ewes were mated by more than one ram. This of course does not estimate the actual number of times the ewe is actually mated. Periods of eight hours of continuous observation showed that rams mated on average eight to twenty times when groups of four rams were run with 14 or 42 oestrous ewes (i.e. the numbers expected in heat at ratios of 1/60 or 1/180 respectively). At such a rate even with high numbers of ewes per ram most ewes would be mated at least twice by each ram.

These data illustrate the very considerable ability of rams, this being further emphasised in a series of five field trials in Otago. A mob of four or five rams run with ewes at the farmers normal ratio, i.e. 1/30 to 1/75 was compared with another mob with the same number of rams but with twice the number of ewes. There were no differences in the percentage of ewes mated, returns to service or subsequent lambing performance between the mobs joined at the different ram/ewe ratios further illustrating the success of using fewer rams.

In the hill country ram/ewe ratios average about 1/50 and in the high
country runs less than 40 ewes per ram is the norm (Scales et al 1975).

Trials with Romney sheep have shown that 2-tooth ewes should not be joined with older ewes and similar results were achieved with Merino ewes. Mating management of Merino 2-tooth ewes is critical particularly if they are low in liveweight. In two years groups of 2-tooth and older ewes were joined with groups of three rams at 3/100 or 3/300 either on small flat paddocks or on extensive hill blocks. The information is summarised in Table 12.

Table 12. The percentage of Merino ewes mated during the first 17 days (from Allison & Davis 1976a)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Age of ewes</th>
<th>Mean liveweight (kg)</th>
<th>Percentage mated at Ram/ewe ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>3/100</td>
</tr>
<tr>
<td>1 2-tooth</td>
<td>35</td>
<td>94</td>
<td>50</td>
</tr>
<tr>
<td>Mixed age</td>
<td>45</td>
<td>99</td>
<td>80</td>
</tr>
<tr>
<td>2 2-tooth</td>
<td>41</td>
<td>93</td>
<td>84</td>
</tr>
<tr>
<td>Mixed age</td>
<td>45</td>
<td>100</td>
<td>98</td>
</tr>
</tbody>
</table>

Differences in the percentage of ewes mated between 3/100 and 3/300 were much more evident in Trial 1 when 2-tooths were small and poorly developed. At 3/100 however, most of these animals were mated. Also within the 3/300 group 37 per cent of animals below 34 kg were mated in comparison with 59 per cent above this weight. It is worthy of note that in this group 15 per cent of 2-tooths were not mated at all and these animals comprised 60 per cent of all barren animals in the age group. When 2-tooths were better developed, i.e. 41 kg in Trial 2 (Table 12), effects of ram/ewe ratio were not as marked and almost all ewes took the ram during the mating period. Paddock size effects did not seem important and the shape and topography of paddocks...
appeared to be more important factors. Allison & Davis (1976b) have also shown that low liveweight ewes do not migrate to rams as readily as do heavier animals, a further disadvantage of poor feeding and light sheep. Obviously if ewes are not mated they have no chance of becoming pregnant. As a great many of the 2-tooth ewes in the high country will be about 35 kg and some even lighter it is critical to join this age group with plenty of rams (i.e. 3/100), on as small paddocks as is possible particularly for the first 17 - 34 days of mating, and not in conjunction with older ewes. This practice may greatly increase the success of 2-tooth mating. Ram/ewe ratio was not nearly as critical with older ewes which are usually heavier and show a greater tendency to migrate to rams.

Thus it seems that in many situations that conventional ram/ewe ratios are more than extravagant in terms of efficiency of ram usage. Using fewer rams offers farmers increased production providing rams are purchased on the basis of known superior productive merit and not on beauty parade criteria unrelated to production as is often the case. Such a strategy is low cost and needs no additional effort on the part of producers and therefore should be attractive. It is notable that when animals are expensive or thought to be of particular merit (i.e. Booroola rams) that they are usually used over many more ewes than is the normal practice.

The use of more productive animals

The search for more productive breeds of sheep than the traditional Romney has prompted producers to swing to crossbreeding, particularly with the Border Leicester and Cheviot and concurrently there has been a major swing towards using superior (performance-recorded) sires. In most cases more productive sheep have resulted.

a) Crossbreeding

There has been a great deal of interest in crossbreeding in recent times. Trials at Lincoln College in the 1950's showed that Border Leicester
x Romney or BL x Corriedale F1 ewes are approximately seven kilogram heavier and wean approximately 25 per cent more lambs than Romney ewes (Coop & Clark 1965, Coop 1957) although longevity was reduced. Part of this improvement in performance of the BL crosses is due to hybrid vigour and some will be lost in the F2 and subsequent generations. Estimates of the amount of this initial superiority lost with successive interbreeding vary but Hight and Jury (1970) reported that the percentage of lambs weaned in F3 animals was only marginally ahead of the Romney. Selection within the interbreds will of course raise their level of performance, the notable example of this being the development of the Coopworth. Most of the interest between breeds for hill country is confined to Romneys, Coopworths and Perendales.

On the hard hill country at Whatawhata and on easy hill country at Invermay, Coopworth and Perendale ewes had similar total productivity both being ahead of the Romney in spite of the Romney's higher wool production (Dalton et al 1978) whereas on fertile flats at Ruakura, Coopworths were clearly the superior breed. As the predominant breed in New Zealand is the Romney these results are cause for concern. While advocates of the various breeds criticise breed comparisons for various reasons the Romney has not performed well in any of the M.A.F. trials, hence the interest in more productive animals is not surprising.

b) The use of high fecundity strains within breeds

When considering the productive merits of any one particular breed against another it should be understood that there is considerable between-flock, within-breed variation in reproductive characteristics which could and should be exploited within the industry. Many stud flocks have high levels of reproductive performance but as the ewes are well fed and are therefore high in liveweight at mating, their apparent superiority is largely, if not entirely, explainable in terms of nutrition and liveweight and certainly not genetic merit. Such flocks often have nothing to offer industry in
terms of added production in their progeny. If the liveweight fertility relationships in Figure 2 are considered then some flocks will be well above the line. That is they are more efficient in terms of their reproductive capability at a given liveweight. It is these animals which have a definite contribution to make in terms of increased production.

Two sources of data point to the efficacy of using high fecundity strains within breeds (Clarke 1978). The Ruakura fertility flock which had been selected on the basis of lamb drop of the dams produced 46 more lambs born per 100 ewes after 25 years of selection than did random bred control Romneys. This resulted in a 31 per cent higher marking percentage. Also many large scale breeding schemes are operating within New Zealand and the largest is a Lands and Survey Scheme at Waihora in the Rotorua area. Experiments using rams from both the Ruakura and Waihora flocks as well as local "industry" rams have compared the performance of progeny all generated from similar base ewes. Substantial advantages have been shown in the progeny from the high performance sires (Clarke et al 1978). Three trials have shown advantages in lamb tailing percentage of 15, 11 and 18 in ewes sired by the high fecundity sires. With the Waihora sires there is some suggestion that the advantage diminishes with age of the progeny (Table 13).

Table 13. Average advantage in lamb tailing percentage to Waihora sired ewes (Crater trial, Clarke 1978)

<table>
<thead>
<tr>
<th>Number of records</th>
<th>Age at lambing (yrs)</th>
<th>Waihora minus industry (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>177</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>436</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>366</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>195</td>
<td>5</td>
<td>-3</td>
</tr>
</tbody>
</table>
c) The use of Booroola Merinos

This breed has been used at Tara Hills since 1973 in a grading up programme. At present 1/2 and 3/4 Booroola ewes are being compared with Merino ewes. The Booroola cross animals have had very substantial advantages in terms of lamb drop as is shown in Table 14.

Table 14. Reproductive performance of Merino and ½ Booroola ½ Merino ewes.

<table>
<thead>
<tr>
<th>Age</th>
<th>Breed</th>
<th>Mating wgt (kg)</th>
<th>Lambs born/ ewes</th>
<th>Percentage barren</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-tooth</td>
<td>Merino</td>
<td>42</td>
<td>1.06</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>½ B ½ Merino</td>
<td>41</td>
<td>1.61</td>
<td>22</td>
</tr>
<tr>
<td>4-tooth</td>
<td>Merino</td>
<td>46</td>
<td>1.22</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>½ B ½ Merino</td>
<td>44</td>
<td>1.80</td>
<td>10</td>
</tr>
</tbody>
</table>

As well as the higher lamb drop Booroola crosses have had lower barrenness in most of the trials. This has also been shown with 1/4 Booroola ewes in field experiments.

Hogget fleece weights of ½ Booroola, ½ Merino, and ½ Booroola ½ Romney ewe hoggets have been similar to the Merino and Romney ewes with which they have been compared. The exception to this is the progeny of the first three Booroola rams used in 1973 where hogget fleece weights were 0.4 kg less than in Merinos. Fleece weights of the 1974 born animals are shown in Table 15.
Table 15. Greasy fleece weights (kg) of ½ Booroola ½ Merino and Merino ewes - Tara Hills.

<table>
<thead>
<tr>
<th>Age</th>
<th>½ Booroola</th>
<th>Merino</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hogget *</td>
<td>5.2</td>
<td>5.1</td>
</tr>
<tr>
<td>2-tooth †</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>4-tooth</td>
<td>4.9</td>
<td>5.0</td>
</tr>
<tr>
<td>6-tooth</td>
<td>4.4</td>
<td>4.8</td>
</tr>
</tbody>
</table>

* Shorn as lambs and then shorn in February 12 months later
† Pre-lamb shorn - 7 months wool

The progressive decline in fleece weight as ewes get older is partially accounted for by the superior reproductive performance and has also been observed in the Romney crosses. The use of the Booroola in industry will most probably be as a ½ to give more moderate increases in lamb drop. This should have some application in both the high country where the reduction in barrenness particularly in lower liveweight young sheep will be an advantage, and in hill country where ½ Booroola ½ Longwool rams can be used over Longwool ewes. In crosses with the Perendale, hogget fleece weights of the ½ Booroola animals have been higher than the Perendale. When considering the use of the Booroola the total production of the crossbred ewe must be considered, that is the increases in lamb production must be balanced against any decreases in wool grown which may occur. It is important to note that the Booroola has never been selected for fleece weight and attention to this characteristic in the future should increase wool production.

The Booroola has had a great many critics as well as advocates and comments of very poor size and wool production are frequently heard. At the
recent high country field day participants were asked to identify which of three pens of animals contained Merino, 1/4 Booroola, 3/4 Merino, or 1/2 Booroola 1/2 Merino ewes respectively. If the choice had been entirely random then 1/6 of the people would have had the correct solution. In fact there were only 13 per cent of correct answers which suggested that, where Merinos and the crosses are run together under similar conditions, it is very difficult to tell the difference.

d) High fleece weight breeds or rams

Selection for fleece weight within a breed will result in much faster progress in that characteristic than selection for fertility. In fact most hill and high country producers tend to do this whether by eye appraisal when selecting rams or by the use of records. Certainly a great many do not use records when selecting sires and consequently often little, if any, progress is made. Of course this assumes records are freely available which is not the case with less than 30 per cent of all sheep studs (including only five Merino studs) on Sheeplan. Particularly with Merino studs the objective records on which to make an accurate assessment of a ram's genetic merit are seldom available.

e) The use of crossbred cattle

A great many research reports point to the greater production from Friesian-cross beef cows and it is difficult to understand why there has not been greater adoption within industry. Of the cattle run in the South Island high country 51 per cent are Herefords, 29 per cent Hereford x Angus and 11 per cent Angus. Purebred Friesian cattle have also proved to be more efficient than the traditional beef breeds as is shown in Table 16.
Table 16. Comparison of Angus, Friesian and Hereford Cows - Tara Hills

<table>
<thead>
<tr>
<th>Breed</th>
<th>Angus</th>
<th>Hereford</th>
<th>Friesian</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of records</td>
<td>154</td>
<td>151</td>
<td>187</td>
</tr>
<tr>
<td>Calving percentage</td>
<td>86</td>
<td>87</td>
<td>84</td>
</tr>
<tr>
<td>Weaning percentage</td>
<td>83</td>
<td>78</td>
<td>76</td>
</tr>
<tr>
<td>Calf weaning wgt (kg)</td>
<td>163</td>
<td>164</td>
<td>213</td>
</tr>
<tr>
<td>Cow wgt (kg)</td>
<td>375</td>
<td>395</td>
<td>415</td>
</tr>
<tr>
<td>* Productivity</td>
<td>135</td>
<td>127</td>
<td>161</td>
</tr>
<tr>
<td>† Efficiency</td>
<td>36</td>
<td>32</td>
<td>39</td>
</tr>
</tbody>
</table>

* Wgt calf weaned/cow mated
† Wgt calf weaned/100 kg cow liveweight

There are considerable advantages in terms of weight of calf weaned either per cow or per 100 kg of cow liveweight. The use of the Friesian in beef production has recently been reviewed by Baker & Carter (1976) who conclude that there is still some doubt about the fertility of the purebred Friesian on hard hill country and under drought conditions. There are of course also problems with the meat grading systems with leaner unfinished carcases receiving a lower price, surely an anomalous situation when the boned out meat is exported. However, the most logical use of the Friesian in the beef industry is as the basis of a crossbred cow, which enjoys advantages of approximately 30 per cent in productivity and 20 per cent in efficiency. Table 17 is a good illustration of this (Parker et al 1977).
Table 17. Production from Angus, Friesian and Crossbred cows
(Parker et al 1977)

<table>
<thead>
<tr>
<th>Cow breed</th>
<th>Cow weight (kg)</th>
<th>Calf weaning wgt (kg)</th>
<th>Percentage cows in calf</th>
<th>Productivity</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angus</td>
<td>405</td>
<td>152</td>
<td>74</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Friesian (F)</td>
<td>438</td>
<td>186</td>
<td>73</td>
<td>121</td>
<td>113</td>
</tr>
<tr>
<td>F x Angus</td>
<td>444</td>
<td>180</td>
<td>82</td>
<td>131</td>
<td>119</td>
</tr>
<tr>
<td>F x Hereford</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Wgt calf weaned/cow mated (Angus = 100)
† Wgt calf weaned/100 kg cow liveweight (Angus = 100)
** Diagnosed in calf, percentage of those joined including 14 month heifers

It is generally assumed that the dairy herds are a good source of Friesian-cross (or Jersey-cross) animals for the beef industry. This is feasible in the North Island but in the South there are few dairy cattle available and a two tier system where some beef cows are mated with Friesian bulls to produce the crossbred dams is more logical. Perhaps the only logical place for the various fashionable "exotics" is as a terminal sire over the crossbred beef dam. The exotics appear to offer no advantages over the Friesian as the basis of crossbred beef dam.

Such a crossbreeding system within industry would offer substantial increases in production and profitability. It seems that farmer traditionalism (i.e. the like for pure but often unprofitable beef animals) together with problems of downgrading of some leaner beef carcases at present are preventing wider farmer acceptance of this strategy. Changing the grading system, in order that the leaner but heavy carcases are not financially
disadvantaged, should be a simple matter but for some obscure reason is not.

f) Reducing fatness in lambs

With a more active discrimination against overfat lambs and a stated long term aim of the Meat Producers Board of drastically reducing the back fat measurement from 16 mm down to 10 mm the problem of fatness becomes serious for the industry. The strategies available to industry have recently been reviewed (Kirton 1978). Delaying drafting lambs or restricting nutrition of lambs after weaning or after they are predicted to be overfat will have little effect on carcass fatness. The effective strategies are:

1. Lowering carcass weights - this would lower the amount of meat produced and is thus not attractive.

2. Increase stocking rates - overfat lambs are seldom found on farms with high stocking rates. This is usually a reflection of lower carcass weights.

3. Using sires with a larger mature size such as the Suffolk, Hampshire or Dorset - this will produce leaner lambs at the same carcass weight in comparison with Romney or Southdown sires. With the present schedule and wool pull system operating, there is little to choose in the profitability of using various Down or longwool breeds for fat lamb production.

Two possibilities could well be effective however. The non-castration of ram lambs prior to slaughter should be considered a high priority strategy for industry and any co-incident labour problems should be anticipated and overcome. Can we afford to let a no-cost method of increased production continue to slip past. Typical growth curves for total carcass fat and total lean are shown in Figure 7 (Drew 1972).
FIGURE 7. Changes in the content of carcass fat and lean from entire male and female sheep.
At a carcass weight of 15 kg, males may have up to 30 per cent less fat and approximately 15 per cent more lean tissue than do females. Castrated males will have a carcass composition which is intermediate between males and females. There are also considerable growth rate advantages in leaving male lambs entire. Ram lambs could be expected to grow 20 per cent faster than the castrates.

Selection within breeds is also a possibility to solve this problem and a major project on this topic is now underway at Invermay. Large numbers of ewes and rams have been screened using an ultrasonic device for measuring back fat thickness. Small numbers of the leanest and fattest ewes have been multiplied using egg transfer techniques and their male progeny will be progeny tested with continuing selections being made for leanness. Selection within breeds has proved effective in pigs and the limited available information in sheep suggests it may also be successful here. In any case the future for the industry in solving the lamb fatness problem does look bright on the selection side but there should be immediate moves to initiate the slaughter of entire males. If this was done, ram lambs could be slaughtered at higher weights than are wethers at present without fear of an "overfat" problem. Other than the use of heavy-weight sires, selection within breed is of course the only strategy available for female lambs.

Conclusions

At present it seems that most hill and high country is grossly underfarmed. Increases in animal production are possible within existing levels of land development and many of the management strategies discussed are low cost and therefore should be attractive. With the likelihood that arable areas in New Zealand will be progressively devoted to more intensive crop and animal production an increasing proportion of the total sheep and cattle will
need to be bred and fattened on hill and high country. Very large increases in these areas will be possible with relatively cheap development of hill and high country lands and improved nutrition through grazing management should make it possible to obtain higher levels of production from existing or improved breeds of livestock. Hopefully the political, economic and industrial climate will combine to make this a reality in the not too distant future.
REFERENCES


DISCUSSION

With regard to the oestrogen problem of the bred clovers and perhaps lucerne in Australia there is a cyanide problem with hybrid sorghums which is overcome by feeding sulphur and sodium in licks. Do you think that the addition of, say, iodised salt, or sulphur, might get around the problem?

Dr Allison:
Absolutely no.

Have they been tried?

Dr Allison:
A lot of things have been tried. Oestrogen affects the reproduction tract itself and other things in the diet. The only way to get over the effect of oestrogen on the reproductive tract is not to eat oestrogen.

Is it sight or smell which determines whether a ewe will be tupped or not?

Dr Allison:
Mainly sight. We have undertaken some ram tethering experiments at Tara Hills. The ewes had to go to the rams to be mated. The lighter animals did not migrate to the rams nearly as readily as the heavier ewes and similarly two-tooth ewes did not migrate to the rams nearly as much as the older ewes.
How long does Selenium last within the body of the animal once you have drenched it? Does the feeding of salt increase liveweight gain of lambs that are not on lucerne?

Dr Allison:
Selenium does not last particularly long. It is most important to give ewes selenium prior to mating them and at pre-lambing which covers the lambs up to tailing.

Other pasture plants are much higher in sodium than lucerne. With most grasses you won't get a sodium response. There are marginal responses in some situations.

Was the feed intake in the cattle experiment measured?

Dr Allison:
No. The efficiency figure is looked at as kilograms of calf weaned per hundred kg of cow. That takes intake into account.
There are significant areas of arable land on many South Island hill farms, which commonly form a key part of the economic unit. This flat land is usually close to the homestead, and is used for the provision of hay or silage, winter forage and the occasional grain crop. The area also tends to have the best pasture, is higher than average in soil fertility, and can sometimes produce very high crop yields.

The costs of crop production have been escalating rapidly in recent years, and this has caused a general trend toward low-cost all-grass farming, which is now successfully established even in districts such as Southland with a traditionally cold winter. This change to greater reliance on grass is extending to the hill farmers too, but with long frosty winters and occasional snow falls the provision of supplementary feed is still essential particularly where stock numbers and performance are still rising as pastoral farming is intensified. The widespread use of oversowing and top-dressing is the primary cause of the increase in stock numbers but it has accentuated the late winter-early spring feed gap, even though there is more growth at either end of the winter and more fat on the backs of the sheep in the autumn.

Limitations to cropping

Cropping in the intermontane basins and valleys of Canterbury and Otago is limited by several factors. The growing season is short, and there is an increased frost risk which can occur in almost any month. Many of the soils

* Lincoln College.
are weakly structured and can blow badly in high winds. Winds can also cause severe damage to cereal crops before harvest. Farmers have learned to cope with most of these problems, but weed control is a never-ending battle, particularly the rhizomatous weeds such as browntop, *Poa pratensis*, and sorrel. These are not easily controlled by fallowing due to the weak soil structure and high winds. Many of the most fertile soils of the MacKenzie Country and the Rangitata are badly infested with *Poa pratensis* which reduces yields markedly in many crops. The new chemical glyphosate may well be the answer to these problems. Relatively low rates will kill browntop, sorrel is severely checked and it may well be equally effective on *Poa*. We have had good results with half the recommended rates in pasture renovation at Hunua, which has reduced costs considerably.

**Minimum tillage systems**

The high cost of seedbed preparation has led many farmers and engineers to closely examine ways of producing a seedbed more efficiently. Already many farmers on the plains have reduced the numbers of cultivations, while some have even moved into direct drilling; that is drilling a crop into undisturbed ground after killing the resident vegetation with a chemical. Minimum tillage will come into increasing use as cost of fuel and machinery rises, but there are considerable problems with it, particularly for the hill farmer. It is important to obtain a complete kill of the existing vegetation, and weeds like sorrel and *Poa pratensis* may be both hard and costly to control. In addition where soil nitrogen levels are low, direct drilled crops will develop acute nitrogen deficiency unless bag nitrogen is applied. A major benefit of normal cultivation is to increase mineralisation of nitrogen and sulphur from the organic matter with release of nitrates and sulphates to the sown crop. In spite of these drawbacks, minimum tillage techniques, or direct drilling are well worth considering for crops such as brassicas or greenfeeds provided the rainfall is greater than 700 mm, the soil fertility is high, bad weeds are absent, and good drilling equipment (triple disc or Baker coulters for direct drilling) is used. A major advantage in windy districts is that risk of wind
erosion is reduced to a minimum. Dr David Painter of the Engineering Institute at Lincoln College measured a loss of 40 kg of soil/ha/minute from a cultivated paddock in North Canterbury during a strong nor-wester in November 1975. This is equal to 5t/ha/day. A 10-15t loss equals 1 mm depth of soil. Using minimum tillage will go a long way towards keeping soil losses low.

What, then, are the new developments in supplementary feeding?

Haymaking

There has been a major change towards the use of large balers in the last few years because they are convenient and quick to use and are less labour intensive. A general impression has also arisen that big bales do not have to be protected from the weather but can be left on a dry paddock ready for feeding, and will shed the rain quite effectively.

Dr Gerald Scales decided to look at hay losses from big bales more closely and started a series of experiments in 1976 at Winchmore Research Station. He examined losses during haymaking, using large round and small oblong bales of both lucerne and meadow hay. He then stored the round bales in a barn, or behind a shelter belt, or left them exposed in a paddock, and measured losses up to feeding in midwinter.

His results so far have shown that losses during harvest average about 20 per cent but range up to 53 per cent and are affected considerably by the type of machinery and baler used, and the moisture content of the material. Losses increase rapidly when dry matter percentage is above 80 (Fig. 1) and as the main loss is brittle leaf material, there is a major decline in quality as well, particularly in lucerne. Table 1 shows losses in the 1977 experiments when hay was baled at 73 per cent dry matter.
Table 1
Haymaking Losses (Scales, unpublished data)
(% Dry matter)

<table>
<thead>
<tr>
<th></th>
<th>Lucerne</th>
<th>Meadow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large round bales</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>Small oblong bales</td>
<td>20</td>
<td>16</td>
</tr>
</tbody>
</table>

Figure 1
Effect of moisture level on dry matter loss during haymaking

% haymaking Loss

% DM at Harvest
Losses during storage showed a large range (Table 2) with the exposed round bales not only showing a large loss of dry matter, but also resulting in a decline in palatability, with up to 15 per cent being wasted. Losses and waste from lucerne were generally higher than from meadow hay.

Table 2

Percentage losses in round bales during storage February - August 1978
(Scales unpublished data)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>DM Loss</th>
<th>Waste</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed</td>
<td>15</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Sheltered</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Hay barn</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

There is little doubt from Dr Scales' work that there are great advantages in storing big bales in a barn, or at least behind a good shelter belt. Leaving bales in the open, particularly in districts with a high rainfall can prove a very costly procedure and may result in a loss of nearly one third of a farmers' hay supplies. When this is added to the 20 per cent loss during haymaking, only 50 per cent of the hay that is cut may actually be eaten by the animal.

Lucerne

Lucerne is important on many properties as a source of high-quality hay and in drier districts for grazing and lamb fattening as well. The advent of the blue-green and pea aphids together with the increasing problems of bacterial wilt, stem nematode and other lucerne diseases has resulted in
lucerne being no longer the easy-to-grow, high yielding, long lived crop it used to be. Wairau lucerne, our standard cultivar for so many years is susceptible to all of these problems, and cannot now be recommended. The best variety to use where wilt is a problem is Saranac. This has a similar growth pattern to Wairau and has the additional advantage of resistance to leaf diseases. It is still fairly susceptible to nematode, and if this pest is a problem, then Washoe is the best cultivar to use. In recent trials Washoe has proved to be one of the most persistent varieties available.

Unfortunately, all of these cultivars are susceptible to aphids and Dr Michael Dunbier a plant breeder of Crop Research Division, DSIR, at Lincoln, has been very active in producing a new aphid resistant selection. He crossed Saranac with a Californian variety CUF 101 which has resistance to the blue-green, pea, and spotted alfalfa aphids. The new selection is called RERE and is resistant to all three aphids and to bacterial wilt. A hectare was harvested for seed in Marlborough this year and some of this has been sent to Idaho for further multiplication in the Northern Hemisphere summer. Seed from this crop should be returned in November, but it will be 1980 before much seed will be available commercially. Rere grows better in the cool season than Wairau but no field scale evaluations have commenced yet. We hope to start a grazing trial this spring at Lincoln College to compare Rere with Wairau, looking particularly at autumn, winter and early spring management.

Many farmers are spraying their lucerne stands to control aphids but Dr Penman and I have found that grazing management can also be very effective, and of course is much cheaper. Aphids spread from field to field by flying, but flights cease from late May until early November. During the winter aphids survive on the lucerne stubble, then multiply rapidly in the spring as temperatures rise. We have found that a hard grazing in late May or early June will eliminate these overwintering aphids and produce aphid-free lucerne
in the spring until aphids start to fly in again during November (Table 3). The winter grazing has no detrimental effect on spring growth of lucerne, provided it is not continued beyond the shortest day.

**Brassicas**

The limited areas of arable land on some hill properties sometimes result in relatively frequent cropping with brassicas for winter feed, with consequent increased disease problems. Clubroot can reduce yields very substantially and I have seen bad outbreaks in turnip crops on some high country properties. Apart from improved rotations, the best way to combat clubroot is to grow resistant cultivars, and Crop Research Division have recently released two new varieties which should soon find favour. The first is a clubroot resistant selection of York Globe turnip named Manga which should be used instead of York Globe wherever the disease is likely. For better fertility soils where swedes are grown, DSIR has released a variety called Kiri. This has a wider range of clubroot resistance than any other swede in N.Z. and outyields other cultivars where clubroot is a problem.
Table 3

Effect of winter grazing on numbers of aphids on lucerne in spring  
(Penman and White - unpublished data)

<table>
<thead>
<tr>
<th></th>
<th>Aphids/stem - Oct.31</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td></td>
</tr>
<tr>
<td>Grazing Date</td>
<td>Aphids/stem</td>
</tr>
<tr>
<td>April</td>
<td>100</td>
</tr>
<tr>
<td>late May</td>
<td>18</td>
</tr>
<tr>
<td>late June</td>
<td>7</td>
</tr>
</tbody>
</table>

| 1978 | Aphids/stem |
|      | Oct. 13 | Nov.9 |
| April | 37      | 0.4   |
| June  | 3       | 0.5   |

Grazed early Nov.

Feed grains

There is good news for those farmers who grow barley or oats as feed grains. The Crop Research Division of DSIR has recently released two new barleys, and a new oat all of which are a considerable improvement on the presently available cultivars.
Kaniere is consistently the highest yielding feed barley in Canterbury and Otago at present. It has a strong straw and is fairly resistant to neck break which is a major problem in the mountain valleys where strong winds are prevalent. Screenings are low and the plump grain makes a very good feed barley.

An alternative is Manapou, which is a malting barley but quite suitable for feed too. It has also been selected for resistance to neck break and has low screenings.

The new oat variety is called Omihi and was bred by Mr Wright at Crop Research. It yields 18 per cent more than Mapua when autumn sown and 30 per cent more when spring sown. Beside the increase in yield the grain has a thinner husk, and the kernel has consistently more protein and oil than Mapua making it a much better feed grain. Only limited amounts of seed are available for 1979 sowings but it should be plentiful by 1980.

Cash Cropping:

Cash cropping has not featured on hill properties except in certain favourable pockets, but there is a very real potential on a surprisingly large number of farms, which could provide useful diversification for the sheep man. It is unlikely that he could compete with the intensive mixed cropping farmer of the plains in the growing of conventional crops because of the extra costs e.g. high transport etc. What he should concentrate on are high value-low volume specialist crops which could be very profitable. Arable land in the high country has three advantages.

1. The climate e.g. cold winters, low humidities, and remoteness results
in freedom from many troublesome insect pests and diseases.

2. The soil is often free of contaminant weeds e.g. hard seed of white clover which prevent the growing of new legume cultivars in most districts. Some flats may never have been cultivated.

3. In summer, the weather may be fine and very warm, with a high light intensity, creating good conditions for high yields, ripening and harvesting.

Water is very important for many cash crops and already irrigation schemes are appearing in some high country areas. Dr Jermy of Crop Research grew a crop of Rovar peas at Haldon Station last season and obtained 1.9 t/ha under dryland conditions. With irrigation however, yields were doubled to 3.8t, which is as high as pea crops on the best soils of the plains.

What are some of the specialist crops that high country farmers should consider?

On virgin land which has not grown legumes before, there is a real potential for growing breeders seed of newly released legumes such as Maku lotus, Pawera red clover, or Pitau white clover. This has the additional spinoff that Maku lotus and Pawera red clover could be extremely valuable for oversowing the nearby hill country.

The passing of Plant Breeders Rights legislation in 1973 is resulting in a wide array of new crop and pasture cultivars being introduced into N.Z. by private plant breeders, some of which are proving to be extremely valuable. There is good opportunity here, too, to grow high quality breeders seed. For example Plant Breeders Ltd have several overseas browntop and red fescues which are considerably better than N.Z. certified browntop and chewings fescue as lawn grasses. They are already on the N.Z. acceptable
cultivars list but seed is very expensive because it is all imported. Northern Southland farmers once made the Chewings fescue a specialist crop - why not these new turf grasses for the high country farmer?

Deer farming provides one of the best opportunities for back-country farmers to diversify into today, and recent research is showing the value of high protein supplements to promote earlier and heavier antler development in stags. Perhaps the cheapest way of providing this is to grow grain legumes such as peas or lupins or produce high quality lucerne hay. It is likely to be considerably cheaper to grow these crops near the deer farms than to transport them long distances from the plains. Dr Jermyn's trial with peas at Halden Station in 1978 showed that yields with irrigation can be quite high. Another grain legume with possibilities for human consumption is lentils, which may thrive in a hot dry climate such as Central Otago.

As irrigation is extended, the possibility of growing other crops may occur. Some Waitaki Valley farmers are already moving into stone fruit production, but what about berry fruit, herbs and even blueberries? The peaty Dobson soils near Twizel may be ideal for blueberries, and the Hermitage could provide pies for all the tourists.

In conclusion, these are the main points to remember from recent research on cropping:

1. Large losses occur in haymaking. Big bales should be stored behind shelter or in a barn, not in the open.
2. New lucerne stands should be sown with disease and pest resistant varieties. But early winter grazing will help control lucerne aphids in the meantime.
3. The aim in growing forage crops and feed grains must be to produce high yields. Newly released varieties will help considerably in this.
4. There is real potential for production of high value specialist crops as a means of diversifying production.
DISCUSSION

You did not mention any of the extremely high yields of Scandinavian wheats which I know are in the country. I have tried to get them released for growing in the high country.

Dr White

Under the new Plant Breeders' Rights Regulations all these new cultivars have to go through two to three years' testing period before they are released as an acceptable cultivar.

Saranac and Washoe are in my experience low producing, but all of the plants remain. What is the comment on that?

Dr White

Saranac has been used in a number of trials where it has produced as well as Wairau. It has a very similar growth pattern although it is a little bit coarser in the stem. Washoe does not produce as well as Wairau in the first couple or three years, but after that, because of its persistance, it does produce well. Both are susceptible to aphids.

Do you get aphids in the high country?

Dr White

Yes. They certainly may not over-winter quite so well as they do down here but they may come in with the easterly winds later on. There have been problems with them in the Mackenzie country and in Central Otago.

Do aphids over-winter in hay?

Dr White

That is unlikely. Aphids will get down to the base of the lucerne
plant in the field and that is where they over-winter. If the stand is bared right down to the ground in early June there is nowhere for them to live.

*What lucerne variety would you recommend for over-sowing on dry-land or sunny faces in the high country? There is no point in using the old Wairau. Is there still a case for Glutinosa?*

Dr White

Our work at Hunua shows that for over-sowing, the best variety would be College Glutinosa because of its rhizomatous habit and greater persistence.

*What about the availability of seed?*

Dr White

There is a crash programme to build up Rere seed and, as I mentioned, we are using the Northern Hemisphere to try and multiply this. There certainly won't be very much around this year.
MECHANISATION DEVELOPMENTS WITH PARTICULAR APPLICATION TO HILL AND HIGH COUNTRY FARMING

J.S. DUNN *

The requirements of hill and high country farming are not always met by general advances in agricultural engineering. The aim of this paper is to review developments which are likely to have particular application under these conditions.

Fodder Conservation

Big bales

The advent of the big baler some five years ago was welcomed by many as the first serious attempt to use tractor rather than muscle power to handle the bulkiest, most widely used commodity in New Zealand agriculture.

The machines met with a ready acceptance and there are now well over six hundred in use throughout the country, although we are still learning how best they may be fitted into our farming pattern. They would seem to have a particular application in the foothill areas where labour and carting contractors are both scarce.

Big round balers

It is often claimed that hay made into big round bales is weather proof

* NZAEI Lincoln College
Figure 1. A round bale stored outside, showing a significant area of deterioration.
and has no need to be barn stored. As a consequence, it is thought that bales can be parked anywhere in the open adjacent to winter feeding paddocks, so saving the trouble of carting into barns and out again. This procedure is widely practised, but it is not generally realised what losses can occur (Figure 1).

Trials at Winchmore Irrigation Research Station (rainfall 750 mm) and others by the NZAEI at Hari Hari on the West Coast (4000 mm) showed that dry matter loss and quality deterioration can be considerable when big round bales are stored outside. In exposed situations, feed value losses of 40 per cent with meadow hay and 50 per cent with lucerne have been measured. Losses were reduced appreciably where the bales were sheltered from the prevailing rain bearing wind. Losses with conventional bales, barn stored, have been up to 25 per cent from mowing to feeding, although they are more often below 20 per cent.

Most round bale loss occurs when rain penetrates the bale thatch. The more open thatch of the lucerne accounted for the high losses with this material. There was little loss due to the bales being in contact with the ground. When big bales on the West Coast were fitted with impervious plastic covers, weathering losses were eliminated, but such a practice on a farm scale would be expensive in labour and materials. Big round bales may be classified into two groups depending upon the way the bales are formed. Machines following the original Vermeer pattern, e.g. New Holland, Hesston, International Harvester, Massey Ferguson, produce bales with a high density core while bales from the more recently developed Welger family of balers have a soft centre and a very tightly wrapped outer skin. Soft centre bales seem better able to breath and so condition any hay baled on the green side. As a result they suffer less moulding. Balers producing these bales, however, require a slightly higher power input.
Feeding

Feeding out big round bales presented problems initially, but it was not long before numerous solutions appeared. There is now a wide range of equipment including the following:

a) A simple bar axle with tow chains each end. Its cost is low but the feed is erratic.

b) A p.t.o. powered spike. Intermittent feeding is possible but the feed is erratic. It costs less than $1,000.

c) A tractor mounted carrier with driven roller or chain flooring. A popular machine costing about $2,000.

d) The bale buggy. Self loading and feeding without hydraulics or p.t.o., but single bale capacity only. Being made by six manufacturers in New Zealand and costs about $1,600.

e) Multiple bale carriers for two, three or four bales with powered feed mechanisms. One four bale machine now costs $13,000.

Big square bales (Howard)

After some knotter and power drive troubles with the early machines, performance has now settled down well. A lower density bale than either conventional or big round bales is produced and this factor allows the hay to condition after baling either naturally or artificially. Simple tunnel drying meadow hay in big square bales has produced a very high value material in the United Kingdom. Supplied with each baler is a gripper attachment for a tractor front end loader and this permits rapid and effortless loading, stacking and unstacking. Straw bales can be stacked to considerable heights and form stable stacks, but difficulties can arise with stacked meadow hay if shrinkage occurs during storage. Low density bales require increased storage space and do not contribute to efficient operation if long distance haulage is involved.
No weather shedding properties are claimed for the big square bales, so hay should be stored under cover. Specific feeding devices have not been developed for big square bales as they break down easily for feeding. But they can be fed successfully in many conventional forage wagons.

**Conventional balers**

Many farmers who have not made a change from the conventional baler are quite happy to continue, having seen some of the foregoing problems experienced by their neighbours. Improved handling techniques for conventional bales have been slow to develop. They are expensive and often do one job only. The G.D.S. system from Southland looks as good as any at this stage. This consists of an effective accumulator towed behind the baler, an impaler on a tractor front end loader and an adaption of a United Kingdom idea, the Amalgam loader. This is a simple tipping trailer with clamping sides which picks up the stack of 48 bales built with the impaler loader. The trailer loader without its sides makes a useful general purpose tipping trailer in the off season.

**Stackmakers**

New Zealand users of the large stack making machines (Hesston and McKay) have had their early problems, but these have been overcome now the need for a uniformly dry swath has been understood. With their appropriate feeder units, they provide a complete one man outfit, but the initial cost is frightening.

**Haymaking in general**

Conservation of feed in the form of hay is often wasteful both in the making and the feeding processes. This is particularly so in areas of high
humidity, high rainfall and strong winds. Yet haymaking persists, probably because the art of making quality silage is less well known and understood and the overall power and capital requirement for haymaking is less.

An alternative

There is a fully mechanised one man alternative that has been used successfully over the years for sheep, with little or no waste. Whole grain feeding has its followers, but we hear little of it. It would be interesting to know the comparative cost per feed unit reaching the animal between this system and that of haymaking and feeding.

Cultivation

Cultivation on hill and high country may be extensive and cover large areas of indifferent and often shallow and/or stony soils, or it may be very localised in small isolated pockets of workable soil in areas broken by stony outcrops or steep terrain. With traditional operations, repeated passes with a succession of implements often at prolonged intervals can expose the soil to erosion, panning and dessication and may never produce good conditions for germination and establishment.

Simultaneous ground preparation, fertiliser application and seed sowing in one operation would have numerous advantages, particularly if much of the existing turf or ground cover could be maintained. Early work with direct drilling on downland farms, firstly with modified conventional drills and, more recently, with the triple disc configuration, have given acceptable results where conditions were favourable, but many disappointments have led to a search for better methods.

The NZAEI, in conjunction with the TGMLI, MAF, DSIR, Lands and Survey and the Forest Service are continuing a series of trials throughout the
South Island using a machine they have developed after a season's work in 1977 with an outfit built by Mr Leighton Coutts of Palmerston, Otago. The Institute machine is basically a Howard Seedavator (a combined Rotavator and Connor Shea seed and fertiliser drill), with rotor and tines modified to cut slits rather than work the full width of the machine and coulters and press wheels flexibly mounted to follow the blade slits. The rotor is geared up to rotate at higher than normal speeds: the machine does not like large stones but it will cope with them.

Results with various species of grass and clover have been very promising in the past two seasons and it is hoped that more than a dozen sites will be treated this year. These are mainly in the South Island, but requests for trials have also come from the North.

John Baker at Massey University has developed a machine with the same intention by employing a banded herbicide application to kill the original ground cover and a large scalloped disc to effect penetration. There is no power drive to the soil-engaging parts. Two replaceable angled tines mounted on either side of the disc open horizontal slots at drilling depth and seed and fertiliser are metered separately into these. There is no contact between the seed in one slot and fertiliser in the other. An approach to the same problem by the Scottish Institute of Agricultural Engineering has some interesting features.

An 'A' blade coulter mounted behind a plain disc is fitted with angled wings which cut horizontally and lift the soil to form cavities. Seed is delivered pneumatically to discharge into the extremities of the cavities and fertiliser is dropped into the central disc slot. In this way, two rows of seed are sown from a single coulter so that less weight and power is required. All seeds are covered in unsmeared soil and there is no seed/fertiliser contact. The cost of fuel even at the present inflated levels still does not constitute a high proportion of total cultivation cost, but
Figure 2. A Water Watcher.
severe reductions in fuel usage may be forced on us by a shortfall in supplies. However, the economics of cultivation are being influenced appreciably by the rapidly rising costs of labour, tractors and machinery. Any reduction in overall working time and effort must produce economic benefits providing yields are not adversely affected.

Water supply and irrigation

A growing interest in the harnessing of natural resources as a source of power must provide benefits to hill and high country areas. More efficient forms of wind and water wheels have already appeared and the application of new techniques and materials is likely to raise efficiencies still higher. A wider availability of water in remote areas will result. Stock watering must have first call on such supplies, but irrigation should not be discounted.

Irrigation on a farm scale is unlikely but localised watering has a place. Assured tree establishment and growth in difficult situations and the subsequent shelter could increase production of both crops and animals. Small amounts of water only are required but they make all the difference. Trickle irrigation is ideal for tree watering, either on individual trees or in a continuous planting, and as pressures and flow rates are both low, small gravity fed supplies are quite suitable. Manual operation of such a scheme at a daily or some other regular interval is frequently not possible in the high country, nor is it necessary with the automatic controllers now available.

The Water watcher from Harvin Engineering is a unique device which uses an adjustable inbuilt electric clock to control the time and frequency of watering. A single cell battery operates the unit reliably for a whole year.

The Methven Autowata valve is another controller, but is much simpler and costs less than one dollar. This may be used to control the supply to a
Figure 3. Fences constructed with light timber posts and 2.5 mm high tensile wire can better withstand high snow loadings than conventional fences.
single outlet or into a length of porous plastic weep hose. Competition from weed and grass growth around watered trees will be increased but release spraying with selective herbicides at infrequent intervals is now possible.

Fencing

High country fencing trials by the NZAEI have shown that conventional methods of construction can be improved while at the same time effecting a saving in cost. Light timber posts in place of steel standards and 2.5 mm high tensile wire (12½ gauge) instead of 4.0 mm (No.8 gauge) have resulted in stronger fences with greater resistance to high snow loadings. In difficult, rocky situations, steel standards may be the only material to give a firm fixing, so these should obviously be used. Timber could still be used in other parts of the same fence. Performance and economy surely come before aesthetic considerations in a high country fence. It is unlikely anyway that the whole length of a fence line can be seen at any one time under such conditions.

The Tyawire batten machine developed by the NZAEI also effects appreciable savings in batten cost, transport bulk and weight, and fixing time - the wire ties used are ideally suited to the lower stock densities of hill and high country situations. A single offset electrified wire is recommended on Tyawire equipped fences for cattle or sheep at high density.

Developments in electric fencing now make it an alternative low cost method for extensive subdivision fencing with a high degree of reliability. Mains operated energisers tolerate no arguments with any class of stock when properly installed. Regular patrols over many miles of electrified fence are no longer so necessary where performance monitors are installed. Any faults or breaks in continuity are immediately indicated and quickly located.
A simple cut-out device introduced at this year's National Agricultural Fieldays will be popular with many electric fence users. Just by touching the electrified wire with a pocket sized controller anywhere along its length, the current can be cut off. Power can be restored just as easily.

Solar generators to power energisers in remote areas are now a practical proposition. Technological developments have been so rapid that the price of a small unit and energiser suitable for a five kilometre fence line which was quoted at $900 three years ago is now retailing here at $310. A larger unit capable of activating a fifty kilometre fence with the power of a mains energiser is available at $810. Long life storage batteries which are trickle charged during daylight hours supply the energiser and their capacity is such that they can deal with a consecutive five day no-sun period. For particularly low sun-hour areas, additional batteries can be added. A monitor in the energiser unit prevents complete battery discharge or overcharge.

The life of complete units is stated to be at least eight years.
Figure 4. A solar power electric fence energiser.
DISCUSSION

Have you had any experience with the small turbine generator?

Mr Dunn:

I have had no experience with it. One of the ex-Ministry of Agriculture machinery advisers in Hamilton has been sponsoring the development of a turbine - a new design - but I don't know just how far he has got with it. I know he feels that it has a big application to high country areas. So this is one of the things we will be seeing developed for either pumping water or developing electricity in outlying areas.

How does the solar energiser work at night, or during sustained periods of bad weather?

Mr Dunn:

The unit has got a battery of small rechargeable cells, which, when the sun is shining, are being charged all the time. They have the capacity to carry the unit over for a period of five days or seven days without sunshine. If you happen to be in an area where sunshine does not shine for longer periods than five days you can put supplementary batteries in the unit, but it does give a very good charge rate.
What is the scope of the smaller solar energiser?

Mr Dunn:
Five kilometres for the small one costing $310; fifty kilometres for the one costing $900.

What are your thoughts about the energy costs of running the really big machines?

Mr Dunn:
There is perhaps a misunderstanding on the energy requirements of big machines and little machines. Take, for example, cultivation; the bigger the tractor the less power required per unit area of cultivation. This came out very noticeably at the energy conference at Massey nearly two years ago. One speaker, a Professor at Newcastle University, said "Please don't reduce your development of bigger and bigger units, because these could affect a considerable saving provided your implements are suited to the power of the tractor".
I hope you will judge any remarks I make against the background of an
intensive flat land farmer somewhat out of his depth in the hill and high
country. However, perhaps it is that background that leaves me with the
consistent and striking impression, each time I visit a hill property, of
the tremendous scope that exists for improving the productivity of that
land. Might I add that I have also been very impressed with some of the
development programmes I have seen.

At this Seminar it is production that we are really talking about -
and the role the scientist plays in problem-solving research to help bring
about these increases in productivity.

I have always believed that, in a country where the welfare of every
citizen is bound up with the prosperity of agriculture, we should be spend­
ing even more - and certainly not less - on research into the problems of
our major exchange-earning industry - the "leaving no stone unturned
approach" mentioned by Dr Hayward. However, I am not advocating that we
blindly commit scarce resources to research projects without a firm sense
of direction. In deciding on that direction, I feel sound decisions are
often first made after full consultation with the practical man in the field.

There are two essential ingredients to improving grassland production -
the herbage being produced and the animals which convert that herbage into
saleable pastoral products. Dr Scott has shown the increases in dry matter

* Farmer, Ashburton.
production that could be achieved in varying situations as soil fertility is increased. He portrayed the seasonal pasture growth curve which is not ideally matched by the requirement of the animal, thus requiring some "banking" of feed and some adjustment in management practices to nullify these effects.

Plant breeding research

Dr Scott pointed out the lack of a really suitable legume for low fertility situations and the need for a continuing plant breeding programme because of its importance to the high country. This only reinforces my earlier contention regarding research effort in our major industry.

Subdivision and mob-stocking

Dr Scott also highlighted the fact that subdivision and mob-stocking provide the key to pasture improvement, sward composition and the protection of plant species. I feel the scope for management here is immense. The complementary role of different aspects of research was evident here when Mr Dunn discussed the excellent work being done by his Institute in relation to fencing research for hill situations particularly as this is a major farming cost.

Animal production

Dr Allison gave us an extremely well documented paper, pointing up some new options and some timely reminders of the importance of the application of knowledge we already possess. His comments relating to selenium, oestrogen effects on lambing performance, and the necessity to feed salt when on lucerne, are all reminders in this category.
Ram ratios

He showed clearly that conventional ram ratios can be increased without detriment, but his figures relating to two-tooth matings with big differences in results between 3 to 100 and 3 to 300 pointed up an apparent contradiction in this respect and to me sounded a note of caution. His profound statement "a ewe won't get pregnant unless she is mated" leads me to say that you won't get paid for a lamb without it first being born.

Mating weights

The increased performance from better nutrition and higher mating weights, both for sheep and yearling cattle, is well documented. I agree with Dr Allison that what we must have are animals with the capacity to give higher fertility performances at the much lower mating weights that are realistic in many practical situations.

I believe that with "Sheeplan" and "Beefplan" New Zealand is well to the forefront in performance recording as an aid to animal breeding. This, coupled to the sound application of population genetics - of which he gave examples - offers scope for steady progress. These principles apply to all breeds in all situations.

Compensatory growth

I believe we need to be well aware of the principles of compensatory growth, because of the practical farm management situations continually met in relating Dr Scott's pasture growth curve to animal requirements. However, remember that failure to provide the later feed to enable compensatory growth to take place can be disastrous.
Both Dr White and Mr Dunn showed that the losses from paddock storage of large round bales can be so serious as to be unacceptable. Their conclusions deserve wide publicity.

I sometimes wonder whether, if we had nothing but big balers, the discovery of a machine which made small rectangular bales might not be heralded as a 'break-through'. They are easily fed out without waste, easily transported by conventional means and give flexibility in regulating quantities to different mobs.

However, the ability of large round bales to turn water if rain occurs immediately after baling means the major losses that periodically occur before conventional bales can be carted are now able to be prevented.

Dr White gave an excellent summation of the potential for various supplementary and cash crops in hill situations which again highlighted the importance of the scientist in the spheres of plant breeding and disease control. His comment that lucerne is no longer the easy-to-grow, high yielding, long-lived crop it used to be is sad but true.

Cash cropping

His comment that "there is a very real potential on a surprisingly large number of farms" reinforces my own impression of a soundly based and sometimes considerable opportunity for diversification. Greater transport costs are more than off-set by much cheaper land, often with similar potential to comparable plains units, and with less weed control problems and, for some specialist crops, less contamination from other species.
Overdrilling and minimal cultivation techniques

Both Dr White and Mr Dunn referred to the value and potential of these practices. The search for improved techniques and machines is valuable research which should continue.

Conclusion

I return to my own strong impression that there is considerable potential for large increases in production from our hill and high country. The surface has only been scratched in many instances in relation to what is possible. Dr Allison has said that he feels the hill and high country is under-farmed at present.

The rigours of climate, the slowness of the fertility building process in many situations, monetary and labour constraints in providing sub-division etc, the inherent slowness of animal breeding progress - in fact the very nature of farming, prevent rapid overnight increases.

The capacity is there. However, if New Zealand is to achieve the production increases that are so badly needed, not only must the farmer and the scientist continue to work in complementary roles, but - as Mr Newson mentioned yesterday - it is essential that the servicing sector plays its part.

I have been disturbed that many farmers with whom I converse - who have the capacity, but not the necessity to achieve these increases - have learnt by experience the sheer necessity to preserve a comfortable safety margin. I have also been disturbed that sound financial advisors present here today find that sometimes the course of action that is best for the nation is not necessarily the best or most prudent for the individual.

I sincerely hope that, in the future, we will see a team effort with all sections combining to work for the total betterment of our society.
PANEL DISCUSSION

How far away are we from the stage where we can consider solar energy as a source of farm power? Maybe with 400 sq. metres of solar energy cells on a haybarn roof?

Mr Dunn:
We are using a lot of power in our tractors and they are getting bigger. Your collecting area would have to be pretty considerable I would think, so it may be some time away. But nothing is impossible today. The power from the sun falling on one square metre was equivalent to one kilowatt. At one kilowatt per square metre (a kilowatt is just over a horsepower) if you have a seventy horsepower truck you would have seventy square metres - perhaps a bit less in the summer time here. But if you had a dull day you would have to stay in bed I would think! It is a feasible proposition. It is getting more that way, anyway. We are a little way off yet.

Could Dr Allison comment specifically on the oestrogen level in Montgomery red clover and state if the haymaking process affects oestrogen levels in red clover?

Dr Allison:
Hay made from red clover is fairly safe to feed, although there is some doubt about it. The haymaking process drops oestrogen levels. Montgomery red is just as high in oestrogens as Pawera red. Pawera is no worse than any other red clovers used in pasture mixtures. However, the
important thing is that Pawera persists longer. Lucerne does not have any lasting fertility effects and probably if sheep come off it for three weeks prior to mating and go on to ryegrass/white clover, normal ovulation rates and fertility will result.

Unlike lucerne, however, red clover can have both 'temporary' and permanent effects on reproduction in sheep. There are some data from Australia which says rearing ewe hoggets on oestrogen-rich clovers can have an effect on their subsequent fertility. We are looking at that particular point at trials at Invermay at the moment and we have reared ewe hoggets on particular pasture types including red clover this year. If ewes are grazed on red clover only during pregnancy and lactation, never at mating, they will suffer very serious permanent effects on their fertility, which may not be evident until after several years of feeding red clover.

What about the oestrogenic effects of pure white clover?

Dr White:

While clover is a non-oestrogenic plant unless it is attacked by foliar pathogens. The oestrogen level in most lucerne and white clover can be high when it is attacked by pathogens, particularly leaf diseases. Certainly the same occurs with lucerne, that is why I mentioned that Saranac would be a much better variety for grazing ewes than other varieties, because it is resistant to most leaf diseases and therefore the likelihood of getting high oestrogen levels is much less. The useful tissue is less affected because it has virtually no leaf disease.
What percentage of red clover in a pasture can be tolerated?

Dr Allison:
Even as little as 20 per cent cannot be considered completely safe.

Does Dr Allison discount wool production on its own in the hill country as the vast majority of his paper seemed to deal with meat production, lambing percentages, etc.?

Dr Allison:
Increasing nutrition and liveweight of ewes as well as the use of more productive sires all relate to increasing wool production. What you can do for wool production is use high-fleece weight sires. That relates to using less rams provided you are selecting them on productive criteria. In my view most producers in New Zealand, and certainly most producers in the high country, pay far too much attention to wool type and not nearly enough attention to wool weight. You are paid on weight, not appearances. At Tara Hills we have shorn trial sheep and found the half Ecorocla wool has been consistently down-graded on the basis of style. The difference in cents per kilo has been between one and four. Many people are very proud of their wool and obviously sheep producers have pride in their product, but they are not paid much more for quality.

Can selenium be fed via salt licks or blocks? How much research work has been done on trace element blocks?

Dr Allison:
There has been quite a lot of work done on selenium as an injection, as selenite super, and as a spray on herbage. There are likely to be problems with selenium; low levels do a lot of good, but high levels can be toxic. Some time in the future selenium application may become an on-
farm situation, that is as far as spraying or fertilising etc. is concerned.

Dr Scott:
In the high country the animal mineral deficiencies are primarily selenium, secondly iodine, and possibly cobalt and copper in some areas. The possibility of sulphur deficiency for animals on unimproved grassland is being investigated.

What about growing oat and pea mixtures as a hay crop?

Dr White:
This is something that has been used for many years, both down country and in the hills. The advantage of having a legume with oats is basically to improve the protein level. The protein level in oats as a hay crop may not be high. I think that provided you have got reasonable country that will grow a good yield this is still something that can be continued.

Dr Scott:
We have investigated oat/vetch combinations in the high country. Visually, the difference is spectacular for the oat/vetch combination, there is no difference if actual yields are measured. There is also the difficulty of having two materials to dry in haymaking.

Would Dr Scott reconsider his estimate of yields under irrigation compared with dryland farming? Is his estimate of two or two and a half times yield increase not an under-estimate?

Dr Scott:
We have to separate the water effect from the fertility effect which accompany conversion of native tussock to irrigation. Based on four to
five years' work on irrigation trials in the high country on a good soil, where we ran the same fertility treatments with and without irrigation, the average advantage across twelve species is two to two and a half times though there are a few that go higher. This is to be compared with the fertility effect where there is an increase of about five-fold in yield in converting a low fertility soil to a high fertility soil, either with or without irrigation.

I thought a figure of an annual 25 tonnes was quoted at an earlier high country field day.

Dr Scott:
An exceptional plot on a good soil in the first year did approach that figure but the top treatments averaged over four years were seldom greater than 18 tonnes on these good soils. On the poorer outwash soils which make up most of the potential irrigatable soils in the high country a maximum anticipated yield is only of the order of 5-6 tonnes.

Would Dr Scott comment on sheeps burnett as a species for use on country infested with Hieracium?

Dr Scott:
I regard Hieracium as a problem of low fertility tussock grassland sites where the potential productivity is about one or two tonnes of dry matter, and where there are few alternatives for pasture species. With Hieracium I suspect it is about half that. In the high fertility situation, Hieracium pilosella is like an agricultural plant, it responds to fertiliser, so I think it is with us for a long time. In the high fertility situation pasture grasses and legumes will out-produce Hieracium three to four times, so that by development farm management need no longer be controlled by
Hieracium. In the low fertility situation there are four new legumes worth consideration (zig zag clover, *trifolium ambiguum*, crown vetch, sweet clover) along with sheeps burnett. We have had the existing sheeps burnett in trials for eight years. Its main characteristic is persistance and good spring growth. On moderately fertile soils its annual production is only about a fifth or a tenth of other pasture species. Newer types being introduced are superior yielding than existing lines.

*Has work been done on Lotus pedunculatis, for Hieracium control?*

Dr Scott:

_Hieracium_ does not reach weed proportions in high rainfall areas where _Lotus pedunculatis_ does best: and visa versa.

_Do Dr Scott believe that there is any solution to Hieracium without development?*

Dr Scott:

No.

_Do Dr Scott said that sheeps burnett gave good growth in early spring. In really dry areas is this better than nothing at all?*

Dr Scott:

Yes, but on an annual basis sheeps burnett probably produces less than five or six other species listed earlier.
Is it true that *Hieracium* is no worse than other species in chemically inhibiting growth of other species?

Dr Scott:
It is true. A similar effect is known for danthonia in hill country. When some twenty or thirty species were checked, *Hieracium* was in the middle of the range. Other species were a lot worse; one of which unfortunately was white clover.

Any suggestions for control of *Hieracium lachanellii* once it is well established?

Dr Scott:
The obvious thing is to raise the level of fertility, to enable pasture plants to be used.

What about lime?

Dr Scott:
There is hardly any justification for lime anywhere in the hill or high country. It is too costly. If you can afford to take up a ton of lime you would be better taking up a bag of sulphur.

Do you have any areas of acid rainfall?

Dr Scott:
Not in the South Island.
Will Hieracium reach a climax state and die out?

Dr Scott:

We don't know. In Britain where it reached weed proportions, following reduction of rabbits by myxomatosis it is now tending to fall back to a minor species.
THE ECONOMICS OF HILL AND HIGH COUNTRY PRODUCTION

N.W. TAYLOR AND G. MARS*

1. INTRODUCTION

In this paper it is intended to cover:
(a) Recent trends in agricultural production;
(b) Factors influencing hill and high country profitability and production;
(c) Trends in profitability and production in the South Island high and hill country;
(d) The future for agricultural profitability and production in New Zealand;
(e) Summary.

2. RECENT TRENDS IN AGRICULTURAL PRODUCTION

In contract to the positive encouragement which has been given to the expansion of manufacturing and some other exporters in the post-war period, the agricultural sector has been left to develop largely on its own earnings until just recently.

However, in spite of this, agricultural production has increased significantly over the post-war period and still contributes 70% of our export earnings. The largest boost took place in the mid 1960s when increased stock numbers were carried at little extra cost, and without any fall in per head production (See Figure 1). These initial increases were profitable for both the farmer and the nation. Towards the close of the 1960s however, inflation began to have a significant impact on farm profitability with consequent lower investment levels. This, coupled with some difficult climatic seasons, gave rise to lower overall stock performance and a slower rate of increase in stock numbers. Throughout the 1970s agricultural output has been virtually static.

* New Zealand Meat and Wool Boards' Economic Service
Figure 1. Agricultural Production—Real Gross Output
1965/66 prices

Total Stock Units
The total volume of output in the 1978/79 year is projected to be 2% below the 1971/72 level, and this represents the third year of falling total production. Numbers of stock units carried today are the same as 10 years ago. Why is this, if scope for increased production exists throughout the industry? Are we on some sort of plateau from which it is likely to be difficult and costly to move? Because of the agricultural industry's important position as an export earner, the slow-down in the rate of growth in investment and production during the early 1970s must be of serious concern from a national standpoint.

3. FACTORS INFLUENCING THE HILL & HIGH COUNTRY PROFITABILITY AND OUTPUT

3.1 Opportunity for Expansion
There must be clearly identifiable opportunities available, in terms of expansion in output. This was certainly the case in the 1960s in the hill and high country of New Zealand and this opportunity was taken. Undoubtedly, there still remains a vast physical potential in this area, yet to be exploited. Is it 10% or 50%?

3.2 The Terms of Exchange
While there is undoubted physical potential in this area, the real question now is "How profitable will the exploitation of this potential be?" Farmers must have some assurance that investment today will pay off tomorrow.

In the high country, the relationship between fine wool prices and costs of inputs (terms of exchange) is all-important. When the terms of exchange are in the farmers' favour, farm investment occurs and vice versa (See Figure 2). For example, in the mid 1960s, fine wool prices were firm and input prices were running at an annual rate of 3 - 4% per annum. Thus, the terms of exchange were
such that the marginal return from higher investment in fencing, topdressing, oversowing and stocking on the hill and high country was high and output expanded. Higher wool prices, higher investment and higher output.

![Graph showing fine wool prices and investment S.I. High Country (Real Terms)](image)

**Figure 2. Fine Wool Prices and Investment S.I. High Country (Real Terms)**

### 3.3 Labour Availability

Availability of suitable labour is undoubtedly one of the major factors influencing the expansion of output on much of our hill country. Substitution of capital for labour has definite limitations in this class of farming. Isolation, availability of schooling and cost of transport all make the retention of good labour in the more remote hill country areas extremely difficult.

### 3.4 Climatic Variability

Much of the South Island hill and high country experiences wide variations in climatic conditions, both between seasons and within. This rugged environment places considerable strain on both live-
stock and man, as a result, the economic and physical results achieved are frequently a reflection of this. Due consideration must be given to this point in the forward planning of any development programme.

3.5 The Challenge to Improve

The motivation to apply new technology is, for many farmers, irresistible. Frequently this overrides the economic considerations in the short-run, though the challenge to improve, develop and increase output must, in the end, be subject to economic evaluation. For example, there would be some hill country farmers who, having applied the then new technology of aerial topdressing and oversowing in the 1960s, with spectacular results in terms of dry matter production and higher stocking rates, may now question the wisdom of this, taking into account the associated higher level of "fixed costs" which frequently follow. Would, in fact, a less intensive lower cost operation be more profitable in the end?

4. TRENDS IN PROFITABILITY AND PRODUCTION IN THE SOUTH ISLAND HILL AND HIGH COUNTRY

Production from this area increased very significantly from the mid 1960s. For example, the estimated 300 high country farms in this class have, on average, increased their carrying capacity (expressed in stock units), from approximately 5,500 stock units per farm in 1960 to nearly 7,500 per farm at the present time, a 35% increase. The most rapid period of expansion has been since 1967/68. Since then, total stock units have increased by 25% or 1,500 S.U. The development of the area has been most impressive, with not only stock unit increases, but improvement in stock performance as well. This is a feature of the area which stands out.
For example, the average lambing percentage has increased by about 5% since the early 1960s, with annual fluctuation much less since 1968/69, reflecting the improved levels of feeding in the mean.

Average wool weights per sheep shorn have been maintained over the period and this reflects the importance placed on both quality and quantity of wool in this class of farm. (The same unfortunately cannot be said for other regions or farm classes over the same period.)

An area of marked change is in lamb sales. Prior to 1965 about 500 lambs per farm were sold each year as stores. At present some 1,100 lambs each year are sold, with over 60% going for export; again reflecting the development which has taken place.

These trends are summarized in Figure 3.

Figures 4 and 5 show the trends in the financial position of the high country properties during this period.

Figure 4 illustrates clearly the trend in income, expenditure and net income per stock unit since 1960/61 on South Island high country farms. These figures have been deflated to take account of cost increases. As the trend lines illustrate, gross income per stock unit (after allowing for inflation) has declined over the period, yet expenditure per stock unit has not deteriorated to the same extent. Farms have attempted to maintain investment, with a consequent decline in per stock unit net income.

As Figure 3 demonstrated, stock units carried per farm increased and this situation was made necessary in the face of declining terms of exchange over the period. The effect of this however, was to lift not only total gross income per farm in real terms (See Figure 5), but
Figure 3. South Island High Country Stock Numbers & Stock Performance
Figure 4. South Island High Country Income & Expenditure per stock unit (Real Terms)
Figure 5. South Island High Country Income & Expenditure per farm (Real Terms)
also farm expenditure. While stock units per farm increased by a significant amount, (and consequently output), net income per farm in real terms increased by only a small margin over the same period. In other words, farmers were forced to intensify, increase expenditure and lift output by a substantial amount, yet their net income showed only a much smaller improvement. Farmers, in effect, "ran fast to stand still".

The wide fluctuations which take place in gross income, are a feature of Figures 3 and 4, (both per stock unit and per farm), and this was particularly so during the early 1970s. While there has been a degree of diversification as a result of the development and expansion which has taken place, (especially into beef cattle), there remains a dependence on wool as a major source of income, with between 65 and 70% of gross income being derived from this source. The gross income levels (and therefore ability to invest) follow very closely the movement in fine wool prices. Wool quality and quantity rightfully rank high in the list of high country management priorities.

While gross incomes and expenditure have fluctuated over recent years, there has been an overall deterioration in the financial position of the high country farmer. (See Figure 6 and Appendix 1.)

Prior to 1964/65, liquidity approximated term liabilities, to give net liabilities of nil. The difficulties of earlier years were remembered and cash resources were maintained at levels which were in many years equivalent to the per annum net farm income.

In 1965/66, however, the lines part, and term liabilities per stock unit increased quite sharply to reach $8.80 by June 1977. At the same time, net income declined through to 1970/71 before showing some improvement, but throughout, liquidity has deteriorated significantly to the point that there has been a working capital deficit in 7 of the last 10 years.
Figure 6. South Island High Country Financial Indicators
The gap between net farm income and liquidity is now quite wide, in contrast to the position in the early 1960s. Likewise, term liabilities are currently running at almost 3 times net income.

The operating cash surplus has not been sufficient to generate, from within the farming operations, an adequate level of working capital, and both term liabilities and liquidity have suffered as a result.

In other words, over the period farmers were encouraged to intensify, increase investment and lift output by a substantial amount, yet their net income in real terms has shown virtually no change, and indebtedness has increased. It could be said, therefore, that the nation gained most from this expansionary phase in pastoral farming.

5. WHAT OF THE FUTURE FOR AGRICULTURAL PROFITABILITY & PRODUCTION

What of the future? Production increase which the nation has called for will certainly be forthcoming if it is profitable for the farmer. However, farmers in a cost-price squeeze situation, as outlined above, have two distinct alternatives:

(a) They can reduce costs in an attempt to maintain a margin between a falling gross income and expenditure i.e. income maintenance. (In the medium to long term this, of course, must have adverse effects on total output);

(b) Alternatively, where farmers have investment opportunities and believe increased output will be profitable, they may attempt to lift output and reduce overhead costs per unit.

The Planning Council, in looking at the period 1978 - 1983, suggests
that a 2% GNP growth rate over the 5 year period would require a 2% per annum lift in traditional exports, and a 10% per annum lift in non-traditional exports — assuming a slight improvement in the terms of trade. This would mean a doubling of value of traditional exports from $2500m in 1977 to $5000m in 1985, and a quadrupling in non-traditional exports from $933m to $3836m per annum.

This would mean that traditional exports would drop from around 70% in 1977 to about 55% by 1985. Is this a reasonable proposition?

What are the possibilities of this growth in output occurring? Given a more open economy and more effective allocation of our resources these figures are not unreasonable, but a continuation of the immediate past policies would render this most unlikely.

We believe agriculture can achieve even better than a 2% growth per annum over five years given the correct environment, and the bulk of this increase is likely to come from "main stream" agriculture. However, there are several areas which are of immediate concern and which affect pastoral farming in particular. These would include:

1. An overall policy for agriculture. What are our targets in agriculture, say over the next 5 to 10 years? What is the commitment and what are we really hoping to achieve? What are the impediments to growth likely to be? Without an integrated strategy, it is not easy to define these.

There is no need to return to the elaborate A.P.C. - N.D.C. committee structures of the past to establish the problem areas, but there is a need to know at least where we are heading, and to establish a plan against which we can measure progress. We need a sense of direction - a more positive approach to the problems of the industry.
(ii) An appropriate exchange rate which would provide sufficient re­sources to maintain growth levels of investment in the export sectors and in particular agriculture, on a continuing basis. (When this has been achieved in the past the industry has responded in volume terms e.g. early 1960s.) This should be coupled with a realistic wage fixing formulae.

(iii) A Close Look at the Whole "Farm to Market" Chain
We should be ensuring that the whole production - transport processing and marketing chain is operating at peak efficiency and in so doing, giving maximum return to the producer. Are all links in the chain adding maximum value at minimum cost? Note that the activities of those outside the farm gate have a major bearing on the returns to the farmer. Are they efficient? A chain is only as strong as its weakest link!!

We should regard the products at the farm-gate not as end products in themselves, but raw materials (or inputs) to an increasingly more sophisticated transport - processing - marketing chain.

Given the very real problems of widescale "further processing" of our traditional product, have we really exploited to the full our potential in areas such as the processing of hides and skins in New Zealand? We need to obtain maximum added value, consistent with providing the customer with what he wants.

(iv) A Positive Encouragement to Increased Production. If higher output, in volume terms, is to be achieved have we really set out to encourage it? In recent years, the economic climate has been such that the high marginal costs of further increasing output has mitigated against this, so it is little wonder that volumes of pro­duction have remained static.
Areas which should be considered as sources for volume increase include:

(a) Development of "new" land e.g. Lands & Survey Department operations.

(b) Further subdivision of existing extensive holdings.

(c) Higher production from existing properties by:
- further intensification - more stock/ha;
- improved performance from existing stock numbers.

The high rates of inflation in recent years have forced many farmers to retrench from the high stocking rates of earlier years in an attempt to reduce costs, but through holding or improving stock performance, minimizing the fall in incomes. (The more drastic move to cut expenditure or level of inputs can only be a short term strategy, as few input items are now able to be withdrawn without affecting production).

The stocking rate on many farms is now considerably higher than was the case in the 1960s. Likewise costs per hectare are higher, and for many farmers, the additional cost of increasing output further by higher stock numbers alone would suggest that this method of lifting incomes would be uneconomic for many farmers today.

On the other hand there is strong evidence which suggests that high stock performance (as measured by, for example, lambing percentage, wool clip per head and stock losses) is closely associated with high net profits.

An analysis of the South Island high country sample of farms
demonstrates some of the points quite clearly. (The same applies to North Island hill country farming.)

The group of farms under survey is grouped into two - those achieving relatively low stock performance Group 1, and those with high stock performance Group 2. (Stock performance is measured by Gross Income per stock unit.) The physical and financial results were then averaged and the main features are shown in Table 1.

Group 1 farms have lower stock performance, lower lambing and calving percentage and low wool clip per head. Expressed together, their gross income per stock unit is some 30% below the farms in the high performance group which, in all respects, have achieved high performance.

**TABLE 1**  
S.I. HIGH COUNTRY FARMS (1975/76)  

<table>
<thead>
<tr>
<th></th>
<th>Group 1 Low Performance</th>
<th>Group 2 High Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock units/ha</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Lambing %</td>
<td>78.0</td>
<td>94.7</td>
</tr>
<tr>
<td>Calving %</td>
<td>77.4</td>
<td>82.3</td>
</tr>
<tr>
<td>Wool (kg/hd)</td>
<td>3.9</td>
<td>4.5</td>
</tr>
<tr>
<td>Stock losses - Sheep %</td>
<td>8.2</td>
<td>6.1</td>
</tr>
<tr>
<td>- Cattle %</td>
<td>6.5</td>
<td>4.1</td>
</tr>
<tr>
<td>FINANCIAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Income/s.u.</td>
<td>7.1</td>
<td>10.4</td>
</tr>
<tr>
<td>Gross/ha</td>
<td>5.1</td>
<td>8.7</td>
</tr>
<tr>
<td>Exp/ha</td>
<td>3.7</td>
<td>6.5</td>
</tr>
<tr>
<td>Net/ha</td>
<td>1.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Fertilizer $/ha</td>
<td>0.14</td>
<td>0.48</td>
</tr>
<tr>
<td>Animal health $/ha</td>
<td>0.14</td>
<td>0.34</td>
</tr>
</tbody>
</table>

The financial results achieved are, as could be expected, vastly different. The less intensive lower performing Group 1 farms have a gross income per hectare of $5.10 with an expenditure of $3.70 leaving a net income per hectare of $1.40. The high performance farms, however, have a gross income per hectare of $8.70, but this more intensive farming system has a high level of expenditure per hectare of $6.50, leaving a net income of $2.20 per hectare.

These two groups, then, represent the wide variation in performance which is found in the New Zealand hill country farming scene. Unfortunately, there is a tendency for farming commentators and policy-makers generally to place emphasis on stock numbers alone. What is important, from the national viewpoint, is total production (regardless of whether this is through higher numbers or higher per head performance) and, from the individual farmer's viewpoint, the associated farm income level. Increasing stock numbers nationally, if associated with lower stock performance, will do nothing for total agricultural production or individual farmers' incomes.

The pay-off to both the nation and the farmer, from an intensive extension programme aimed at improving lambing percentages and wool weights nationally over a period of years could be extremely high.

The impact of small changes in overall stock performance are quite dramatic on a national basis.

The figures have been quoted elsewhere, but are worth repeating - a 1% lift in the national lambing percentages produces an additional 400,000 lambs which, at today's price, would generate almost $8m at F.O.B. An additional 0.5kg on each lamb carcase exported would generate an extra 12,500 tonnes of lamb or the equivalent of nearly 1 million additional lambs - worth approximately $20 million
at F.O.B. Likewise, a 0.1kg lift in wool clip per head nationally (or an additional 6,000 tonnes of wool) would generate a further $15m at F.O.B. Potential gains of these magnitudes should be exploited first in any drive for higher production.

(v) The Wider Application of Present Technology. There is a wide range of technology currently available which has yet to be adopted by a sector of the farming industry. The failure to demonstrate adequately the place in overall management and the economics of new technology appears to be one of our continuing weaknesses. While it is important that current technology be adopted by a wider section of the industry, there is also a need for on-going research designed to generate new methods and refinements for the leaders in the industry.

(vi) Diversification away from Traditional Agriculture. We have seen some spectacular results in recent years, as many new industries have developed within the farming scene. These include:

- kiwi fruit farming
- deer farming
- goat farming

with others on the horizon e.g. rabbit farming, trout farming and even milking sheep!

Pressure to diversify in the high country has always been great. While new areas of production should be encouraged, how much of this diversification away from traditional forms of farming is really the end result of frustration and disenchantment, coming about simply because these industries in recent years have not had a real opportunity demonstrate their full potential? Or is it the challenge to try something different? Would these alternative
forms of production have fared any better under the economic conditions which prevailed over recent years?

We must be careful that new industries do not require the sort of protection which was regarded as undesirable in e.g. manufacturing in the past. It is interesting to note that the wine industry is in just this position. Between 1973 and 1978, the cost of imported wines has increased by 34% - N.Z. wines 145% - yet even more stringent import controls are being asked for by this industry!

Also, diversification usually requires the commitment of significant capital inputs - often largely unrecoverable if the venture fails for one reason or another.

Output from traditional forms of agriculture has fallen in recent years, but it must be remembered that the area of land available for traditional farming has also decreased. One estimate places the area of land which has been taken out of traditional livestock farming for urban, forestry, horticulture and small holdings use as equivalent to 5m s.u. from 1967 - 1974 - possibly the same again in the last 5 years.

While the new developments in agriculture are exciting, we are looking for significant export industries, those with high net overseas earnings. Which of the new ones has, for example, the potential to rival dairy export receipts in the future?

There are other areas which deserve comment. These include:

- the relationship between labour inputs in farming and labour saving capital areas. Have we gone too far in substituting capital for labour? This is especially a problem now with interest rates at the new high level. The economics of the
additional labout unit now may be quite different to 5 years ago.

- the relationship between farm profitability, interest rates and land values.

Today, some 20% of interest free net profit (per average sheep farm) is being diverted to pay interest, compared to about 12% in the early 1960s.

This reflects - lower profits
  - higher interest rates
  - increased indebtedness

- the effect of the energy crisis in traditional agriculture.

Have we really thought this through in a balanced way? What, for example, will be the effect on main stream agriculture, and especially hill country, of a significant increase in aerial topdressing charges? Most superphosphate is sown by air, yet higher fuel charges, restrictions on aviation fuel usage, plus wage increases, as well as the removal of part of the subsidy, could push up topdressing charges very significantly in the next twelve months.

While on a long-term level our energy position may be satisfactory, in the short term the energy crisis could have quite a disruptive effect on traditional farming and we should be prepared to meet it.

- the fragmentation of agricultural assistance measures. The problems which the agricultural sector has laboured under over recent years are reflected in the wide range and often fragmented assistance measures now available to the industry. (Ref. M.A.F. "Assistance and Incentives For Farmers" - 35 pages, 83
measure). For our major export sector, surely this indicates vividly an imbalance in the economy?

While there will be problems of marketing and access for all our major products to a greater or lesser extent in the future, the real problem over the next decade, at least, is likely to be that of insufficient production to meet the new markets opening up (e.g. China - wool). However, it should be remembered that we largely fill deficiencies in other countries production and therefore there will always be "ups and downs".

Given the correct economic climate, the industry has the capacity to go forward again. It has the ability in terms of technical capacity and managerial skills - all it needs is the financial incentive.

TO SUMMARIZE

The New Zealand economy is suffering from the effects of:

(1) Continuing double digit inflation;

(2) A highly regulated and insulated domestic economy in which most areas (75%) are able to pass on costs;

(3) A growth rate of export receipts which is insufficient to sustain full employment and to provide some lift in living standards.

The insulation of the domestic economy has undoubtedly been a major factor in sustaining inflation and weakening the export drive. Thus, the restructuring being called for would, over time, improve the position of the export sectors and, in this pastoral farming, profitability is likely to benefit.
Current trends in the economy are not encouraging and this has given rise to a widespread feeling of apprehension throughout the country - surely no basis on which to expect growth. We believe that much of the diversification away from traditional agriculture which we are now seeing, is borne out of a sense of frustration with the returns from existing forms of agriculture, when it is really the imbalance in the economy which is at the root of the problem. Hopefully, recent changes will improve this position at least a little.

We cannot afford to have our attention diverted from sorting out the problems of the "main stream" export sectors - we must work to ensure that profitability is restored to those areas in which we still have potential and a real competitive advantage internationally, and on which we will continue to be dependent for several decades to come. We refer, in particular, to the vast potential in the hill and high country of New Zealand.

We must ensure that growth is in those areas which earn net overseas funds (the hill country of New Zealand is a good example), and not in those areas which simply employ people and other resources.

A return to the investment climate of the early 1960s, when the interests of the individual and the nation coincided, is urgently needed if the growth in output we require is to become a reality.
APPENDIX 1

INCOME & EXPENDITURE/S.U. ($)

S.I. HIGH COUNTRY

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wool</td>
<td>6.06</td>
<td>6.20</td>
<td>3.77</td>
<td>5.61</td>
<td>7.52</td>
<td>7.52</td>
</tr>
<tr>
<td>Sheep</td>
<td>2.13</td>
<td>1.85</td>
<td>1.54</td>
<td>2.21</td>
<td>2.82</td>
<td>1.76</td>
</tr>
<tr>
<td>Cattle</td>
<td>0.80</td>
<td>1.07</td>
<td>0.72</td>
<td>0.78</td>
<td>0.89</td>
<td>0.87</td>
</tr>
<tr>
<td>Other</td>
<td>0.37</td>
<td>0.10</td>
<td>0.14</td>
<td>0.09</td>
<td>0.17</td>
<td>1.30</td>
</tr>
<tr>
<td>TOTAL GROSS</td>
<td>9.36</td>
<td>9.21</td>
<td>6.16</td>
<td>8.69</td>
<td>11.41</td>
<td>11.45</td>
</tr>
<tr>
<td>Expenditure</td>
<td>5.29</td>
<td>6.40</td>
<td>5.78</td>
<td>6.44</td>
<td>8.23</td>
<td>9.23</td>
</tr>
<tr>
<td>NET INCOME</td>
<td>4.07</td>
<td>2.81</td>
<td>0.39</td>
<td>2.25</td>
<td>3.18</td>
<td>2.22</td>
</tr>
<tr>
<td>Liquidity</td>
<td>1.07</td>
<td>1.09</td>
<td>-1.06</td>
<td>0.25</td>
<td>-0.39</td>
<td>-0.46</td>
</tr>
<tr>
<td>Term Liab.</td>
<td>5.89</td>
<td>6.94</td>
<td>8.88</td>
<td>8.84</td>
<td>8.80</td>
<td>9.16</td>
</tr>
</tbody>
</table>

* Provisional

SOURCE: New Zealand Meat & Wool Boards' Economic Service
DISCUSSION

Q Is the 18% drop in lamb price in real terms due to the E.E.C. levy?

Mr Taylor:

Yes, a high proportion of the drop is due to the levy. (At present, the levy is costing the New Zealand farmer approximately $5.30 per 14.2 kg p.m. lamb.)

Q Would the staggering level of long term liabilities, which, of course, is quite contrary to the traditional pattern in the high country, be caused by such factors as higher living costs that are forced on people today - education, for example - and by properties changing hands at high values, some of them having been mortgaged to purchase extra lands to settle sons?

Mr Mars:

There would be many factors. I do not think the turnover of farms is any greater. The colossal expenditure on farm machinery for development, the normal transition and the costs involved in transferring properties from father to son are all factors.

Q Does Mr Taylor think that, now there is greater certainty about prices, there has been greater expenditure by high country farmers? When they had highly variable prices, they kept their expenditure down because they knew what it was going to be like next year, and invested more.
Mr Taylor:

I believe that you get higher farm investment, longer term, under stable prices than you do under fluctuating prices and therefore steadier expenditure. I believe you get a lot of tax-induced expenditure under fluctuating prices and income, and some of this is not really productive. In the short term, there may be some cost minimising over the next few years, while people get adjusted to more stable prices, assuming that the exchange rate is going to move the way everybody says it will. However, once sheep farmers adopt the new philosophy, they could be like dairy farmers and invest to a higher level because they have some assurance of future returns. The traditional sheep and beef farmer has not been used to this, and if we are going to have more stable prices and incomes, it seems to me that it will call for a completely new approach to investment by the sheep and beef farmer. As a result, investment could be more consistent over time.

Q  The difference in gross income between low and high performance farming (between $5.1 dollars per hectare and $8.7) was $3.60, and yet net-wise there is only 80 cents difference. After tax, you could say there is only 40 cents difference. Do you think it is reasonable to expect farmers to increase gross income by $3.60 and finish up with only 40 cents of that in their pockets?

Mr Mars:

High Country farmers are torn between the status quo of the old grazier system and the "get out and develop" approach. Many have developed in a big way and have seen the results, but the returns have been distinctly disappointing. The figures you refer to show the increase in net return/ha from improved stock performance, not necessarily development as such.
Q You stated farming needs financial encouragement. When you talk about the removal of subsidies, what sort of financial encouragement have you got in mind?

Mr Taylor:

The present system has not given a sufficient incentive. There is no doubt about that. We might be surprised at what happens to prices in the next six months to two years and I think that is really the point. In a more open economy, if the exchange rate system as it has been introduced is going to be effective, it has got to increase profitability for exporters. However, it must be remembered that these exchange rate changes are going to affect all exporters; the rate is not going to be moved just because high country farmers' incomes are not adequate. There will still be some sections of the exporting community that may not have the correct financial incentive even with what looks on the surface, anyway, to be a more promising exchange rate.

Q What is the ultimate going to be for all the inputs in the high country? Is there going to be any gain to the individual; after all, it comes down to the question of what happens to the individual in the end?

Mr Taylor:

What I call fixed costs have been pushed up. High stocking rate systems certainly have higher fixed communications. There is a lot more risk and more vulnerability from all points of view. To answer the question - is there sufficient return and incentive to encourage people who want to push on again? I would have to say, at present, that there really is not the incentive unless we are going to see some changes in the near future. We are starting from a much
weaker financial position than that pertaining 10 years ago. From a physical point of view, the potential is probably just as great now as it was then. It is a question of the economics of the after-tax return to the farmer.

Q Farmers who developed have become disillusioned because they did not achieve what the technocrats said they would achieve.

Mr Mars:

Yes, I think it is probably only one in every ten who has achieved what they hoped for in their endeavours. Many are feeding very large quantities of hay which is not being reflected in higher unit production. There is the problem in the high country of determining what is an increase in production and what is not. Returns are not what they should be and certainly there is a cash flow problem closely linked to the wool price, which accentuates the whole thing. The extent of the country and the severity of the climate makes a development-production break-through very difficult to achieve without a colossal investment.
HIGH COUNTRY PRODUCTION SURVEYS

I.G.C. KERR*, K.R. LEFEVER*, E.J. COSTELLO*

The Tussock Grasslands and Mountain Lands Institute has now completed three series of surveys of livestock, production and performance in the high country of the South Island. What follows summarises:

(a) the changes in production and performance of 289 high country runs between each series of surveys; and
(b) the variation in production, performance and some factors influencing production within the 300 runs in the 1976/78 series.

Data for each survey within each series has been collected in personal interviews with individual runholders and is strictly confidential.

The authors gratefully acknowledge the willingness of all runholders to participate in the study and the generous hospitality given to interviewers.

A summary analysis of all information collected from each property, together with average data from the appropriate region, has been forwarded to the runholders concerned. Further analysis and comment is available to individual runholders on request.

Complete survey details have been published as Tussock Grasslands and Mountain Lands Institute Special Publication No. 18.

* Lincoln College.
Number and Area

The number and area of high country properties within the 1976/78 series of surveys and classified according to province and climate zone (Hughes, 1973), are shown in Table 1 below.

<table>
<thead>
<tr>
<th>Province</th>
<th>Number</th>
<th>Total (ha)</th>
<th>Average (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marlborough Moist</td>
<td>23</td>
<td>505263</td>
<td>21968</td>
</tr>
<tr>
<td>Canterbury Moist</td>
<td>51</td>
<td>432571</td>
<td>8482</td>
</tr>
<tr>
<td>Canterbury Wet</td>
<td>36</td>
<td>647193</td>
<td>17978</td>
</tr>
<tr>
<td>Otago Dry</td>
<td>46</td>
<td>362409</td>
<td>7878</td>
</tr>
<tr>
<td>Otago Moist</td>
<td>91</td>
<td>564519</td>
<td>6204</td>
</tr>
<tr>
<td>Otago Wet</td>
<td>36</td>
<td>537623</td>
<td>14934</td>
</tr>
<tr>
<td>Southland Moist</td>
<td>17</td>
<td>209027</td>
<td>12296</td>
</tr>
<tr>
<td>TOTAL</td>
<td>300</td>
<td>3258605</td>
<td>10862</td>
</tr>
</tbody>
</table>

Three Canterbury runs which are within the 'dry' zone are grouped with the Otago 'dry' runs so as to preserve confidentiality. Generally those runs within the 'wet' zone are the 'gorge' runs and those in the 'dry' zone are those in the most arid areas of the high country, principally in Central Otago. The predominant 'moist' zone encompasses those runs between the two extremes.
Stock Units

The changes in total stock units carried on the 289 runs common to all three series of surveys is shown in Figure 1.

Figure 1. Changes in stock units 1965–1978

The substantial increase (26 per cent) in total stock units (mainly cattle), which was a feature of the period between the first two surveys, has not continued. Nevertheless, the increase (nine per cent) in stock units over the five years up to the 1976/78 series has been considerably in advance of the almost unchanged New Zealand total.

The earlier trend of rapidly increasing cattle herds appears to have waned sharply. Recent trading in cattle in the high country (Figure 5) and a six per cent recorded fall in total cattle numbers between 1976/77 and 1977/78 shows that the peak in cattle numbers has, for the present at least, been reached. There is no doubt that low returns from sale stock and the
strong competition between sheep and cattle for limited forage has caused runholders to re-examine cattle policies. Recent price advances may, at least temporarily, tend to reverse current trends.

Over the period of the series of surveys a steady increase in sheep has been maintained, thus confirming runholders' confidence in sheep production.

Recently deer have become a feature on 30 runs and now account for well over 3000 stock units in total.

Sheep

The steady increase in sheep numbers which has continued in the high country since 1965/67 is substantially in breeding ewes. Breeding ewes have also replaced wethers to a significant extent.

Figure 2. Changes in sheep numbers 1965–1978
The separate regional changes in sheep numbers are similar to the overall total. There has been an increase in the popularity of Merinos, but at the same time some variability in the popularity of halfbreds both between and within regions. A major part of the recent six per cent increase in sheep numbers has been in breeds other than Merino and halfbred.

The decline in store sheep sales has continued, but there has been an impressive increase in fat stock sales (lambs principally), which are now twice those of store stock (Figure 3).

Figure 3. Sheep trading pattern 1965–1978

Cattle

The doubling of cattle numbers between 1965/67 and 1971/73 was a
feature of that period. A much more moderate increase has occurred since, with a significantly lesser proportion of breeding cows.

Figure 4. Changes in cattle numbers 1965–1978

The number of cattle traded annually (Figure 5) has more than doubled over the survey period. The numbers of fat stock sold is reflected in the increase in the productivity of the runs, as is the policy of many runholders to add value to surplus stock rather than accept low store prices. There has recently been a significant deplenishment of breeding stock.
**Figure 5. Cattle trading pattern 1965–1978**

![Diagram showing cattle trading pattern 1965–1978]

**Performance**

Along with the initially large and recently moderate increases in stock units carried on runs there have been some changes in stock performance in sheep.

**TABLE 2**

<table>
<thead>
<tr>
<th>Stock Performance</th>
<th>65/67</th>
<th>71/72</th>
<th>76/78</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wool/sheep (kg)</td>
<td>3.9</td>
<td>3.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Lambing (per cent)</td>
<td>79</td>
<td>85</td>
<td>86</td>
</tr>
<tr>
<td>Calving (per cent)</td>
<td>82</td>
<td>81</td>
<td>82</td>
</tr>
</tbody>
</table>
The reduction in wool production per sheep, though not substantial, is, however, disquieting. The reduction may be attributable to the nine per cent decline in wether numbers. It should also be recognised that the five per cent drop in wool/sheep was accompanied by a 15 per cent increase in overall sheep numbers.

The range in wool production per sheep for 300 runs in the 1976/78 series is illustrated by Figure 6 below.

Figure 6. Range in wool production per sheep 1976–1978

Because wool is the major income earner for most high country runs, the two-fold range in wool per sheep indicates a vast avenue for improvement in wool production efficiency in many flocks. A 0.25 kg per sheep increase in wool production over the whole of the high country amounts to approximately $1.2m added annual return.
Wool production per sheep varies significantly between regions with noticeable advantage to those runs within the warmer and drier regions (Figure 7). This apparent advantage is likely to be significantly reduced if the wool clip is assessed on a clean basis.

Figure 7. Regional wool production per sheep 1976–1978

Lambing

Clearly the use of selenium and other management practices caused a marked increase in average lambing percentage between 1965/67 and 1971/73, but thereafter major cultural and environmental limitations have applied (Table 2).
With one notable exception (Canterbury 'wet') the average lambing percentage between regions currently varies by a maximum of only three percent.

Figure 8. Regional lambing percentage 1976–1978

Over the series of surveys there has been an exceptional increase (nine per cent) in the average lambing percentage of the gorge runs of the Otago 'wet' region. Otherwise little improvement in reproductive efficiency has apparently taken place over the last five years.

A range in lambing percentage from 60% to 120% within the 300 runs in the 1976/78 series has been recorded. This extremely wide range applies to all regions.
Figure 9. Range in lambing percentage 1976–1978

There was an overall reduction of 29 per cent in the total area of new development (cultivation, over-sowing, top-dressing and over-drilling) recorded between the 1971/73 and 1976/78 series of surveys (Figure 10).

Figure 10. Area of new development 1971–1978
When examined regionally, this drop in the rate of new development has, in aggregate, occurred principally in 'dry' and 'moist' regions of Otago. Similarly, the rate of development (of a much lesser area) in the Canterbury runs has fallen to half that of 1971/73. Conversely, runs in both Southland and Marlborough have increased the rate of development substantially.

Figure 11. Regional pattern of new development 1971–1978

The eight per cent increase in the total area fertilised (initial and maintenance) for all runs is reflected in a drop in the rate of development (-29 per cent) offset by a 20 per cent increase in the area receiving maintenance fertiliser. Overall there has been an increase in total area (and total
tonnes) fertilised of eight per cent, which corresponds approximately to the overall increase in stock units carried (Figure 12).

**Figure 12. Initial and maintenance fertiliser (ha) 1971–1978**

In the 1976/78 seasons there was a considerable variation between runs in the quantity of fertiliser applied per thousand stock units (Figure 13).
Figure 13. Fertiliser per thousand stock units (tonnes) 1976–1978

The regional variations were as follows (Table 3)

<table>
<thead>
<tr>
<th>Region</th>
<th>Tonnes/Run</th>
<th>Tonnes/1000 s.u.</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marlborough Moist</td>
<td>132</td>
<td>19.6</td>
<td>0.1</td>
<td>49.5</td>
</tr>
<tr>
<td>Canterbury Moist</td>
<td>91</td>
<td>11.9</td>
<td>0</td>
<td>30.0</td>
</tr>
<tr>
<td>Canterbury Wet</td>
<td>123</td>
<td>11.7</td>
<td>0</td>
<td>27.1</td>
</tr>
<tr>
<td>Otago Dry</td>
<td>75</td>
<td>13.7</td>
<td>0.1</td>
<td>50.1</td>
</tr>
<tr>
<td>Otago Moist</td>
<td>97</td>
<td>16.2</td>
<td>0</td>
<td>72.9</td>
</tr>
<tr>
<td>Otago Wet</td>
<td>144</td>
<td>15.5</td>
<td>0</td>
<td>55.7</td>
</tr>
<tr>
<td>Southland Moist</td>
<td>225</td>
<td>21.4</td>
<td>2.4</td>
<td>54.0</td>
</tr>
<tr>
<td>All runs</td>
<td>104</td>
<td>14.5</td>
<td>0</td>
<td>72.9</td>
</tr>
</tbody>
</table>
Over the 1976/78 series of surveys maintenance fertiliser was applied by runholders at an average rate of 10.7 tonnes per thousand stock units, which was approximately the same rate (10.5t) as in 1971/73. The recent survey series indicate a rate of new investment in fertiliser at three tonnes per thousand stock units, which is a reduction of 25 per cent since 1971/73.

**Winter feed**

The total amount of winter feed crop grown in each of the series of surveys is shown in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>Area (ha)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1965/67</td>
<td>1971/73</td>
<td>1976/78</td>
<td></td>
</tr>
<tr>
<td>Greenfeed</td>
<td>2902</td>
<td>1192</td>
<td>1953</td>
<td></td>
</tr>
<tr>
<td>Brassicas</td>
<td>3852</td>
<td>4393</td>
<td>3570</td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td>NA</td>
<td>1124</td>
<td>966</td>
<td></td>
</tr>
<tr>
<td>Hay</td>
<td>NA</td>
<td>9168</td>
<td>11022</td>
<td></td>
</tr>
<tr>
<td>Silage</td>
<td>NA</td>
<td>262</td>
<td>496</td>
<td></td>
</tr>
</tbody>
</table>

Hay continues to be the dominant form of winter feed crop grown, accounting for approximately 70 per cent of the dry matter produced. Overall the total winter feed grown amounts to about 40% of the normal maintenance requirements of all the stock units run in the high country. The importance of winter roughage to supply the vast majority of winter feed requirements should not be underestimated.
Drenching

In the 1976/77 season less than three per cent of runs did not drench hoggets with an anthelmintic with or without selenium added. Seventy two per cent of runs drenched hoggets two, three or four times and all but 11 per cent reported the use of selenium.

Ewe drenching was not practised on 30 per cent of runs carrying ewes, but two-thirds of runs did drench either once or twice, and 81 per cent of these used selenium.

Wether drenching is comparatively rare, with 91 per cent of those runs carrying wethers reporting no drenching at all.

Since the 1971/72 series of surveys, drenching frequency of hoggets has increased marginally and ewes significantly (14 per cent). The use of selenium for hoggets has increased by 15 per cent.

The overall incidence and frequency of calf drenching is unchanged since 1971/72 when approximately 70 per cent of all calves were drenched at least once.

Labour

The labour input on high country properties averages 2655 stock units per labour unit, or 2.7 labour units per property. Whilst there are but few runs with sheep only (14) or cattle only (3), there appears to be a much higher than average labour input into properties carrying only sheep. Seventy eight runs (26%) are managed by people other than the owner (although in several cases an owner - usually the father - contributes substantially to labour input). Two hundred and twenty three runs employ shepherds and 185 runs call on casual musterers. The balance of the labour employed (apart from shearers) consists of tractor drivers, fencers, cooks and casuals.
Land use

The 'average' high country property currently consists of 10862 ha of land utilized as follows

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryland pasture</td>
<td>168</td>
</tr>
<tr>
<td>Irrigated pasture</td>
<td>23</td>
</tr>
<tr>
<td>Dryland lucerne</td>
<td>31</td>
</tr>
<tr>
<td>Irrigated lucerne</td>
<td>4</td>
</tr>
<tr>
<td>Oversown native pastures</td>
<td>998</td>
</tr>
<tr>
<td>Fallow</td>
<td>6</td>
</tr>
<tr>
<td>Crop</td>
<td>16</td>
</tr>
<tr>
<td>Exotic trees</td>
<td>14</td>
</tr>
<tr>
<td>Native trees</td>
<td>114</td>
</tr>
<tr>
<td>Unimproved and waste</td>
<td>9488</td>
</tr>
<tr>
<td>Total</td>
<td>10862</td>
</tr>
</tbody>
</table>

Of the 300 high country properties, two-thirds are between 5251 ha and 16473 ha in area, with a range from 500 ha to over 185,000 ha.

Land tenure

Table 5 summarises the variations in land tenure within the high country.
TABLE 5

LAND TENURE
SOUTH ISLAND HIGH COUNTRY 1978

<table>
<thead>
<tr>
<th></th>
<th>Runs</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fee simple:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freehold</td>
<td>164</td>
<td>205033</td>
</tr>
<tr>
<td>Deferred payment license</td>
<td>24</td>
<td>41348</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>246381</td>
</tr>
<tr>
<td><strong>Leases with right of renewal:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lease in Perpetuity</td>
<td>13</td>
<td>2930</td>
</tr>
<tr>
<td>Renewable lease</td>
<td>27</td>
<td>54939</td>
</tr>
<tr>
<td>Pastoral lease</td>
<td>240</td>
<td>2336085</td>
</tr>
<tr>
<td>Endowment lease</td>
<td>11</td>
<td>101203</td>
</tr>
<tr>
<td>County lease</td>
<td>12</td>
<td>15279</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>2510436</td>
</tr>
<tr>
<td><strong>Leases with no right of renewal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pastoral Occupation License</td>
<td>31</td>
<td>158188</td>
</tr>
<tr>
<td>Grazing permit</td>
<td>3</td>
<td>2135</td>
</tr>
<tr>
<td>Special lease</td>
<td>7</td>
<td>38328</td>
</tr>
<tr>
<td>Forest Lease</td>
<td>7</td>
<td>8091</td>
</tr>
<tr>
<td>National Park lease</td>
<td>2</td>
<td>4746</td>
</tr>
<tr>
<td>Army lease</td>
<td>1</td>
<td>2913</td>
</tr>
<tr>
<td>Miscellaneous licence</td>
<td>28</td>
<td>9629</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>223030</td>
</tr>
<tr>
<td><strong>Other:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crown Land</td>
<td>8</td>
<td>278758</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>3258605</td>
</tr>
</tbody>
</table>
Ninety three per cent of high country runs are either farmed by the Crown (nine per cent) or held under a Crown or public body lease (77 per cent) or occupied through a licence from a Crown agency (seven per cent).
WEEDS

The following table (Table 6) summarises high country runholders' opinions of weed infestations on their properties in the 1976/77 season.

**TABLE 6**

PERCENTAGE OF RUNS REPORTING WEEDS 1976/77

<table>
<thead>
<tr>
<th>Weed</th>
<th>'Excess'</th>
<th>'Occurs'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broom</td>
<td>9</td>
<td>52</td>
</tr>
<tr>
<td>Gorse</td>
<td>6</td>
<td>45</td>
</tr>
<tr>
<td>Brier</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>Matagouri</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Manuka</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Trees</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Fern</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>Thyme</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>Hieracium spp.</td>
<td>11</td>
<td>45</td>
</tr>
<tr>
<td>Nodding Thistle</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Barley Grass</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>St John's Wort</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Ragwort</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Hemlock</td>
<td>&lt;1</td>
<td>3</td>
</tr>
<tr>
<td>Tutu</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Spear Grass</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
The distribution of major weeds (broom, gorse, brier, hieracium and fern) throughout the high country can be gauged from a table of the incidence of runs reporting 'excess' weeds within each county (Table 7)

**TABLE 7**

**NUMBER OF RUNS REPORTING 'EXCESS' WEEDS 1976/77**

<table>
<thead>
<tr>
<th>Runs</th>
<th>County</th>
<th>Broom</th>
<th>Gorse</th>
<th>Brier</th>
<th>Hieracium</th>
<th>Fern</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Marlborough</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Kaikoura</td>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Amuri</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hurunui</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Oxford</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Malvern</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Ashburton</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Mackenzie</td>
<td>1</td>
<td>11</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Strathallan</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Waimate</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Waitaki</td>
<td>3</td>
<td>2</td>
<td>12</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Vincent</td>
<td>2</td>
<td>1</td>
<td>22</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>24</td>
<td>Maniototo</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Lake</td>
<td>3</td>
<td>5</td>
<td>21</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Tuapeka</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Southland</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>300</td>
<td></td>
<td>26</td>
<td>18</td>
<td>90</td>
<td>33</td>
<td>24</td>
</tr>
</tbody>
</table>
Pests

Over the high country as a whole the percentage of runs reporting animal pests in the 1976/77 season were as shown in Table 8.

**TABLE 8**

PERCENTAGE OF RUNS REPORTING ANIMAL PESTS 1976/77

<table>
<thead>
<tr>
<th>Pest</th>
<th>'Excess'</th>
<th>'Occurs'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbit</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>Hare</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Deer</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Thar</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Chamois</td>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>Goat</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Opossum</td>
<td>5</td>
<td>74</td>
</tr>
<tr>
<td>Kea</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Geese</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Pigs</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

'Excessively' high numbers of rabbits generally existed in the 1976/77 season in the Waitaki, Vincent and Lake Counties with many areas of localised concern elsewhere. The incidence of opossums was widespread and apparently of growing importance as a serious animal pest.
The science of improving animal performance inevitably involves the use of comparisons or relativities, yet in the hill and high country such comparisons are severely constrained by variation in soil type and climate between regions, and between sites within properties on large stations. O'Connor (1978) attempted to overcome these problems in the upper Waitaki Basin by grouping properties into those with easy and difficult terrain, whether the property was predominantly moist or dry and the extent of development, in order to provide a fair basis for comparisons. Year round stocking rates of nine stock units/ha were disclosed on certain improved land, compared with mean rates of 0.5 stock units/ha on unimproved land. Significantly, grazing stock unit months/ha as a measure of year round stocking rate varied by a factor of up to 61 fold within unimproved categories of property and by a lesser ratio - 2.4-3.7 fold - within improved properties, though the latter figures are still very significant if one considers that production from the poor properties could be lifted to that of the better.

On the other hand Taylor (1979), in comparing high and low performance farms in the North Island hill country, considered the difference between good and poor properties to be due to individual stock performance. Moreover, in a recent survey of high country runs conducted by the T.G.M.L.I., similar marked variation in animal performance was disclosed - wool clipped per sheep, though having a mean of 3.72 kg, ranged from 2.12 to 6.49 kg per run. Similarly, lambing percentage mean 84.8 varied from 50-117.5 per cent. These data are clearly the result of the complex interaction between herbage growth, its distribution, the extent of utilization through stocking rate and individual animal performance.

* Lincoln College.
A specific statement about methods of achieving better stock performance which are generally applicable is therefore impossible and I plan as a consequence to take a more general approach.

The science of husbandry involves matching the annual cycle of energy requirement of the ewe flock or cattle herd with the annual pattern of food energy grown, while carrying the maximum stock numbers possible through the critical period of herbage energy supply and maintaining optimal health and efficiency of food utilization in the stock. An analysis of potential for animal production from basic principles should therefore commence with herbage supply. Unfortunately there are limited data available. Those of Radcliffe and Cossens (1974) for ryegrass/white clover, Poa pratensis and bromus dominant pastures at Poolburn in Central Otago, illustrate one of the major problems in optimising animal performance.

The annual yield of herbage energy in megajoules of metabolizable energy (MJME) at this site between 1961 and 1971 is shown in Figure 1. Annual feed energy accumulation ranged from 9,000 MJME to 55,000 MJME on dry land and from 51,000 to 131,000 MJME on irrigated pasture. A 50kg ewe requires approximately 4,700 MJME annually to maintain body weight and rear a single lamb. The theoretical carrying capacity of these pastures would therefore range from 2-12 stock units/annum/ha (mean 7) on dry land and between 11 and 28 stock units/ha on irrigated land if grassland management under animals could be made as efficient as the frequent cutting of herbage. Of course it cannot, but nevertheless the exercise is useful to estimate inefficiency. The most optimistic estimate of year round stocking rate on properties in the upper Waitaki (O'Connor, 1978) showed stocking rates of 6.6 on moist areas which have been oversown and topdressed. Is it possible to narrow the gap between this theoretical potential for production and actual performance?

As those with direct experience appreciate, it is the uncertainty of volume of annual production of herbage, associated with seasonal variation in climatic conditions, which is a major inhibitory influence to improving output while maintaining acceptable stock performance. Good pasture management, with optimisation of herbage yield demands frequent
defoliation of herbage growth. If stock losses are to be avoided in years of poor growth, a conservative approach to stocking rate is inevitable. It is during the years of luxury growth, however, that the potential for maximisation of animal output and returns is greatest and that stocking rate should, if possible, be geared to accommodate. There are two approaches to this problem:

(a) the creation of flexibility in stock numbers
(b) the creation of flexibility in feed supplies.

Flexibility in stock numbers

The one source of supply of animals in New Zealand which can be adjusted rapidly are the surplus calves from dairy herds. While use of such calves for our beef export effort would be biologically more efficient than maintenance of beef cows for 12 months each year to produce an equivalent calf, there are logistical problems. These calves become available mainly in spring before the feed supply situation is known on hill farms. It would be a considerably risky, speculative venture to contract to rear against this possibility unless alternative uses for such calves could be developed.

Flexibility of feed supplies.

The widespread adoption of lucerne for mid-summer production and cultivations in short rotation ryegrass and forage crops in winter and spring has served to reduce variability in herbage supply between seasons. However, considerable variations between seasons still occur and cause major depression of stock performance, particularly during periods of increase in stock numbers.

Development of hill and high country livestock production by substantial further increases in stocking rate is clearly possible. The ultimate potential for animal production will not, however, be realised without substantial conservation programmes which allow feed supplies to be carried for several seasons. This enters into the realm of incentives for
production increases for this type of country, which is where I leave the subject, having, I hope, made the point of a major area of potential for improvement of animal output.

Superimposed on between-year variation in pasture production is the within-year variation in feed energy supplies and the relationship of this to the annual cycle of nutrient requirement by the breeding ewe (Figure 2a and b). These are again data from Poolburn observations of Radcliffe and Cossens (1974). They illustrate quite clearly that, whether we consider unimproved land or developed irrigation in blocks, major problems of feed distribution occur, with severe feed deficits in winter if summer stocking rates are going to operate at the level which will make effective utilization of pasture. Again, we can consider the potential for adaptability within livestock and the manipulation of feed supplies.

Increased reproductive rate

The single most important factor in providing the most closely adapted feed requirement curve to the pasture production curve is an increase in lambing percentage, and more particularly in lambs weaned per ewe mated.

Improvements in percentage of lambs weaned can be achieved slowly by selection within a flock, more rapidly by a switch to a more fertile strain or breed, or by utilizing hybrid vigour in crossbreeding programmes. The possibilities for rapid improvement in the former two are remote. The introduction of the Booroola Merino into New Zealand offers the possibility of improved fertility among fine wool sheep but still requires objective evaluation. To date, increases in litter size in 4-tooth ewes of 48 per cent, with a reduction in the percentage of barren ewes from 23 per cent to less than ten per cent, have been recorded at Tara Hills (Allison, 1978). There are, as yet, no objective data to suggest that Booroola crossbreds are markedly inferior in wool production, and indeed a substantial reduction in wool growth could be tolerated if only a 10-20 per cent increase in lambs weaned was achieved by introduction of this breed. A potentially important attribute of this breed appears to be the lower sensitivity of oestrous activity and ovulation rate
to low bodyweight, which would mean that greater consistency and higher reproductive performance could be maintained despite the impact of variable and poor late summer and autumn feed supplies on bodyweight at mating.

The importance of condition or bodyweight at mating in influencing reproductive performance has been emphasised since the work of Coop (1962) and has been reiterated here (Allison, 1979). More recent work (Rattray et al 1978), cited also by Allison (1979), has shown the poor potential for rapid increase in bodyweight of dry sheep prior to mating on herbage with a significant proportion of dead material, a situation which will exist on many high country properties if stock numbers have been inadequate to cope with the spring and early summer growth of pasture. Attainment of bodyweights of 50-55 kg at mating must be achieved by planning to ensure the availability of sufficient high quality feed for mating. Alternatively, this may be achieved by planning to ensure that bodyweight losses induced during winter are replaced more rapidly in mid-lactation and soon after weaning, and that a steadily rising bodyweight is achieved over the summer using conserved feed in necessary. A second advantage of such a pattern of nutrition during the summer period of long day length (Hart et al 1963) is that higher fleece weights could be anticipated. Such a pattern of ewe bodyweight change would better fit the natural pattern of feed supply.

Allison (1979) discussed the consistent responses in ewe fertility to selenium therapy two to three weeks before the commencement of mating in large areas of the South Island high country. Earlier studies have suggested the response to be due to a reduction in embryonic mortality three to four weeks after mating (Hartley, 1963). The precise nature of the response and, indeed, the most effective dosing regimen are still not clear. Recent trials on Ashley Dene farm at this College have shown a response of 10-15 per cent to selenium therapy 30 days after mating, with no response from dosing at earlier stages. This work must, however, be repeated before we can make recommendations with any confidence.

Perinatal mortality still detracts seriously from animal performance and losses of 10-30 per cent are not uncommon. With improvements in fertility,
these losses will assume greater proportions. Many surveys have shown clearly that the lambs at risk are those which are larger or smaller than average, the former dying from dystocia, the latter from exposure. A controlled rising plane of nutrition, giving an increase in bodyweight of six to ten kilograms, should be sought during the last six to eight weeks of pregnancy. Of major importance is the provision of shelter in such a way that ewes and new born lambs:

(i) do not have far to travel to seek shelter and thus run the risk of separation.
(ii) seek shelter sufficiently early - the temperature at which a ewe, even with a short fleece of 5-10mm, has to increase heat production to maintain body temperature will be about 5°C, while a young lamb would begin to waste its body reserves or increase its food intake simply to keep warm at 30°C and
(iii) are not forced to stop feeding.

Tussock itself appears to have many natural advantages over artificial and planted shelter in providing such generalised shelter for sheep. It may have additional benefits by allowing increased plant growth through the maintenance of higher soil temperatures in winter and reduced evapotranspiration in summer. This development, I understand, requires careful management but the potential advantages to livestock production seem to merit careful consideration.

Finally, the output and efficiency of stock from these and any system depend on efficient utilization of feed consumed for production and maintenance of both the ewe and growing lamb. Of major significance is the ratio of requirement for growth and maintenance, which means that the more rapidly the lamb grows the smaller the maintenance component and the greater the efficiency. Lambs will grow at rates of up to 350-400g/day, given freedom from disease and adequate supplies of feed of high digestibility with an adequate protein and mineral content.

Growth rates of approximately 280g/day have been achieved on Tara Hills (Thompson, 1971) during the first six to eight weeks of life, although reductions
in growth rates subsequent to this, to 110g/day, seem to be normal. A reasonable target for hogget weight prior to winter would be 35kg, which requires an average growth rate of only 180g/day from birth until 180 days of age in mid April. Of crucial importance to the young growing lamb, with its relatively small digestive tract in relation to its requirement for digestible nutrients, is an ample supply of feed of high digestibility and adequate nutrient content. There is no reason why this cannot be achieved with indigenous and improved grass species on hill country. Analyses for herbage from high country properties (Clark, 1977) are shown in Table 1. With the exception of fescue tussock and sweet vernal, the digestibility of these indigenous species is relatively high. Moreover, levels of intake compatible with growth rates of 200g/day should be attainable by young growing lambs on such pastures. The mineral composition of such plant species and the daily requirement of a lamb growing at 200g/day are also shown in Table 2. The concentrations of calcium, magnesium and phosphorus would give little cause for concern. On lucerne or predominantly clover pastures, sodium intake may become limiting, and there are data showing good responses to sodium supplementation on pumice lands in the North Island (Joyce, 1975). Where grass makes up a large proportion of the diet such a deficiency seems unlikely.

Trace elements

We have less information on the trace element composition but, as stated earlier and by Allison (1979), the hill and high country region of the South Island is likely to show responsiveness to selenium where pasture herbage concentrations are below 0.03-0.04 ppm Se in dry matter, or blood levels in stock are below 0.1 ug Se/ml. The lamb has limited ability to store Se in the body and an adequate continuous intake is required. While regular drenching or injection provides protection against the clinical symptoms of Se deficiency, the efficacy of more regular treatment, e.g. Se bullets or pasture dressing, still requires further investigation.

The adequacy of other trace elements is hard to judge in the absence of reliable data. In the final analysis, assessment will come from animal responses to supplementation. However, we can anticipate that copper
deficiency problems could develop as the results of irrigation in traditionally dry areas with high soil pH, especially where Mo has been used in herbage establishment.

These problems can be readily overcome. The major constraint on lamb growth rates is most likely to be the supply of digestible nutrients from the ewe in the form of milk and an inadequate supply of highly digestible herbage. During mid-summer, when herbage supplies are diminishing under excessive evapotranspiration, priority should be given to the growing lamb and its need for highly digestible feed. The competition of the ewe for highly digestible material should, therefore, be removed before the feed supply and quality to the lamb becomes critical. Early weaning of lambs in mid-December, at four to ten weeks of age, has been shown to have no detrimental effect on bodyweight (Thompson, 1971) and this ensures that maximum use can be made of the high quality feed available at this time for lamb growth. Lambs have a high requirement for protein (Table 2) and this can be met by the use of leguminous feeds such as white clover and lucerne. At this time, acceptable bodyweight gain can be achieved in ewes on less developed blocks where feed of lower digestibility is available.

Internal parasites
Parasitic disease can be a major problem in the maintenance of high lamb growth rates. Maintenance and multiplication of worm larval populations requires infected stock, moisture and warm temperatures for larval development, and concentration of stock for cross infection. It is often assumed that the low stocking densities associated with extensive farming are not conducive to the development of parasite populations. Warm, moist areas - conducive to best herbage growth - are, surprisingly, used intensively as stock camps and can be a major source of infection. A programme of subdivision should ensure that grazing of these areas is controlled and that stock having access are introduced only after entering a controlled programme of preventive anthelmintic drenching.

Irrigation development may provide the ideal micro-climate for the development of worm eggs on pasture to infective larvae. Studies have shown
that, given ideal conditions of warmth and moisture, development of worm eggs deposited on pasture into infective larvae can occur within ten days, and that larvae can survive for up to six months under cool, moist conditions. Thus, a continuous source of infection can be anticipated, even if rotational gazing is practiced. Where infection has already been established, control can be effected by alternate grazing with cattle or by dry sheep, neither of which allow larvae to develop to maturity in the same way as do young stock. In young stock, prevention of larval multiplication in the host will require fortnightly drenching, since the development of larvae to maturity, with the concomitant capacity for egg production and spread of infection, may take only 17 days. Each mature worm can lay between 250-2,000 eggs per day!

The serious implications of subclinical worm infestations for the growth of lambs can be seen in Table 3. These lambs were exposed to numbers of worm larvae such as those which sheep might typically consume with herbage in the field. Growth rate and efficiency of food utilisation were reduced by up to 50 per cent and skeletal growth severely impaired. Other studies have shown that while regular treatment with anthelmintic will be effective in preventing further multiplication of infection by lambs they may still grow very poorly. Clean pastures are, therefore, essential. Effective anthelmintic control means that pastures, once decontaminated, must be maintained by a combination of stock and pasture management and anthelmintic treatment designed to ensure that, when potentially contaminated stock move on to "clean" areas, preventive anthelmintics are used.

We cannot assess the production loss in adult sheep as a result of intake of nematode larvae. Pre-tupping and pre-lambing drenches are used because these are times when removal of parasite burdens, would result in the maximum long term benefit. The efficacy of this treatment has not been proven, but there is sufficient sense from a biological point of view for them to continue until proven to be of no value.

The problem of "achieving better stock performance" is a big one, encompassing many disciplines. I have covered the wider issue of herbage
growth potential and the problems of matching this to consistently increased levels of stocking and high levels of individual performance. Some of the major potential for improvement in this area will be realised only in response to legislative changes. There are, however, many areas of animal husbandry where manipulation based on scientific endeavour will allow realisation of improved performance.
Figure 1: Annual yield of herbage energy, megajoules of metabolizable energy (MJME) 1961 – 1971 (after Radcliffe and Cossens, 1974).
Figure 2a: Seasonal variation in herbage energy production in relation to energy requirements of ewes stocked to maximum pasture utilization on dry high country.
Figure 2b: Seasonal variation in herbage energy production in relation to energy requirements of ewes stocked to maximum pasture utilization on irrigated hill country.
**TABLE 1:** MEAN DIGESTIBILITY OF SWARD SPECIES FROM MESOPOTAMIA STATION *

<table>
<thead>
<tr>
<th>Species</th>
<th>Digestibility</th>
<th>Crude Protein (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fescue Tussock</td>
<td>0.434</td>
<td>67</td>
</tr>
<tr>
<td>Sweet Vernal</td>
<td>0.658</td>
<td>101</td>
</tr>
<tr>
<td>Browntop</td>
<td>0.707</td>
<td>131</td>
</tr>
<tr>
<td>Yorkshire Fog</td>
<td>0.769</td>
<td>150</td>
</tr>
<tr>
<td>Cocksfoot</td>
<td>0.780</td>
<td>167</td>
</tr>
<tr>
<td>Bromus spp.</td>
<td>0.744</td>
<td>135</td>
</tr>
<tr>
<td>White clover</td>
<td>0.845</td>
<td>230</td>
</tr>
<tr>
<td>SE $\bar{X}$</td>
<td>0.0056</td>
<td>2.40</td>
</tr>
</tbody>
</table>

* From Clark (1977)
### TABLE 2: MINERAL COMPOSITION OF RESIDENT VEGETATION COMPARED WITH 'NORMAL' VALUES FOR INTRODUCED SPECIES AND ANIMAL REQUIREMENTS

<table>
<thead>
<tr>
<th></th>
<th>Sunny</th>
<th>Shady</th>
<th>Ridge</th>
<th>Introduced Species</th>
<th>Daily Requirement for gains of 200 g/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mid-November)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mesopotamia)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein (g/kg)</td>
<td>188</td>
<td>177</td>
<td>244</td>
<td>175 230 200</td>
<td>170</td>
</tr>
<tr>
<td>S</td>
<td>4.3</td>
<td>4.3</td>
<td>5.4</td>
<td>?     ?   ?</td>
<td>3.0</td>
</tr>
<tr>
<td>P</td>
<td>2.2</td>
<td>2.7</td>
<td>3.6</td>
<td>3.0 3.0 4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Mg</td>
<td>2.3</td>
<td>1.7</td>
<td>1.8</td>
<td>3.0 4.5 5.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Ca</td>
<td>10.4</td>
<td>7.2</td>
<td>5.7</td>
<td>6.5 11.5 14.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Na</td>
<td>0.9</td>
<td>1.1</td>
<td>0.5</td>
<td>2.0 0.5 0.5</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* from Clark (1977)
TABLE 3: The effects of infection with O. circumcincta (4,000 larvae/day) or with T. colubriformis (2,500 larvae/day) on the relative rates of body tissue deposition. Rates in infected (ALI) and pair-fed (PF) animals are expressed relative to controls fed ad libitum.

<table>
<thead>
<tr>
<th></th>
<th>O. circumcincta</th>
<th>T. colubriformis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ALI</td>
<td>PF</td>
</tr>
<tr>
<td>intake</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Food (N. app. digestibility)</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>D.M. digestibility</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>Liveweight gain</td>
<td>48</td>
<td>80</td>
</tr>
<tr>
<td>Fat deposition</td>
<td>58</td>
<td>84</td>
</tr>
<tr>
<td>Protein deposition</td>
<td>49</td>
<td>66</td>
</tr>
<tr>
<td>Efficiency of retention of digested energy</td>
<td>72</td>
<td>105</td>
</tr>
<tr>
<td>Skeletal Ca deposition</td>
<td>36</td>
<td>75</td>
</tr>
<tr>
<td>Serum albumin</td>
<td>86</td>
<td>102</td>
</tr>
<tr>
<td>globulin</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Ca</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>P</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Maximal mean faecal egg count</td>
<td>480 ± 59</td>
<td>1,500 ± 309</td>
</tr>
<tr>
<td>Worm population at slaughter</td>
<td>x</td>
<td>18,450</td>
</tr>
<tr>
<td></td>
<td>range</td>
<td>950-42,700</td>
</tr>
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</table>
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Joyce, J.P. (1975) Proceedings Ruakura Farmers Conference


DISCUSSION

We are always told about certain live-weights that should be achieved. Is there any difference between breeds?

Professor Sykes - If you had asked me this question about U.K. breeds I would have said there were different body-weights, but within New Zealand, there are fewer breeds and not so much variation in mature body-weight between breeds. The Merino is, perhaps, the exception and that is why we recommend a separate lower weight - tempered by recognition of the weight which is actually attainable on the country on which they are generally run. In addition, the genetic potential of the traditional Merino for fecundity is inferior to the other breeds - and there is, therefore, little point in recommending high body weights. Looking at other breeds in New Zealand, we might recommend 60 or 65 kg as a target live weight. Body condition of the ewe is probably related more closely with reproductive performance than live-weight but the latter is used because it is easier to measure. Live-weight targets can be used in New Zealand because there is relatively little variation between breeds in mature body-weight, but body condition is probably the key factor in determining fertility.

The digestibility of browntop and species of that type were fairly high. I take it that applied to a situation where clovers had been over-sown or where nitrogen had been applied.

Professor O'Connor - There was no nitrogen fertiliser applied. The figures are averages of the un-topdressed and topdressed blocks. The level of topdressing on the topdressed blocks was very mediocre; about three hundred-weight to last four years. The area as a whole had been oversown and topdressed by Graham Dunbar is 1964. The clover comprised about five per cent of the total herbage production. It was nothing wonderful, but it had good grazing, and this is one way of applying nitrogen.
Selenium has been mentioned several times. There have been words of caution; by Dr. Allison yesterday, when he said some veterinary surgeons do not necessarily agree with everything he had to say; another by Professor Sykes, who suggested that climatic conditions could have some bearing on the likely response from selenium. I am interested to hear the comments from both those people who put this word of caution before us, because Ashley Dene may not get results under certain climatic conditions.

Professor Sykes - My caution is only the instinctive conservatism of a scientist. That result seemed to be too good to be true and it is only because of that, that I have any reservation about it. The question is, to what extent might body condition at mating influence the result. There are no data to suggest an interaction between body condition and selenium status. However, the studies were conducted in a drought year when the ewes were in relatively poor condition. We have repeated the experiment again this year under conditions of ample feed supply. The ewes are in very good condition.

Dr Allison - There is a great deal of information in the South Island of a selenium deficiency throughout. There are a lot of lamb growth experiments, many of which are unpublished, which all show responses to selenium in varying degrees. There are some which have no response. Selenium is cheap, it is easy to mix in with other drenches and in most cases will yield a response.

Did you get a response to your pre-mating drench at Ashley Dene?

Professor Sykes - No. I should say that ewes were only dosed ten days prior to mating, which is rather late by normal standards. In this year's experiment, we dosed 30 days prior to mating. Timing may be significant.

Comment: Dr R.S. Scott. I suggest you look at the intensity of stocking. If you were close-grazing prior to mating, there would be a large ingestion of soil which has about four times more selenium than pastures. If you were doing it later or immediately prior you would probably have a large feed
allowance and little soil ingestion. I have recorded selenium levels in animals which I relate to the occurrence of parodontal disease and it did not occur under low stocking where soil ingestion was low.

I would like to hear the Professor's views on the importance of copper cobalt and selenium and the inter-relationship between those elements, particularly in the rearing of young stock.

Professor Sykes - The interaction between elements is probably of greatest significance to this audience in the depressing effect of sulphur and molybdenum on copper availability. Where extensive use of sulphur and molybdenum is carried out, one should be aware of the possibility of introducing copper deficiencies in areas that are marginal for copper. This is an area in which we are surprisingly ignorant. First of all, we are not absolutely certain of the amount of copper or any other trace element that an animal requires. We can calculate the theoretical from controlled experiments. However, if we take the example of zinc, controlled experiments indoors suggest 7 ppm zinc in the diet is adequate for growth of the lamb. Yet work on pasture shows a dietary requirement of about 25 to 30 ppm. We don't understand these interactions. Many supplementation experiments have been carried out using a single dose of a particular trace element, and the response examined over a three month period. Close examination often reveals that the dose covers the animal's requirement for only the first few weeks of that period. It would not be surprising in those circumstances, to find negative results.

The other problem is that of maintenance of adequate controls with which to judge your response. Animals in field scale trials need to be run under identical circumstances. When these criteria are applied to results of research work, it becomes very difficult to make a judgement as to whether supplementation could have been effective. A word of caution is that expert advice is needed before attempting this sort of supplementation. Copper is an example. We can show circumstances where five to ten parts per million of copper in the diet would be adequate. We can show situations where five to ten
parts per million of copper in the diet would be inadequate and we can show you diets and results of experiments on diets where with only twenty parts per million - that is only double - animals have died of copper poisoning. Investigations cannot be made in an uncontrolled, haphazard way. It is an area which requires careful investigation.
A FORWARD LOOK

K.F. O'CONNOR *

In welcoming you to this seminar, Professor Langer predicted that at this time you should hear some prophetic utterances. You have had discourse enough on profits, so you don't really need some other kind of prophet now. I admit that Isaiah and Amos used to give up their regular range management jobs from time to time, to come down and stir the tripe out of the Jews, upbraiding them for their worldliness and their infidelity. It was Amos who used to get really stuck into them for their Hebrew concern for profit at any price: "You would swindle and cheat the poor for the price of a pair of sandals." There are New Testament scholars about who can see in these times a special literal message in the story of the unjust steward: "How much do you owe my Master?" said he. "Eighty barrels of oil" he might have answered. "Take your bill and write twenty", says the unjust steward. It is interesting to recognise that inflation could be so rampant so long ago. It is salutary too, in the light of Jock Allison's untutored two-tooth ewes, who needed coaxing, to remember the foolish virgins, who tried too late at night to buy oil at spot price for their lamps. Those wise ones who had trimmed their lamps ready for the bridegroom, were admitted to the party. The foolish were shut out.

I am not really expected to summarise all that you have heard and said and seen. While pretending to give you a forward look to hill and high country land use, I could paddle about in circling commentary on the papers that we have had, leaning on one side and then on the other; as a result, pointing nowhere in particular.

* Lincoln College.
Twenty two years ago, when Alan Dick was at Lilybank, I spoke at Pukaki to the Mackenzie Branch of Federated Farmers about prospects for fat lambs, for small seeds and for crops from the Mackenzie. I did not then, nor do I now, have very much time for cattle, except as a way of cleaning up pastures from worms, foggage or unwanted tussock. For cattle generally spelled fewer people, and it is occupation with people that the hill and high country really needs. I had no hate for wool, merino or otherwise, but simply feared for the viability of our society, which had then more than an 80 percent dependence on it. When Alan Dick asked me twenty two years ago what prospects were there for Lilybank, I told him simply enough, tourists and tulips. We have the tourists. The tulips, the blueberries, the seed potatoes and the like will not be far behind. It is really a question of whether we introduce intensive agriculture and horticulture into the high country or whether some other society introduces it. Whether our society survives to introduce them depends on whether we, from our ranks, make shrewd and prudent energy choices, not only to suit ourselves, but to make ourselves useful to others. If we want New Zealand the way we want it, we had better be confident that it is also the way that others want it for us.

In recent days, we have become very conscious of refugee problems, especially of the problems of the boat people. How would we behave to them? In my view, there is no other defence against thousands of boat people at every beach from Woodend to the Bay of Islands except that we use this country to serve their needs as well as our own. Our own sense of humanity would prevent us repelling them with violence. Therefore we must forestall them with productive foresight. I am not panicking myself or anybody else. I am not stirring in futurology. We have a Commission for that. I am just indulging in that ancient British sport of rowing, propelling ourselves forward into the future with arching back and thrusting limbs, keeping our vision clearly fixed on the past.
How did we see our land and our opportunity in the past? David Scott reminded you how we fenced North Island hill country as each new precious hectare was hard won from a reluctant forest. In the open country of the South Island, we made our tussock lands safe for sheep first by fire, then by poor famine-driven Scottish shepherds and boundary keepers, by tethered dogs and last of all by retirement fences. For Kupe, as for James Cook, it had been open country, unoccupied. For Australian pastoralists a hundred and thirty years ago it was open country, still unoccupied, because the Wakefield settlers had clustered round Christchurch and Dunedin, trading in land rather than trekking a few miles to sink a plough. So much is in the history books. If some new boat people walk unarmed up our beaches, spared by our own humanitarian conscience, it will be for them once more open and unoccupied country. Environmental perception is an essential element in an understanding of the vital issues of mankind and the biosphere, tussock, tulip and pine tree. Let us not expect others in the future to see our hill and high country as we see it now, stocked up to limitations and secured with perpetual rights of lease renewal. Rather expect others to see it in our future as we saw it in our past.

I have learned this much from looking at the past. I have emphasized our need to be useful to others. Our pastoral expansion from the 1880s was indeed useful to industrializing Britain. It is not so useful to them any more. We look for new prospects for traditional pastoral exports in new markets closer at hand, in China, Japan, Korea, Indonesia, Iran, Egypt, Arabia. We do little in the hill and high country to consider the new opportunities for land use that pastoral development can bring. Our troubles earlier this century arose because we allowed a mercantile system to lock our land holding and our land use in a straight jacket of pastoralism for the British market. Perhaps our problems have not just been with the market but with pastoralism itself.
Perhaps we succeeded too well in the past, in the past-watching role of the coxless four, efficient, organised, and unmanoeuvrably headed for disaster. Maybe we need a new image. Perhaps it should have some elements of the Polynesian canoe - forward facing, with more people involved on the paddles. Perhaps a bit more singing to keep us together, with the respected chief amidships and the good scouts in the prow. Perhaps we should be looking to the role that pastoral development has had in the Waikato and on Canterbury lowlands, the role of rebuilding soil fertility to make other land use possible. Wool and meat production can produce more than dollars.

The images I have pictured before you may seem designed to startle or even to frighten. They are not so intended and they need have no such effect. I suggest that fruitfully we can interpret our own place in history as the most recent of successive waves of boat people. We are now entering waters of destiny far more fateful for New Zealand society and for the whole human population of this planet than ever before. The needed leadership and foresight, to which I have referred, themselves demand the convergent efforts of many different kinds of people.

Foresight itself requires both near and far vision and some continuity between. I commend the practical foresight which has been demonstrated at this Seminar by Jim White and John Dunn in matters of cropping and mechanization, by Jock Allison and Andrew Sykes in livestock health and production. I welcome the clarity of the middle distance in pastures and tree crops as portrayed by David Scott and Alan Nordmeyer, in recreation and tourism by Gary Joll. I am enthralled by the continuity of vision which Ralph Frizzell and Chris Kerr develop before us with a new kind of "terrestrial gold standard", soaking up the inflationary middle distance like some ancient but rediscovered refracting binocular. Sadly, I am at a loss to describe for you what lies beyond our horizon, for that can be described only from the highest masthead.
It is the special talent of politicians to convince us that they can see over horizons and that what they can see is what we all want. It is the rarer gift of the statesman to be prepared for what lies over the horizon and to have us all see at last, what each of us needs. I am neither politician nor statesman and I am both suspicious about the future and probably ill-prepared for it. For our tussock grasslands and mountain lands, our horizons of a few decades past were the bouncing waves of Merino wool prices. The horizons are now more varied; venison and velvet, tourists and tulips, water and wood, weeds and biological conservation. The horizons are more varied but they are not less fluctuating. What lies beyond them I can only surmise. Of one feature I feel sure, that there is change ahead, continuing change. Of one alternative I am confident. Either we have serious participative resource use planning or we shall have serious disruptive resource use conflict.

It has become fashionable in recent months to misrepresent our national future as either national development or national stagnation or contentment. Conventional economics is usually represented on the side of development. The less conventional environmentalists, banded with green dye, are portrayed on the side of contentment. As one enjoying some intellectual formation in economics as well as in ecology, I consider this attempted polarisation an unreal and unproductive charade. The real issues of national development are not whether, by which and whither.

The same kinds of questions to the tussock grasslands and mountain lands, and the right answers for ourselves, for our grandchildren, and for any future boat people, are not likely to be the same answers everywhere in the tussock grasslands and mountain lands. For this reason above all, I am convinced of the urgent need for local and regional creativity and for the kind of national policy and leadership that will encourage such local and
regional creativity. I do not expect that we will have such national policy and leadership if we continue to play charades. I fear that if we devote as much effort in the next twenty years to developing centralist regulatory power and tight-reined policy as we have in the past twenty years we shall have achieved genuine stagnation. I look therefore to the renaissance of ingenuity and creativity in the hills and mountains to dispel such fears. If the people of the hill and high country are content to leave the necessary planning to central government and its agencies, then perhaps it would be better if we had no planning. At least we might enjoy the alternative conflict.