Our Cover—The Hut at Billy Creek by Charles McKenize.

It gives us the greatest pleasure to acknowledge the gift of our cover sketch by this well known Queenstown artist.
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While in Australia recently I had the privilege of staying with Mr John Watson of Wollogorang Station near Goulburn, New South Wales. This controversial man is known throughout the country for the business-like breeding and management policies which he practises on his station. They enable him to carry 32,000 Merino sheep on 8,000 acres—some of it old lake bed but mostly rolling Southern Tableland country mantled in stony hill soils and dotted with eucalyptus trees. Its average altitude is about 2,500 feet. Due to the latitude difference this would give it a climate about the same as 1,000 ft altitude in the South Island, New Zealand.

The sheep numbers have doubled twice since 1959 and Mr Watson expects them to double again by five years’ time. In fact he has succeeded in producing eight lambs and 100 lbs of wool per acre already on parts of the property.

As you might imagine, Mr Watson has some positive ideas on how to achieve his aim of maximum profit per acre—not just maximum weight of meat or wool. These are some of them. They are meant for efficient wool production on country similar to Mr Watson’s own, but the principles I feel, apply just as well to fine-wool sheep properties here, too.

GRAHAM HUGHES.

Stocking Rate

1. Carry the biggest number of sheep which can be maintained on the commercial body weight curve without having to drop to the emergency curve for more than a few weeks every two or three years, or hand feed or agist, on the average, more than once in five years.

2. The commercial body weight curve should give 10 lb/head wool and an 80% lambmarking for grown sheep, the emergency curve 8 lbs/head and 70% lambmarking.

3. Higher stocking rates—lower body weights—can give more production per acre but less per sheep.
4. Lower stocking rates—higher body weight—can give more production per sheep but less per acre.

5. The body weight curve proposed is close to the economic optimum between (3) and (4) above.

6. There is little chance of a 7% or better return on capital at current land and normal livestock values unless stocking rate is close to optimum.

Stocking Methods of Management

1. Use the stocking methods—fixed stocking, rotational grazing, deferred grazing, pasture saving, high density grazing, etc.—which best suits the circumstances at the time.

2. Avoid being committed to any particular system of grazing irrespective of circumstances.

3. The stocking method used should be selected to maintain the designed body weight curve, and maintain and improve the pasture.

4. Whenever possible avoid stocking two or more paddocks with the gates open allowing the sheep to move from one paddock to another—it promotes development of sheep tracks and worn gateways.
5. Leave the sheep in the paddock until it is grazed down to the desired level.

6. Use sufficient sheep to graze the paddock down in the desired time.

7. Sheep graze the short pasture first—except lucerne—and need sufficient time to graze the long grass.

8. Lucerne should be grazed down within 4 to 10 days.

9. Don’t expect untrained sheep to graze out a paddock quickly and effectively.

10. Always handle sheep quietly.

11. Get sheep tame by frequent association with humans and minimum use of dogs and noise.

**Hand Feeding (Supplementary Feeding)**

1. When available feed is insufficient to maintain sheep on the commercial body weight curve, they can be allowed to fall to the emergency curve.

2. If there is any risk of the body weights falling below the emergency curve, hand feeding or number reduction is necessary.

3. When hand feeding is started sheep weighing is most important for economy and to ensure that the feeding is beneficial.

4. Hand feeding for less than four weeks is most likely to do more *harm*—(decrease body weight)—than good.

5. Any change in the type of feed should be introduced as slowly as possible—feed just enough for each sheep to get some.

6. It is a slow process for a sheep’s digestive system to change to a different type of feed.

7. The more of a new-type feed supplied during the change-over period the greater the body weight *loss* will be.
8. An increase in body weight with a new type of feed is seldom achieved in commercial operations in less than six weeks.

9. This applies when changing from dry to green feed—green to dry feed, dry feed to grain, etc., or any similar changes.

10. Use the feed which costs least per food unit landed in the paddock.

11. When sheep are being hand fed, divide them into separate mobs on body weight and feed the appropriate amount to each group.

12. Three or more groups of each class of sheep, high, medium, and low body weights and a hospital or R & R (Rest and Recovery) mob is generally necessary.

13. Changing sheep from hand feeding to grazing requires the same care as going the other way.

14. Grazing a new green shoot too soon can greatly reduce pasture production and is not beneficial to the sheep.

15. When sheep are being hand fed they can be held on a small area to avoid any more pasture being damaged than necessary, or grazed on tussock and weed areas to remove weeds and increase the fertility of the area.

16. Big mobs on small areas or high stocking pressures (or densities) of 200 or more sheep per acre, help to distribute the droppings evenly and avoid high concentration of plant nutrients on sheep camps.

17. If sheep are divided into body weight groups, supplies of feed at infrequent intervals—once a week—to give the shy feeders a chance, are of no advantage and tend to increase the difference between the high and low body weights in the mob and crowding around feed truck.

18. Hand feeding to increase production of wool or lambs is seldom economic.

19. Hand feeding to keep sheep alive is generally economic, especially if done efficiently.
20. Wean lambs as soon as they reach design body weight, or at a lower weight if the design weight "emergency curve" cannot be attained.

21. It is uneconomic to feed a sheep which will die before it is shorn or rears a lamb.

22. These sheep—selected by minimum body weight—should be disposed of or killed before much feed is wasted on them.

23. Sheep reared on the emergency weight curve can be good producers in later life and genetically they are just as good as those reared on a higher curve.

24. Efficient methods of hand feeding for bad seasons are essential if optimum stocking rates are to be used in normal seasons.

Drenching

1. Drench sheep:
   i. Whenever their egg counts show that it is necessary.
   ii. Whenever climatic conditions are suitable for rapid increase of worm infestation.

2. When sheep are drenched or dipped, do every sheep in the mob and move to a spelled paddock—drenching lambs only, in a mob of lambs and ewes, is a waste of time and money.

3. Drenching should be done by careful, competent operators to avoid damaging the sheep with the drenching gun. Be sure not to miss any.

4. Use the cheapest drench which will deal with the infestation.

5. Never drench sheep as a tonic.

Fencing

1. Use the Piesse type high tensile*, or electric fencing.

2. Make plenty of small paddocks.

3. When planning subdivisions for paddocks draw the plan with paddocks half the size of the minimum you expect to need.

(*Like the N.Z. Soil Con fence.—Ed.)
4. Design fencing on the square, avoid angle and bent fences.

5. Avoid making paddocks which have high corners which produce sheep camps.

6. Make lanes for easy sheep handling, quick access and fire breaks. Grading is preferable to ploughing for fire breaks.

General

1. Don’t grizzle about adverse seasonal conditions—think of ways to take advantage of them and talk about that.

2. All the wool produced is used and will be, whether synthetics are better or not, as long as wool advertising is sufficient and effective.

3. Don’t turn grass into fat for sale, fat contains very little water, flesh is 80% water. It takes five times as much grass to make a pound of fat as it does to make a pound of flesh and fat is worth far less than flesh.

4. The genetic gain possible from culling flock sheep at a culling rate of less than 30% is of no commercial value. The improvement in the flock’s production is not likely to be of any consequence.

5. Any genetic improvement of consequence in a flock will be from the rams.

6. No permanent improvement can be expected from rams selected on appearance, whatever the price.

7. Employ only as many extra men as can be made to pay for themselves.

8. Give as much support as possible to organisations for training men for farm management and farm work.

9. Whatever you do, most probably there is a better way of doing it.
THE ECONOMICS OF LAND RETIREMENT

A CASE STUDY

by

R. W. M. Johnson

Principal Research Officer, Agricultural Economics Research Unit, Lincoln College.

One of the recommendations of the Waimakariri Report produced by the Tussock Grasslands and Mountain Lands Institute a few years ago was that more investigation was required into the effects of land retirement on the pastoral economy of the South Island. In this article, I want to discuss a retirement plan for one property which has been in operation now for six years, and which demonstrates some of the economic problems that runholders face with retirement of Class VIII land.
The Property

The case study is based on Grasmere Station, the uppermost property on the south side of the Waimakariri River. The property actually consists of two runs, Grasmere and Cora Lynn; Grasmere having 984 acres of freehold and a University Endowment lease of 13,446 acres, and Cora Lynn having 387 acres of freehold and 25,170 acres of Crown, Forest Service and National Park leases. At one time Cora Lynn run extended to 43,200 acres but various adjustments had reduced this to 25,000 acres by 1965. The run plan, drawn up by the North Canterbury Catchment Board, suggested a further consolidation of the property whereby a further 15,597 acres of the Cora Lynn lease were to be given up.

Grasmere is situated in the glacial basin once occupied by the Waimakariri Glacier and its tributaries. The property has a topography partly determined by old glacier flows (steep mountains, rounded hills and dumps of moraine) and partly by subsequent erosion of the landscape (wide grassy shingle fans and river terraces).

Vegetation is typically fescue tussock with some beech forest toward the main divide, and depleted snow tussock on high areas. A considerable amount of middle altitude country is covered by manuka and matagouri scrub. Some of the lower fan country (at approx. 2,000 ft above sea level) is suitable for cultivation, and steeper fans and part of the rolling hill country respond reasonably well to oversowing and topdressing. The growing season is limited to 7-8 months of the year and some form of fodder carry-over is necessary for the remainder of the year.

The Programme

Before the run plan commenced, some 8,600 sheep and 180 head of cattle were wintered. About 450 acres were in sown pastures with around 75 acres sown down in turnips each year. Hoggets and breeding stock were wintered on paddocks, or on the low hill country surrounding the flats. During the summer and autumn, some 3,000 wethers and dry ewes were put out on the higher parts of Cora Lynn run for 3-4 month. In this way, some 10,350 grazing months were obtained from the summer country, or about 10% of the total sheep grazing requirements. It is the use of this summer country which is lost to the runholder under the retirement plan.

The management effects of this loss are quite considerable. Sheep displaced from the retired summer country must be grazed on the more extensive hill country below 4,000 ft and the stock
which formerly grazed this country must in turn be accommodated on improved hill country and cultivated land. Under this plan it was thought that because the hill country and improved pastures would have less spelling in summer, autumn and particularly winter grazing would be seriously reduced by retirement of summer country. To maintain the same number of sheep on a property, cultivated pasture or oversowing hill country must replace the grazing formerly conserved by adequate summer spelling.

The run plan proposed that some 1450 acres of steeper fan and rolling country should be oversown and topdressed regularly. Experiments on the Bailey block of the run by the North Canterbury Catchment Board and the Soils Department of Lincoln College had shown that considerable improvements were possible by aerial methods. In addition the annual acreage of turnips would be increased from 75 to 130 acres and sown pastures increased from 375 to 540 acres. An extra shelter belt was proposed on the open fan country that was to be brought under cultivation. The changes needed by the plan were to be completed by appropriate fencing of the new cultivation paddocks and oversown country.

These are the broad principles of land retirement as initially worked out for this property in 1964-65. Since the plan was put into operation it has been modified slightly in speed and direction. Oversowing and topdressing of the hill country has been delayed in favour of more subdivision fencing and more cultivation. The annual acreage of turnips has been increased to 150 acres.

The estimated cost of all extra development expenditure on the property for the full seven-year period from 1964 to 1971

Heifers winter grazing the lower slopes of the Bailey block, Grasmere Station.

(Photo: I. McLeod)
The Ribbonwood fan from above Long Hill, with Lake Grasmere to the right. Long Hill and Ribbonwood fan are both suited to aerial topdressing and oversowing. Part of the Cass fan (above Lake Grasmere) is suited to cultivation. (Photo: V. C. Brown)

comes to $40,338. It is assumed that 75 acres of turnips would have been required to continue in the old grazing pattern and that existing improved pastures would continue to need maintenance topdressing. The costs of these operations are not included in the above total. The yearly pattern of extra expenditure required on cultivation, fencing, topdressing and oversowing, along with a summary of the subsidies payable, is shown in the following yearly totals of development expenditure:

<table>
<thead>
<tr>
<th>Development Expenditure</th>
<th>Subsidy</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964-65</td>
<td>$4,703</td>
<td>$1,358</td>
</tr>
<tr>
<td>1965-66</td>
<td>5,291</td>
<td>1,375</td>
</tr>
<tr>
<td>1966-67</td>
<td>9,715</td>
<td>3,429</td>
</tr>
<tr>
<td>1967-68</td>
<td>6,136</td>
<td>2,530</td>
</tr>
<tr>
<td>1968-69</td>
<td>7,152</td>
<td>2,257</td>
</tr>
<tr>
<td>1969-70</td>
<td>3,315</td>
<td>1,739</td>
</tr>
<tr>
<td>1970-71</td>
<td>4,026</td>
<td>1,065</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$40,338</strong></td>
<td><strong>$13,753</strong></td>
</tr>
</tbody>
</table>
Thus the cost implications of this run plan can be broadly summarised as involving the runholder in $26,585 of development expenditure and a government contribution of $13,753. On this basis, 35% of the land retirement proposals will be met by subsidy.

The gains from the retirement plan can be conveniently discussed from two points of view. First of all readers will want to know how the runholder fares with this plan. Secondly, many readers would like to see discussed the wider reasons for the type of land retirement proposals that this plan represents. Let us take these in turn.

**Retirement from the Runholder’s Point of View**

From the runholder’s point of view the extra costs imposed on him by land retirement would be impossible to meet without some form of permanent extra income. In some properties, off-site development can bring about considerable increases in sheep carrying capacity which soon compensate for the loss of some summer grazing. It is doubtful, in these cases, whether a large subsidy payment is really necessary. But on other properties, especially those in the headwaters of the main catchments like Grasmere, increased sheep grazing capacity can only be gained slowly and at some cost. Some properties have little scope for development at all and these runholders should probably opt for straight-out compensation for land retired.

In the case of Grasmere, no absolute increase in sheep numbers is provided for at all, but the greater consolidation of all sheep grazing on the lower country should result in better thrift and less winter stress particularly. The runholder is satisfied that the stock are in better condition than formerly, but as yet there have been no significant changes in lambing percentage, wool weight or in the number of surplus sheep for sale. So far there have been few savings in mustering costs and the like but some savings are possible in the long run in this direction. It is fairly clear that under this plan further gains in thrift and productivity are hard to achieve in this environment, and great gains in this direction cannot be expected at all.

In the first five years of the run plan, carrying capacity on the flats and low hills has increased by 1700 ewe equivalents. Roughly 1300 ewe equivalents of this total has been taken up by the sheep displaced from the summer country on Cora Lynn. The remainder has been taken up in increased cattle numbers. In terms of the total costs of development each unit increase in ewe equivalents has cost $19.35. Of this total, subsidy represents $6.45.
Under the plan there has been an increased summer use of what was formerly winter country. Greater provision therefore had to be made for winter feed.

(Photo: I. McLeod)

The permanent income increases that will result from the plan will therefore come from increased cattle alone. At present cattle numbers are 323 head as compared with 189 in 1964. By the end of the run plan period the total will have reached 377, with a changeover in selling policy from some 2½ year steers and some weaners, to weaners only. Without going into the details, it can be estimated that on present prices, the gross profit from cattle sales will increase by $5,000 by 1971. Against this, the cost of operating the property will have also increased permanently as a result of consolidation by around $2,500 per year.

In summary, therefore, the runholder will need to find $26,500 over the seven-year period of the run plan, some of which will be found out of a steadily rising level of cattle sales (about $11,000). At the end of the period, gross revenue has increased by $5,000 but working expenses by $2,500, so that he is permanently better off by about $2,500 per year after putting $26,500 back into the property. This is roughly equivalent to a 10% return on the capital investment involved, a modest return in terms of the risks and anxiety involved.

Retirement from the National Point of View

The national benefits from the proposals can be stated quite simply. Some 15,500 acres of the watershed of the Waimakariri River are legally placed in a fully protected soil conservation status, thus potentially adding to the headwaters area of the river already fully protected in the Arthurs Pass National Park
and under Forest Service administration. If a high level of control of noxious animals is achieved over the whole area, then it is reasonably certain that the surface cover of the catchment will be noticeably improved, that the water-holding capacity of the catchment will be better, and that the movement of shingle and sediment will be less.

In addition to the area actually retired from domestic animals, fencing, topdressing and improved management practices on the balance of the property will also result in an improvement in surface cover, therefore resulting in better soil conservation practice as well.

These improvements in the Waimakariri catchment’s soil conservation status do not affect the runholder very much. It is generally claimed that it is the people on the plains below and the people of Christchurch in particular who will benefit from greater flood control of the Waimakariri River brought about by land treatment practices of the kind described.

As I see it, there is a broad political issue in this matter as to who should pay for the protection of the watersheds of the rivers that flow across the Canterbury Plains. If the beneficiaries are the community at large then it is the community who should, in my opinion, pay for the measures that are necessary to reduce flood hazards in Christchurch.

**Conclusion**

I believe this runholder has had to pay for an excessive share of the costs of protecting a bit more of the Waimakariri watershed, when he will benefit very little from it. I would argue that society should pay for the benefits it received in a case like this and reduce the burden on the runholder.

This article has been based on the analysis of one run plan in one watershed of the South Island. There are undoubtedly many variations in the problems that are met throughout New Zealand, and the results of one case study should not be interpreted as typical or representative of all the conditions that can be met. This article is about the problems in the case study described and further research is undoubtedly needed to establish whether the problem raised is more general in the tussock grassland areas of the South Island.

**Acknowledgements**

May I conclude by thanking all those people who have contributed to this study; the runholder, Mr David McLeod; soil conservation officers of the North Canterbury Catchment Board, Messrs R. D. Dick and J. H. Stone; staff of the Tussock Grasslands Institute; and my research assistant, Mr David Shepherd.
PERENDALES ON WAIPORI STATION

J. C. Logan
Manager, Waipori Station, Lawrence.

I am not a breeder and I do not put myself forward as a Perendale expert. Nevertheless I am very happy to share my experiences with this breed on fairly tough Otago hill country.

Waipori Station runs from good average ewe country to hard weather country. Anyone who knows the Lammerlaw Mountains will agree that our winters can be long and fairly tough. To thrive, our stock must have a better than average constitution. As far as a grazing proposition was concerned, it appeared we could expect no significant increases in production from our Romney flock.

Changing the breed is a major decision on any property and one that is not entered into lightly. However, in 1961 we decided to introduce Perendale blood, with the hope that we might have some of the desirable features of two different breeds of sheep; the Romney and the Cheviot. We hoped that by doing this we would improve our wool production and perhaps most important, our lambing percentages.

Although it would have been possible to buy Cheviot rams and cross them with our Romney ewe flock we doubted if we would be able to get enough rams of the right wool type. (In addition, we weren’t sure at that time whether we really wanted a Perendale flock or whether we just wanted to introduce some Perendale blood.) We decided to buy Perendale rams even although we knew that it would take four crosses to produce what would virtually be a Perendale flock. We also knew that by working this way we could not expect immediate benefits.

The Perendale cross lambs in that first season looked good. They were full of life, clear about the face and points and were well wooled on the body. They seemed to stand out well as individuals which would be well suited to our hill country. However, although we thought our stock were improving in those early years, we had to wait for our proof until the Perendale blood became firmly established in the ewe flock. After nine years we now have all the proof we want to convince us that we made a wise decision.

Wool weights have increased. Our wool weights showed a spectacular increase from 5¾ lbs per head in 1960 to 8lbs per head in 1967-68. As well as this we have up-graded the quality of our wool.

Lambing percentages have increased. Although Perendales were introduced in 1961, lambing percentages didn’t show any
real increase until 1967. Prior to 1961 we had lambing percentages of about 72 per cent. However, since 1967 they have increased to 85 per cent. As well as this our death rate has fallen from about 12 per cent to about 5½ per cent. One of the major advantages of this is that we have had a larger two-tooth flock from which to select flock ewes.

Mustering is easier. One of the most striking features of changing to Perendales is that it now takes about half as long to muster most blocks as it used to. In view of the steadily increasing shortage of good shepherds I believe this to be a most important advantage. A number of people believe that Perendales are wild and therefore difficult to handle. My experience has been quite the reverse. With good shepherding their liveliness is a real advantage. A good loose free-running dog will handle these sheep without any problems.

I do not believe that the Perendale is the perfect sheep. However, after experience with many breeds from Canterbury to Southland under some fairly harsh conditions, I do believe that it is amongst the toughest in the country. They are mobile and are great foragers using almost all of the available grazing. The ewes are good mothers and give their lambs a good start. In heavy snow their tenacity to live is amazing.

Their toughness is a very important feature when you are farming in a difficult environment and I do not think that our recent increases in production would have been possible without them.

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RESEARCH REPORT

FERTILISERS, GRASSES AND CLOVER FOR HIGH ALTITUDE REVEGETATION

G. A. Dunbar
Tussock Grasslands and Mountain Lands Institute.

INTRODUCTION

Although the literature relating to tussock grassland improvement has many early references to work aimed at plant introduction and improvement in drier areas, particularly in the Mackenzie country and in Central Otago, almost all of this work was conducted at altitudes of less than 3,000 feet. Until the late 1950s when the Protection Forestry Branch of the For-
Progressive deterioration of sites such as this may be expected unless the eroded parts are revegetated artificially.

(Photo: G. A. Dunbar).

The Tussock Grasslands and Mountain Lands Institute, through the objects laid down at the time of its establishment, also has a direct interest and responsibility in the improvement of cover in the mountain lands but of necessity, with a small staff, has been active over a much less extensive field than has the Protection Forestry Branch.

The results of the revegetation work within the Institute, mostly conducted by the author, but initially under the direction of Dr S. N. Adams, have been outlined in the Annual Reports published over the past few years. This article summarises these reports and elaborates on some aspects of the work.
THE APPROACH TO THE PROBLEM

Our main concern in this work has been to re-cover and protect eroded land. The emphasis has been on learning how to establish a protective plant cover with one treatment and learning how long this cover will persist without maintenance fertiliser.

It is also important to note that a different approach to revegetation is necessary on the high altitude, higher rainfall areas, than on the lower rainfall areas. Due to higher rainfall and consequent higher rate of leaching the soils are generally less fertile than in lower rainfall areas. Moreover increased soil moisture in late autumn and spring leads to an increase in plant mortality rates through damage from needle ice formation. Unless soil fertility receives a boost from added fertiliser sufficient to ensure almost complete ground cover in the first growing season, then the chances of plant survival into the second season may be remote.

Our major line of revegetation research over the past five years has been the study of the fertiliser requirements for high altitude revegetation with herbaceous species. There has been no attempt to test a wide range of species, but much has been learnt about a few introduced species during the fertility investigations. A second, less intensive but important line of work has studied the prospects for using native tussock species in secondary stages of a revegetation programme.

PROGRESS OF SOIL FERTILITY INVESTIGATIONS

Preliminary Trials

To guide the development of the more detailed soil fertility investigations, three exploratory trials were laid down in 1965 at Porter’s Pass, Craigieburn Range and Mt Olympus. The sites varied in slope and aspect, but were all on exposed subsoils at altitudes of from 3,200-3,500 feet.

Ten species, comprising seven grasses, two clovers and yarrow were sown in separate replicated plots, both with and without a “complete” fertiliser. The “complete” fertiliser contributed nitrogen, phosphorus, sulphur, calcium, potassium, magnesium, copper, boron, zinc and molybdenum. Despite a late spring sowing, plots with the fertiliser developed very well and some species had produced almost complete ground cover by the end of the season. In the no fertiliser plots seed germinated well but plants failed to develop and did not persist into the second season, even on gentle slopes. Although the immediate effect of these trials was to confirm once more the need for fertiliser, the growth was surprisingly vigorous and suggested that
something besides the nitrogen and superphosphate in the mixture was having a marked effect on growth.

One of the grasses sown, Yorkshire fog, proved outstanding in its ability to provide ground cover quickly, and it was subsequently used as a standard grass species in all the glasshouse and field trials.

**Intensive Investigations**

Investigation of the fertiliser requirements of exposed mountain subsoils continued more intensively in 1966. Ten trial sites were chosen, from the Black Birch Range in Marlborough to the Takitimu Mountains in Southland. Subsoils from these sites were used in glasshouse pot trials, growing Yorkshire fog and white clover. The pot trials showed that all subsoils were acutely deficient in nitrogen and phosphorus. Yorkshire fog made virtually no growth unless both elements were applied, and white clover needed added phosphate to thrive. In the presence of these basic dressings a fertiliser mixture supplying potassium, magnesium and minor elements increased growth of grass and clover significantly on most soils.

These results gave a valuable guide to the design of field trials which were laid down on the ten sites in the spring of 1966. In these field trials the four “species” treatments were Yorkshire fog, cocksfoot, white clover and a mixture of these three. Plots with clover or clover and grass together were given Native tusocks as well as introduced grasses show a very strong response to nitrogen and phosphorus applications on subsoils. This photo is of silver tussock (*Poa caespitosa*) after seven months’ growth.

*(Photo: G. A. Dunbar).*
a basal phosphorus dressing. Grass plots were given basal phosphorus and nitrogen. The trials were designed to test the effects, separately and in the various possible combinations, of sulphur, lime, magnesium, and a mixture containing potassium, copper, boron and molybdenum. Concurrently, during the spring of 1966 and winter of 1967, further glasshouse pot trials were run, to parallel the field tests to some extent but also to examine the effect of minor elements in more detail.

Field Results

In the field, grass and clover established satisfactorily on several treatments in eight of the ten sites. At the end of the first growing season analysis of the field records for the eight sites showed that taking the four “species” as a whole, there were significant growth responses to magnesium applications on seven sites and significant responses to a mixture of potassium and minor elements on six sites. Moreover, there was a positive interaction between the magnesium and the potassium/minor element mixture on seven sites. As pot trials had shown a strong positive interaction between magnesium and potassium but little effect from minor elements, it was assumed that potassium played the major part in the field response to the potassium/minor element mixture. The field trials showed that for all sites tested, application of magnesium and potassium could be regarded as beneficial to growth. On several of the sites application of both elements was essential for satisfactory growth.

Of the other elements tested, sulphur proved beneficial on most soils but no clear evidence emerged for the need for minor element application. Lime applications, at rates of half a ton per acre, benefited clover growth on strongly acid subsoils when magnesium and potassium were also applied. In the absence of these two elements lime applications frequently proved detrimental to growth.

Survival of Species

Principal interest in this series of field trials now lies in observing the persistence of the sown species in the absence of additional fertiliser. In general there has been a slow decrease since the second season in the vigour of cockfoot and fog sown without clover. Where grass was sown with adequately fertilised white clover but with no nitrogen the grass growing amongst the clover has shown a slow increase in vigour. Although no dense plots of clover persist above 4,000 feet altitude, it has been encouraging to note that where some white clover plants did establish in the first season with suitable fertiliser treatment, they have persisted with good vigour at altitudes up to 5,000 feet.
The importance of fertiliser on exposed subsoils is shown by this comparison of a sowing of seed only on the left, and of seed plus complete fertiliser on the right. Photo taken after one winter.

(Photo: G. A. Dunbar).

**Amount of Fertiliser Needed**

The rates of fertiliser used in the field trials have not been high. In the main series of trials nitrogen equivalent to 4 cwt of sulphate of ammonia and sulphur and phosphorus equivalent to 5 cwt of superphosphate per acre when applied. The rates of potassium and magnesium were 54 lbs (approximately one hundredweight of muriate of potash) and 26 lbs (approximately one hundredweight of magnesium carbonate) respectively. Although little field work has been carried out on the effects of different rates of fertiliser, recent pot trials indicate that although some benefit could have been obtained from using higher field rates of phosphorus, no benefit would have derived from higher rates of magnesium and potassium. In fact lower rates of these two elements would probably be satisfactory.
SUITABILITY OF INTRODUCED GRASSES

As was stated earlier, there has been no attempt to test a wide range of species. In fact white clover has been the only legume used. Of the grasses, cocksfoot and Yorkshire fog have been used most widely. Brown top and chewings fescue have been used more intensively over a few sites. Some general comments on the usefulness of these few grass species may be made.

Yorkshire fog has shown great ability to provide a protective cover in a short time. While it has shown a strong tendency to behave as a biennial there is a very persistent soil protective effect from the dead foliage and intensive surface root system. Cocksfoot has grown well at altitudes up to 5,000 feet and active growth has persisted better than for Yorkshire fog. However, it seems to be more demanding in its nutritional needs and is not such an efficient soil protector.

Brown top and chewings fescue while much slower than fog during the first season have shown increasing vigour in the second and third years. Brown top has shown especially good persistence in the wetter sites.
TESTING OF NATIVE TUSSOCK SPECIES

In comparison with many introduced grass species the major native tussock species are at a disadvantage in colonising eroded subsoils because of their slow growth rate. Glasshouse trials in 1967 with five tussock species showed that they, too, needed fertiliser nitrogen and phosphorus for satisfactory growth on a mountain subsoil. Additional responses were obtained from potassium and magnesium in combination. However, even with good nutrition the fastest growing species, silver tussock, was considerably slower than Yorkshire fog.

On the other hand there is the possibility that once established in protective cover the tussocks may persist longer under conditions of severe climate and declining soil fertility.

Field seedings of tussocks in 1967 and 1968 under a range of grass and clover cover treatments showed that even when sown with fertiliser, a high percentage of unprotected tussock seedlings were killed by frost heave. Seedling emergence in the field has been satisfactory for silver tussock, hard tussock, blue tussock and Festuca matthewsii but has been very low for Notodanthonia setifolia. Although tussock seedlings have established and persisted for two years amongst the cover species, their growth has been very slow. It is difficult to know at this stage whether in fact they will surpass the introduced grass species in persistence.

CONCLUSION

The use of grasses and clovers with adequate and correct fertiliser nutrition is only one of several possible means of re-vegetating eroded high mountain country. There are without doubt many areas for which grass and clover establishment alone would be inadequate. However, there is the advantage that aerial sowing methods avoid the high manpower costs associated with hand planting of trees or shrubs and allow a greater spread of remedial treatment. There are still many unknowns but our experience so far has given us a much greater confidence in the physical possibility of re-establishing a plant cover on eroded mountain lands.

Acknowledgement

Much of the field work would not have been possible without the ready co-operation of many soil conservators of Catchment Boards and the Ministry of Works throughout the South Island and the staff of the Forest and Range Experiment Station, Rangiora. The author is also most grateful to those runholders who have allowed trial plots to be erected on their properties.
On mild evenings the whirring beat of wings and the occasional dull thud and bang against the window pane separating twilight and the bright electric light reminds one of the dusky world of moths. Large and small, broad and narrow, furry and feathery there are some 1500 species in New Zealand.

It may come as a surprise to find that we have only eight native species of butterflies, only ten other introduced or more cosmopolitan species, and two of these have only been seen twice.

Why such a paucity of butterflies in a country so well endowed with other insect life?
One possible explanation is that the New Zealand bush, beautiful as it is, has very few brightly coloured, heavily scented flowers. Certainly New Zealand's history of heavy afforestation, with little marginal bush other than alpine and coastal, has influenced species present.

However, there is one native butterfly familiar to all. This is the Red Admiral, a beautiful insect with its black and dark-brown wings set off by bright red transverse bars.

If you have the common stinging nettle growing nearby it is very likely that you will be visited by the Red Admiral. The eggs are laid on the undersides of the leaves of this plant in the summer, lie dormant through the winter and hatch in early spring. The tiny caterpillars that hatch from the barrel-shaped eggs feed vigorously on the nettle leaves and grow until they are an inch and a half long—striped speckled white and brown on their tops and sides and green underneath.

When fully grown the caterpillar makes a small tent to hide in by pulling together several nettle leaves, fixing them in position with silken threads to form the outer shield of a cocoon. During this pupal stage of its life history it neither feeds nor wanders about. It spends two to two and a half weeks inside the cocoon developing wings, legs, adult body—even the biting jaws of the caterpillar are drastically replaced by a long coiled tongue through which the butterfly will sample nectar from flowers once it has emerged.

The adult butterfly may live up to a year or more. In winter it hibernates, stirring occasionally on sunny days to stretch its wings and feed.

Though there are Red Admiral butterflies in other parts of the world, this species *Vanessa gonerilla* is found only in New Zealand. It ranges from alpine slopes to city gardens, and here it favours the sweet smelling buddlea flowers—just as its counterpart in Europe does.

Smell plays a vital part in the lives of many insects and especially in moths and butterflies. It is by smell that the female and in some species of moth, the male can detect the female over a mile away.

The transition from smell to taste is a gradual one and it is difficult to distinguish separate organs of either in insects. Scientists, therefore, group both under the general name of chemoreceptor. Chemoreceptors are found on the antennae, the mouth parts and even on the insect's feet. Those on the feet of the
Red Admiral butterfly have been found to be 200 times more sensitive to a sugar solution than is the human tongue.

A final point about the antennae: do you know how to distinguish a butterfly from a moth? Some moths are just as colourful as butterflies but you will find that only the butterfly has a small and distinct knob at the tip of the antenna.

“MOLESWORTH”

“Molesworth” by L. W. McCaskill,* first Director of the Tussock Grasslands and Mountain Lands Institute and directly the founder of this Review, was long awaited. His current attitude to the future of this Lands and Survey Department 450,000-acre cattle station has already been made clear in at least the Canterbury press and doubtless that of Marlborough. Clearly heard, too, one would imagine, in the Lands and Survey Department and in Ministerial offices. But McCaskill’s book is to be enjoyed not for his predictions for the future but for his history of the past, a history against which we see the present and plan for the future.

Historical geography is my classification of this book. Historical geography because it is a description of an area and all it contains, analysed in time—a difficult métier. “Molesworth,” as McCaskill himself says, “. . . is a story of land and people.” Perhaps land, people and stock for without the latter Molesworth could not be. But all this is really what we want to know about.

Who emerges from this book? Acton-Adams, perhaps the Marlborough equivalent of George Moore of Glenmark, or “Ready Money” Robinson of Cheviot. An owner of much land and many stock, attending to detail great and small, and effecting the closest scrutiny of accounts and management practices; probably the greatest single force in the early evolution of the Molesworth. Bob Boddington, illiterate (in the exact sense of that word) but Molesworth’s greatest stayer—38 years there and most of them under Acton-Adams’ stringent control. And Bill and Rachel Chisholm, the second great Molesworth stayers (28 years). Chisholm the developer of greater Molesworth and New Zealand’s challenge to the famous “King Ranch,” Texas. Of course many others feature, some with renowned names; a few trying to make money; some musterers; William Blackadder’s chance meeting and the story he heard. While these are

the people, overshadowing the whole of Molesworth are the administrators of the land itself, and the stock firms supplying the capital. In the ultimate the land administrators took over, the last stock firm, N.Z. Farmers' Co-op., having been defeated.

For an account of the difficult landscape, for history of land ownership and land development of what is now Molesworth (that is Tarndale, St Helens, the Dillon and the original Molesworth) McCaskill's book is worth owning. For stockmen it is all there: the sheep numbers, the breeds and attempts at changing them, the losses in the historic big snows, the troubles with scab and inspectors, Acton-Adams' ambition to shear 50,000 sheep (actual number 43,834 in 1889), Boddington's trouble with shearers. Pervading the whole, but not truly an indication of future policy, is the history of cattle raising. At the stock sale in April 1937, ending "... the era of private exploitation," the Farmers' Co-op sold 1,600 cattle. But from the beginning there had always been cattle; Acton-Adams was well to the fore and hopeful of "... laying the foundation of a long business connection" with Duckworth and Co., meat salesmen of London, for frozen beef.

The decline of Molesworth, plagued by rabbits, high costs, depletion of resources, change of ownership and a depression, all led directly to the current period of development which is modern history.

McCaskill is at home discussing the rabbit menace, the weed problem, soil erosion, and the control measures effected for them. He is not disinclined to quote from others whose judgments he respects. But his support for M. M. Chisholm's policies, his admiration for Chisholm's methods and achievements are constant. The financial detail given backs up the success story. The miracle of Molesdoes not lie in the number of acres oversown, the rabbit control programme, the high prices for cattle paid at
Addington. No, the miracle of Molesworth is that it did happen. And while credit must be given to the many civil servants who must have had nightmares about their decisions, the lion’s share must go to one civil servant, M. M. Chisholm, M.B.E. I am not sure that there is, “... a legend which is Molesworth.” I think there is an enigma which is Molesworth and that enigma is Bill Chisholm. True, we all know him, his bluff style, his innate ability, his modesty, his accomplishments. But where did the stockmanship come from? Where the judgment over land use? His early years did not seem to prepare him for this. Some people are just “a natural” and Bill Chisholm must be one. Perhaps he will tell us himself one day.

There is more in McCaskill’s book of course: Harry Gibbs, formerly of Soil Bureau, D.S.I.R., wrote an appendix on the soils; there is mention of scientists, soil conservators, officials. The Lance McCaskill charm gets through in places and there is little McCaskill invective.

I think you will like it, even if your own hobby horse has received scant treatment. But where in the list of station books does “Molesworth” fit? It is not a “Tutira” by W. Guthrie-Smith, nor a “Te Waimate” of E. C. Studholme, nor a “George Rhodes of Levels” by A. E. Woodhouse. These are all too personal; and as one would expect, it is better on the long head than Peter Newton’s stuff, and no kinks on the run out. The “Molesworth” is global, more a sub-regional history, though intentionally lacking documentation in the true sense; this latter perhaps unwise. Because of his outlook the author has written a commentary on land administration over a century and a quarter. That it includes success should not be essential to our enjoyment or understanding of a huge modern enterprise in management, conservation and production in a most difficult high altitude environment.

There are some printing errors and no captions to the maps in the body of the text. Colin Wheeler’s painting of the homestead is the dust cover. All high-country men will enjoy it.

H.E.C.
A NOTE ON AUSTRALIAN FENCES

J. G. Hughes
Tussock Grasslands and Mountain Lands Institute.

Southern Australian graziers are showing increasing interest in what is locally known as the "Piesse" fence. It is very similar to the "Soil Con" fence of New Zealand. Although its specifications vary, the fences usually have ten 12½ gauge wires stapled to 3-4 inch diameter posts for a fence height of 3½-4 ft —high enough for barbed wire to be unnecessary, even for cattle. Posts and wooden droppers or batten spacing varies. The more traditional fences have two posts per chain but others have posts only on high rises with the fence suspended through shallow depressions between them. On the gently rolling or near-flat country so common in Australia this means that the posts may be several chains apart. They hold up an apparently sloppy fence which gives freely when pushed. This is claimed to be an advantage—several men said that cattle may test but will not cross a fence which is flexible. On the other hand they may damage a rigid one.

At Wollogorang the wires are sometimes held to a post by a vertical dropper-wire threaded down through horizontal staples. Or, the top two wires may simply be slipped over the other side of the post. Both these methods allow mobs of sheep to be easily shifted from one block to another by dropping the battened wires away from several posts, thus flattening the section for the stock to walk over. This eases the stock stress at gateways (in fact it almost makes gateways unnecessary on this type of country) and allows large mobs to be moved from block to block wherever convenient.

Permanent electric fences are becoming more popular for controlling cattle. I saw many New Zealand made "Waikato" units on Australian fences. One ingenious farmer had done away with gates in his three-wire cattle fences by training cattle to walk under a section of fence which could be raised above the ground. This was done by pulling on ropes passing over pulleys fixed to the top of two high pole uprights like extra-high gateposts. The system allowed him to have very long, often farm-wide fence strain without the problems of electric cables and expensive strain endings at gateways. This method is not only well suited to the flat Australian topography but also to fencing the inland plains and river valleys of New Zealand.

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TRANSPORT

A. E. McQueen

(Formerly Victoria University, Wellington, now Deputy Director, Research and Economic Planning Division, New Zealand Railways.)

Farming in New Zealand is, in industrial terms, small scale and widely dispersed. Production schedules are governed by the vagaries of seasons and climate, as well as by variations in international market demand or the dictates of government policy. Again in terms of industrial comparisons, most farmers are the equivalent of the small scale forest or mine owner, or a small factory owner; but the way in which the farmer is basically different is that he is usually producing a number of commodities and demands a variety of stores at different times of the year—all of which adds up to a very diverse pattern of transport demand. The forester produces only logs, the miner only coal or some other easily handled and stored product; their produce is available all the year round, and production can be adjusted to meet industrial or consumer demand. But fat stock, dairy produce, and many crops, must be shifted for processing or storage when the season demands it. In this respect there is a peculiarly immediate quality about the farmer's demand for transport services; he is producing something which, if not shifted within a quite short period of time, will often be totally wasted.
This factor, coupled with the diversity of products calling for transport, and the widespread geographic dispersal of farms, puts farm transport demands in a rather different category from those of other parts of the primary sector. It also explains why the transport operator serving the farmer, faced with such seasonal and only partially predictable demands, needs to have maximum flexibility built into his fleet, his staff, and the management of his resources.

INDIVIDUAL AND COMMUNITY INTEREST

The transport decisions of the individual farmer are of very little significance to anyone but himself. There are very few farmers whose transference of custom would seriously affect a single transport operator; as a community, however, farmers could make or break him. Rural transport services must therefore be considered on a community or district basis; for maximum economic benefit, the majority or community interests come first.

The potential division between community and individual interest has always been one of the knottiest points in transport. It appears in the apparent conflict between the farmer who uses his own truck extensively off the farm, yet expects to have a licensed transport operator waiting to serve him when required. It appears in the individual farmer who rarely uses a local railway station or branch line, then complains vociferously when abandonment is announced. It also appears with the protests against the 40-mile limit imposed on road competition with the railways for some commodities; a restriction imposed traditionally in the public interest yet often opposed without any real understanding of the likely effects upon freight rates and rail services to all sectors of the community if it were to be lifted.

ATTITUDES TO TRANSPORT

All the individual viewpoints in the above cases are very understandable, and entirely logical if you accept that the individual’s convenience should always come ahead of the community interest. In transport, in particular, it is very easy to make this assumption because transport is not a very exciting or interesting matter—except, of course, to the actual operator or to the producer so far as it concerns his costs. Transport is but a means to an end. There is no intrinsic advantage in having goods transported; it does not add to their value in any way except in the sense that it puts the buyer and his goods together. For these reasons transport is often regarded as rather a nuisance. No one particularly likes transport, or likes to think very
much about it—except when some part of the system does not work. For those who do make the mental effort, the results are at times unrewarding, because the complexities of running all but the most simple transport service are considerable. Thus there exists a considerable fund of ignorance about transport and about the nature of the problems which an operator, whether it be road or rail, may have to meet in fulfilling an apparently simple request. Ignorance is never a sound basis for sympathy, and the reaction of the man who is thwarted in a request for a lorry or a wagon is very predictable and often unprintable.

Farmers, as an occupational group, and for reasons which I have already outlined, are very good at making unusual demands on transport services—demands which seem eminently reasonable to the individual farmer or stock agent or buyer, but can pose very real problems for the transport operator. He may well be torn between conflicting factors such as hay in the pad-dock with rain forecast, drivers tired and over their regulation hours at work, a lorry sorely in need of routine maintenance, and the desire to keep a farmer—very likely personally known to the operator—as a satisfied customer.

CO-ORDINATION AT DISTRICT LEVEL

The fragmented structure of the farming industry means that there will be little co-ordination of transport demand from a district’s farmers until that demand reaches the transport operator, or unless the demand is channelled through a co-ordinating organisation such as is the case with wheat movement. This puts the transport operator in the position of being co-ordinator of transport and assessor of the relative priority of demands between many people wanting service at the same time. Most decisions are reached by negotiation; a few are forced upon him by the weather, or other factors beyond either the farmer’s or the operator’s control. In general, however, most decisions have to be assessed at the local level and this places a considerable onus upon the skill and knowledge of the local transport operator, or his manager, in terms of weighing up the priorities of competing demands for sometimes limited transport resources. Where rail is used, the local stationmaster is faced with the same problem. However, because he is part of a larger unit, a national transport system, the ultimate decision about allocation of wagons will often be taken at a district or provincial level, where the relative priorities of various demands from a much wider area will be taken into account. This administrative structure can at times leave the railways at a disadvantage compared to the local road operator, who can take decisions on
The New Zealand designed AB-class locomotive was first introduced in 1924. Diesel powered locomotives are steadily replacing steam locomotives on the New Zealand railways.

(Photograph: The Press)

the spot and in relation to only his local area’s demands. He is rather more a part of the rural community than the railway which has loyalties and priorities far beyond the ken of a particular farming district or an individual farmer. Certainly there have been, and still are, railway staff whose interest in providing a service has held customers to rail. It would be interesting to explore the extent to which some farmers continued to use their district’s line until closure from a sense of loyalty to something peculiarly a part of their district as much as from any rational argument about the choice of transport services. But the role of rail in directly serving the farmer now tends to lie in supplying centralised stores with fertilisers and other farm needs, and in the longer and larger hauls of farm output, particularly where these commodities can be loaded at larger stations. The day of the small local railway station, and of most local branch lines, is receding.
FROM PROCESSING TO PORT

The movement of commodities such as wool, meat and dairy produce from store to port is, in theory, much more easily controlled than the very fragmented distribution pattern of goods evident in rural areas. Unfortunately such factors as shipping delays, labour disputes, and odd demands from consignees make such theories very difficult to put into practice, and introduce unwelcome and often uncontrollable elements of reality into the exercise. The evidence for this reality lies in such documents as the then Transport Department’s publication, “Movement Costs of New Zealand’s External Trade, 1966,” published in 1968, the Waterfront Industry Commission’s annual reports, and various papers published by the Transport Commission in recent years.

Briefly, the problems of goods movement to the wharf can be summarised under the following sections:

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

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

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

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

TRADITION AND INVESTMENT

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

The introduction of containers puts all these matters to test, and many more as well. New technology, new investment, and new methods of organisation and management are all
Container ships planned for the future. The stern and side doors will allow quick roll-on roll-off loading of 1000 cars and 80 to 90 heavy vehicles or trailers. The ships will also carry 580 ft by 20 ft or 290 ft by 40 ft containers stowed on the deck or inside.

*(Photo: The Press)*

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

**CONCLUSION**

The transport industry requires a considerable amount of capital and economies of scale can be very real. The ability to achieve economies of scale, however, implies bigness in size; size of organisation, size of operations, even size of vehicle or wagon. Size, in turn, implies a certain remoteness in management, a rather impersonal quality so far as the farmer is concerned—because the farmer lies at the other end of the organisational scale; he is small-scale. Size also implies the ability to support research staff, who will be the source of new ideas and change.
Farmers operate on a local or community level so far as transport is concerned; already they are, as an occupational group, getting used to dealing with bigger firms or combines in the road transport industry. The local flavour of rural transport is diminishing—not without protest—but I doubt if it will ever completely disappear, however strong the economic arguments against it.

So the trend is in the broadest sense towards specialisation and concentration of transport facilities—and I think the way farmers can do most to keep their transport costs down is to be aware of the advantages of this process, to be informed about it, to watch for signs of over-centralisation. The benefits to be gained are already apparent, such as the reduction of rural road freight rates in Southland.

Transport, as a service industry, can be only as economic and as efficient as the demands of its customers will allow. As customers, farmers are collectively a powerful group; as informed customers they are not only powerful but influential. My answer to a specific question about ways of keeping rates down would be to encourage the maximum interchange of information both formally and informally between the two sectors, farmers and transport. At a local, regional and national level I suspect that appreciation of each other's problems and points of view can do much to improve efficiency—and therefore hold farmers' transport costs—as the expensive and time-consuming research which is going to accompany the rapid changes at present being experienced in the transport industry.

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A SHEARING SHED WATER POT TO CONTROL LYMPHO

J. O. H. Tripp
Dunkery Downs, Outram.

Thirty years ago I was living in the Hakataramea Valley. At that time it was quite common for the works to reject 30 to 40 per cent of the wethers from that district because of lympho. Some farmers had 80 per cent plus of their wethers rejected. When I moved to my present property 15 years ago I found that I too had a serious problem of lympho in its most virulent form.

I sought advice, and was told that the disease was thought to spread either by infected dust entering small wounds and cuts in shorn sheep or by the occasional pricking of infected sheep by combs and cutters. I thought it probable that the latter was the
most important means of spread and a letter from Mr Norman Hay of Moa Flat confirmed my suspicions. He wrote in 1954, “Until 20 years ago my sheep were shorn by machines and at least 25 per cent of the flock had lympho. One wether mob had 54 per cent rejected. As the cutters and combs were suspected of spreading the disease I changed to blades. For the last 15 years lympho has been no real problem. To me this proves that it is spread by handpieces.”

Well, as far as I could see the only hygiene difference between blade and machine shearing was the fan-shaped water pot which was usually hung alongside the blade shearer. This had a wad of wool in the bottom and was filled with disinfectant. And, of course, handpieces have far more crevices, e.g. under cutters, and dross that builds up under combs, both of which could retain infection.

I was told that the lympho germ could be killed at temperatures between 105 deg. F and 120 deg. F. To me the logical solution was to design a water pot which would sterilize machine shears.

After a period of trial and error I designed a galvanized pot which holds one gallon of disinfectant and has an electric element to keep the liquid well above sterilisation temperature.
It has a sloping lid to cradle a handpiece so that the cutting edges are in contact with the hot detergent and disinfectant. There is also an internal basket to hold and sterilise combs and cutters. An internal, circular, nylon brush can also be used for cleaning the comb if required.

Some of the shearers had difficulty in remembering to use the pot but I found that by paying a small premium per 100 sheep shorn their memories could be greatly improved. Within five to six years lympho had completely gone.

This method will not cure lympho, but it will stop its spread. Therefore as infected sheep are sold or killed, the incidence of lympho is reduced. In our case we had a major problem 15 years ago; for the last nine years we have been completely free of the disease. During this time I have not asked the shearers to use the pot for insertion of handpieces, but they do use the internal basket as it keeps their gear clean and ready for grinding. From my point of view sterilisation is a worthwhile precautionary measure.

Editor’s Note: Readers who would like to know more about this method of lympho control are invited to write directly to Mr Tripp.

WHAT ROT?

W. H. Southcott
Pastoral Research Laboratory, CSIRO, Armidale, N.S.W.

In 1965 I was privileged to attend the Lincoln College Farmers’ Conference to present a paper on pizzle rot (ovine posthitis) and its treatment\(^1\). Since then further research has confirmed that the suggestions made about the cause and control of the disease were soundly based.

The visit to Lincoln was prompted by an increase in the incidence of posthitis in wethers accompanying changes in the type of grazing enterprise and improved feed conditions.

THE DISEASE

There is no space here to describe in detail the disease, its cause or its control, but there are some key features that should be understood by all stockowners.

Posthitis is a chronic ulceration of the sheath of wethers and to a lesser extent of rams. A similar disease occurs in steers and bulls, and vulvitis (scabby ulcer) of ewes is analogous to the early external lesion of the sheath.

"Scabby Ulcer"—vulvitis in ewe.

(Photo: CSIRO, W. H. Southcott)

External ulcers first appear at the opening of the sheath. At this stage the disease is economically unimportant and does not affect health and production. Ulceration may later extend into the sheath and sometimes to the penis. This is the stage of the disease often called pizzle rot or sheath rot. Internal ulceration is associated with accumulation of foul-smelling pus, necrotic tissue and urine within a swollen sheath. Depending on the severity of ulceration and how much the prepuce (fore-skin) is closed the wether loses condition, wool production is reduced, and in advanced cases the animal may die.

Fortunately there are several control measures available to eliminate, or reduce substantially, the incidence of severe posthitis.
CAUSATIVE FACTORS

Until about 10 years ago it was believed that posthitis was a disease due solely to physiological malfunction associated with high protein diets, and in some way modified by the male sex hormone, testosterone. It was then shown in experiments at Armidale that the disease in the early external form could be transmitted from one animal to another. Subsequently the causal organism was identified as a bacterium which broke down urea in the urine, liberating ammonia. The ammonia was thought to be important in causing the external ulcer. Thus the disease was not a simple breakdown in bodily function but a complex transmissible disease. A re-examination of the control methods was necessary.
METHODS OF SPREAD

Experiments and observations made after the infectious nature of the disease had been shown, established that affected wethers were an important source of contagion for healthy wethers and that the organism was transmissible between sheep and cattle. It may not be possible to treat cattle effectively and economically but it must be recognised that they can serve as a reservoir of infection for sheep.

Contagion is probably transferred between wethers on camping areas or on contaminated pasture. Flies can carry the bacterium and may provide another source of infection. Venereal transmission can occur, and while the health of ewes generally is not affected by vulval ulceration, they obviously could infect their progeny. Clearly, since healthy wethers may carry the bacterium they must also be included in control programmes.

CONTROL MEASURES

These may be directed at the factors of diet, contagion and hormone, that are involved in the disease. It must be stressed that the use of one control measure does not exclude the use of any other, and that these should be manipulated to best advantage for any given situation. Whether a grazier uses any or all of the techniques will depend on how important he thinks the disease to be on his property.

Changing the diet to reduce protein intake is one measure that has limited possibilities on well developed properties. Restricting the feed intake or fasting sometimes helps in the treatment of affected wethers.

A second approach is to control the causal bacterium. Treatment of the prepuce with antiseptic several times each year has been found to reduce the incidence of posthitis in wether flocks to low levels; but all wethers must be treated. Diseased wethers must be isolated and given additional treatment. There are a number of antiseptics that can be used satisfactorily for the prevention and cure of external ulcers and these can be applied in either ointment, paste, or liquid forms. Copper sulphate (5-10%) was an early favourite and we have routinely used 0.8-3.2% hibitane solutions for a number of years at the CSIRO Pastoral Research Laboratory at Armidale. Alcoholic solutions of cetrimide (20%) are valuable for treat-
ment of severe external ulcers and in treatment of internal lesions but as they may irritate normal tissue they are not recommended as a preventative measure. Antibiotics given by injection or applied locally are sometimes used in valuable rams. Advanced lesions not responding to washing of the prepuce with antiseptics are often finally healed by opening the sheath to provide drainage.

Another control technique that has been accepted and is successful under Australian conditions has been the implantation of testosterone propionate. Testosterone implants are of value as preventives, limiting especially the incidence of internal ulceration. They can assist in the cure of both internal and external forms of the disease. Where lesions are present it is recommended that implantation be combined with antibacterial treatment. A side benefit of testosterone treatment is an increase in liveweight and wool production of treated wethers. However, these benefits do not appear to be sufficient to warrant the use of testosterone implants except where they are part of a posthitis control programme.

It can be claimed that the problem of posthitis and its control is now well enough understood for most practical purposes. But some questions remain to be answered. For instance, we still do not understand fully how testosterone implants act in the control of the disease. And while it is known that the severe form of posthitis is preceded by the external ulcer, the microbiology of the internal lesion is not yet clearly defined. Research work on this is now being carried out at the University of New England with the aim of devising even more effective and economical control.
NEW CHIEF PASTORAL LANDS OFFICER

Mr J. D. Gregan has been recently appointed Chief Pastoral Lands Officer of the Department of Lands and Survey. His predecessor, Mr Ralph Wilson, has retired after much of his life had been spent in association with the high country.

Mr Gregan is a fellow of the New Zealand Institute of Valuers, and an associate member of the New Zealand Society of Farm Management. Born on his father's farm near Waimate, he attended Timaru Boys' High School on a junior national scholarship and later returned to his home farm. He held most offices in the local Young Farmers' Club movement of which he was a foundation member in Canterbury in 1934. He was chairman of the South Canterbury district committee and active in debating and stock judging competitions.

In 1939 he started on his own farm at Hook, and later held a small grazing run on Hunters Hills. As a member of Federated Farmers he served on the meat and wool committee of the Waimate branch.

Mr Gregan joined the Valuation Department in 1947 as a rural valuer covering Christchurch, the West Coast and Timaru. He held this post for 23 years, the last five as district valuer at Christchurch. For some years he has specialised in valuing high-country runs in Canterbury and Marlborough. His association with the high country has not been solely professional. He was formerly a member of the Canterbury Mountaineering Club and on one memorable occasion accompanied Mr Peter Newton on "High Country Journey" from Tekapo to Molesworth.

Mr Gregan is married, with three daughters, one of whom is a teacher in Guadalcanal with Volunteer Service Abroad.
INTRODUCTION

The role of the Protection Forestry Branch, Forest Research Institute, in the high country has already been described in general terms in Review No. 16. One major research objective was stated to be the development of techniques to restore an effective plant cover, not necessarily of trees, to severely eroded debris-producing areas at altitudes above the probable future limits of pastoral production, i.e. on the Class VIII lands. This article describes the problems and progress in this field of research.

EARLY TRIALS (1956-62)

Work began soon after the establishment of the Branch in 1956. We were then woefully ignorant of the problems involved and could only guess their general nature. Because we were interested only in severely eroded debris-producing areas at high altitudes, we could safely assume that we would have to overcome serious problems of site and soil instability and that climatic factors would be severely limiting. Similarly, we could guess that soil fertility problems would arise, particularly where all trace of the original topsoil had been lost. But the precise extent to which these factors would be limiting, or what their relative order of importance might be, could not be guessed.

Earlier Catchment Board and Forest Service trials provided little guidance. They had generally been established on moderately stable sites at fairly low altitudes, or were too recent to be of much assistance. Overseas experience suggested that satisfactory results could only be achieved through the use of extremely expensive techniques of mechanical site stabilisation followed by the laborious stage-by-stage reconstruction of the soil and plant cover. It was highly improbable that sufficient money for such an approach would be forthcoming without proof that cheaper methods were inadequate.

It was decided to start with the collection of climatic and other data needed in the design of a comprehensive research programme, and with a large number of trial-and-error experiments using the most likely plant materials available. There
Six to seven-year-old lodgepole pine on a scree subsoil site at 4,500 ft. Growth is vigorous but an increasing amount of mechanical damage by wind and snow can be expected from now on.

(Photograph: K. Plett, N.Z. Forest Service)

was no more than a slight chance that we would discover wonder species which would solve all problems, but it was probable that we would learn much from these experiments, particularly if causes of failure were carefully documented. To permit this it was essential that trial areas should be readily accessible at all seasons, in addition to being adequately representative of sizeable tracts of eroded country. The areas selected were the Craigieburn Range (Canterbury) and the Kaweka Range (Hawkes Bay).
From 1956-62 several hundred different species were planted at altitudes ranging from 3,000 to 5,500 feet, on sites varying from well covered tussock slopes to steep running scree. Most were tree species but some rangeland shrubs and a few grasses and herbs were included. Some of the seed was collected locally, e.g. Scots pine from Glynn Wye, Norway spruce from Tarndale and ponderosa pine from Black Forest. Other seed came from as far afield as Europe, North Africa, India, North and South America and Australia.

Many different planting techniques were employed, e.g. spring and autumn planting, the use of open-rooted as opposed to tubed or potted stock, and the use of stock raised in upland nurseries. Where sufficient seed was available, direct seeding was also attempted. For experience, a few mid-altitude sites were stabilised mechanically before planting, using classical text-book techniques. Hardy native species, e.g. mountain beech, were often planted alongside the introduced species in response to frequent criticism of the use of exotics.

Results of Early Trials

Most species, including all native species, failed completely on all sites except those where the cover was already excellent and there had been no loss of topsoil. In some cases their failure was possibly due to the use of faulty techniques of stock preparation or planting, and a few of these species may be worth further trial when time permits. None of them, however, could be recommended for immediate use or even immediate research attention.

Several species of spruce and true fir survived well on a wide range of sites but their growth was uniformly very poor probably because of soil nitrogen deficiencies. European and hybrid larch grew vigorously on fair to good sites at altitudes up to 4,000 ft but there was a rapid decline in vigour on more severely eroded sites and at higher altitudes. Douglas fir demanded well sheltered conditions even at 3,000 ft. Likewise, some species of cedar and cypress could tolerate conditions at 3,000 ft but failed on exposed sites and at higher altitudes.

The most successful conifers were all species of pine. Many of these, however, suffered recurrent frost, snow or wind damage even at 3,000-3,500 ft. Ponderosa pine and Scots pine were able to tolerate conditions on moderately depleted sites at altitudes up to 4,000 and 4,500 ft respectively, but only lodgepole pine (Pinus contorta) and mountain pine (P. mugo) displayed fair to good growth at higher altitudes or on severely eroded
sites at all levels. On exposed high altitude sites the shrubby mountain pine was much the most promising. The erect-growing lodgepole pine suffered severe bark abrasion from wind-borne ice and stone particles, and severe stem malformation through the action of wind and snow.

With few exceptions, the hardwood species failed. Several species of high-altitude eucalypt grew well at 3,000 ft but did not survive at 3,500-4,000 ft. All poplars failed at all elevations. Of a dozen or more species of willow, three or four were promising though establishment problems were acute. One species of birch grew well at 3,000 ft but was repeatedly cut back by frost at higher altitudes. One species of alder, however, grew vigorously on steep unstable scree at 4,500 ft. This was green alder (*Alnus viridis*), a shrubby species from Europe.

All attempts at direct seeding, even of lodgepole pine, failed except where soil cover conditions were already fair to good. Seed germinated readily on bare ground but few seedlings survived the heat of summer or frost action in winter. Very satisfactory results were achieved where the sites were stabilised prior to planting but costs were extremely high. It was clear that these mechanical techniques could not be used on a large scale. They could only be employed in special cases, e.g. where continued erosion would cut a highway or present an immediate threat to some other high-cost structure.

**LATER TRIALS AND CURRENT RESEARCH**

By 1962 it was obvious that it would not be very difficult to re-establish a forest cover on slopes up to 4,000-4,500 ft altitude provided there was already a fair to good grassland cover. The effort and expense involved, however, was not readily justifiable. Any erosion in progress could generally be checked much more cheaply by simple retirement of the land from grazing coupled with stringent control of wild animals, or by top-dressing and oversowing while retaining the land in grazing. Hydrologically, a tree cover might be superior to a grassland one but it would take decades of intensive study to prove this conclusively one way or the other. Reafforestation for timber production, though technically feasible at least up to 3,500-4,000 ft, must, with a few possible exceptions, remain economically indefensible until all available land of better tree-growing quality at much lower altitudes is fully utilised. Experimental planting in preparation for this day, if it ever arrives, is all that is justifiable.

On the other hand it was equally obvious by 1962 that
Successful stabilisation of a rapidly eroding gully at 3,500 feet altitude using 'classical' techniques (temporary terracing, topdressing and oversowing with grasses and lodgepole pine). No further movement in the seven years since treatment.

(Pho to: K. Plett, N.Z. Forest Service)

there was and could be no simple way of restoring an effective cover of vegetation to areas in an advanced state of depletion and erosion, particularly at altitudes exceeding 4,000 ft. A few species had been found that would grow on all but the worst sites at altitudes up to 5,000 ft but even these rarely grew with sufficient vigour for the early formation of a closed canopy or for the all-important formation of a new cover of soil litter. Indications were that this would take a minimum of 10-15 years on severely eroded slopes planted with the most vigorous species of pine at 3,000 ft, and very much longer at higher altitudes.

Meanwhile the soil beneath the trees would remain bare and soil loss would continue relatively unabated. Ways of speeding up the processes of canopy closure and litter formation would have to be found.

Similarly, by 1962 it was clear that costs of manual planting in country of this sort were too high for planting to be undertaken on more than a token scale or in a few selected localities, a procedure that would itself be a waste of time and money. Where the objective is river control, the work of watershed rehabilitation must be carried out on a large scale if results are to be of real significance.

All told a fresh approach to the problem was essential if the dual objectives of cost reduction and more rapid development of a soil cover were to be achieved. That this approach
should be through the soil was clearly indicated by past results and by the soils data then coming to hand. Vigorous growth, even of species ideally suited to the climate, could not be expected on the sites and soils in question without restoration of the soil nutrients that had been lost and, in particular, the reconstitution of an effective nitrogen cycle. One simple experiment in particular showed that soil, not climate, was the key limiting factor. A number of legumes were grown satisfactorily in a lowland soil transported to 5,000 ft but the same species barely survived in soil from an eroded site at 5,000 ft transported to a lowland glasshouse.

Emphases in research were accordingly adjusted as follows.

Species Trials

Work on the introduction and testing of new species of woody plants, other than known nitrogen-fixing species, was suspended. Particular emphasis was given to the search for species capable of effective N-fixation at low to very low levels of available phosphorus. Other N-fixing species could be established with the assistance of heavy applications of phosphatic fertilisers but there were indications that rates of phosphate fixation were very high. Therefore frequent applications would probably be necessary with a consequent major increase in cost.

Work on species incapable of fixing nitrogen will be resumed when we can identify more precisely the physiological and other attributes required for the successful survival and growth of plants on high altitude sites after site amelioration by the introduction of fertility building species. It should then be possible to screen new introductions under laboratory conditions much more rapidly and effectively than in the field. Controlled environment equipment for this purpose has been designed and should be available by the time it is required.

Provenance Trials

In the early species trials we were able to test only one or at most a few varieties of each species, but there were indications that selection of the right variety was sometimes as important as selection of the right species. We therefore began trials of a wide range of geographical strains (provenances in foresters' jargon) of the most promising species. The species selected were lodgepole pine, mountain pine, Scots pine, European larch and green alder. On the assumption that soil nitrogen deficiencies would be overcome, the most promising species of spruce (Picea engelmanni) was also included.
Green alder on a steep unstable scree at 4,500 feet altitude, 8 years after planting. During the last six years (see photo TGMLI Review No. 16 page 39) gaps between plants have closed and gaps between rows are closing. Litter is accumulating beneath plants and self-sown seedlings have appeared.

(Photo: K. Plett, N.Z. Forest Service)

Green Alder

Particular emphasis was given to work on green alder, the only species so far discovered that could tolerate the climate, grow well on very unstable sites, and fix nitrogen at low phosphate levels. Immediate arrangements were made for the comprehensive study of all aspects of its life cycle and growth requirements including detailed studies of its N-fixing and phosphate absorption mechanisms (in association with Lincoln College). On the practical side an immediate start was made on the development of techniques for its large-scale propagation and possible establishment by direct seeding.
Legumes and Grasses

Much greater attention was given to the use of legumes and grasses. Though it was unlikely that permanent swards, fully effective in control of erosion, could be developed on most of our sites, it was probable that temporary swards could be established that would allow better establishment and growth of woody species. They would provide an initial fertility gain, an early addition of soil organic matter and litter, and might pave the way toward the introduction of woody species by direct seeding rather than by planting. A reduction of costs in this direction would be ample recompense for any necessary expenditure on fertilisers. Where the fertility gain and temporary protection was sufficient to permit invasion of the site by volunteer native or exotic species, all further expense would be avoided. Under the most favourable circumstances, i.e. where it became obvious that a stable sward could be maintained, it might be possible to return the land to grazing.

Stock Preparation and Planting Techniques:

As already suggested, some suitable species may have been written off as failures simply because we used faulty techniques of stock preparation or planting. Even for successful species there was no certainty that the best methods were employed. For each species it is necessary to know the best methods of seed storage, treatment and sowing; the best techniques of cultivation and weed control; the best time for lifting; the best method of holding stock in store in readiness for planting; and the best time and technique of planting. These things were not known for many of the species used. For other species, normal nursery techniques required modification for the production of stock suited to high country use. Therefore nursery and planting practices were also given increased attention.

Related Research

The reorganisation of our research programmes created a need for more detailed information, particularly about the reserves of plant nutrients on eroded sites and site microclimates. The appropriate research sections of the Branch were accordingly strengthened.

In addition, because it was obvious that the costs of land treatment would always be high, it was essential that we should be able to classify sites according to their need for treatment. Money should not be spent to stop erosion that is of no downstream consequences whatsoever, or on the artificial revegetation of mountain slopes that will heal in reasonable time as a result of retirement from grazing and noxious animal control.
Cost-benefit analyses in strict monetary terms may never be possible but the broad principles inherent in such analysis must never be forgotten. Intensive study of processes of natural recovery and of a wide variety of geomorphological, erosional and sedimentary processes was therefore essential.

RESEARCH RESULTS

It is not possible to report progress in all the above research fields in the space available. Moreover, many experiments are far from complete and it would be foolish at this stage to draw firm conclusions. Some species or site treatments, for example, may appear very promising for several years but fail abruptly during the first high intensity storm or during the first severe winter or drought summer. Time alone is the only real test. The following items, however, will indicate the kinds of results that are being obtained.

Species and Provenance Trials

Mountain pine and green alder are still the most promising woody species for use on eroded high-altitude sites. The importance of using the correct geographical strain of each species has been further confirmed. Annual dry matter production per plant over the critical early years of establishment and growth, for the best provenances of several species, has exceeded that of other provenances by a factor of eight.

Day length rather than climate appears to be the most important consideration. The best strains typically come from regions of comparable latitude, not necessarily from regions possessing a similar climate. The search for new species should probably be narrowed down accordingly. A further guideline was provided by research carried out in co-operation with the Austrian Forest Research Institute. This shows that an important attribute of plants for successful growth at high altitudes in New Zealand is the ability to resume photosynthetic activity very rapidly after growth is checked by frost during the growing season. Species or provenances that do not have this ability cannot take full advantage of the very short growing season.

Green Alder

The original plot of green alder, established on highly mobile scree at 4,500 ft altitude, continues to make vigorous growth (2,000 lbs dry matter per acre per annum) and to fix appreciable amounts of nitrogen (100 lbs N per acre per annum). Litter is beginning to accumulate and the first self-sown seedlings have appeared. Further plots covering a wider range of altitudes and site conditions have been established, both
Good survival and fair growth of shrub-form mountain pine (P. mugo) on a severe scree site at 4,500 feet altitude, 6-7 years after planting. Closer planting in a mixture with green alder would now be recommended for this site.

(Photo: K. Plett, N.Z. Forest Service)

of the original strain and of new strains. Several additional alder species belonging to the same sub-genus have been obtained for trial.

The two outstanding problems are how to raise green alder stock in bulk lots for planting and how to establish it by direct seeding. Large scale propagation by layering or the use of cuttings is not difficult but stock prepared in this manner has not been successful in the field. Large scale propagation from seed is difficult. The seedlings are very small, are readily smothered by weeds in the nursery beds, and are as susceptible as the weeds to most herbicides.

Direct seeding has been an almost complete failure to date. On bare ground no seedlings survive for long. When sown in mixture with grasses, seedling growth is severely retarded by
Trials of several species of willow on steep scree at 3,000 feet altitude. Upper two rows of various age but remainder 1-2 years old only.

(Photo: K. Plett, N.Z. Forest Service)

root competition. When sown in mixture with clovers, seedlings are suppressed by the more vigorous initial growth of the clovers. A possible solution is to sow it into a clover or other legume sward at some stage during the deterioration or decay of the sward. An aid to its ready establishment by direct seeding would be the selection or breeding of varieties or hybrids which have larger seeds and better seedling vigour. This appears to be a distinct possibility.

Legumes and Grasses

The first experiment undertaken was that in which various legumes were successfully grown in a lowland soil transported to 5,000 ft altitude. In subsequent experiments these and other readily available species were sown on a severely eroded subsoil site subject to intense frost action at 3,500 ft. All seed was heavily inoculated and various rates and combinations of fertilisers were used.
Equipment designed for the planting of willow poles on steep unstable scree. Poles must be planted to a depth of 30-36 inches without damage to the bark.

(Photo: J. C. Baker, N.Z. Forest Service)

Briefly, the results indicated that swards of white and alsike clover of sufficient density to protect the soil against frost action could be obtained in a single growing season with the aid of heavy dressings of superphosphate. The alsike swards, however, did not persist. Plots of this species, and of all other species with one exception, were steadily invaded by white clover. The exception was lotus major (Lotus pedunculatus). This species was slow to establish but survived the first winter well. By the end of the second summer it was well established and was spreading vigorously.

Maximum dry matter production was obtained for all species where regular maintenance applications of superphosphate were made. On some sites, the correction of other soil deficiencies, notably magnesium and potassium, may also be required. But where the objective was simply the preparation of the site in readiness for the introduction of woody species, there was at least a strong possibility that one heavy application of superphosphate would be all that was necessary. The objective of present work is to determine the extent to which this is true. On what sites, at what altitudes, and under what conditions can such a one-hit method of site preparation be used? Simultaneously, the use of other species of legumes, better varieties of the common legumes, and better strains of rhizobiae are being explored.
The use of grasses in combination with legumes may or may not be desirable. Many species will volunteer once a legume sward is established. Some new introductions have been made but work on them is in its infancy. The possible value of several native grasses with desirable habits of growth, e.g. carpet grass (*Chionochloa australis*), has been investigated without promising results. The species currently being studied is *Notodanthonia setifolia*.

**Stock Preparation and Planting Techniques**

Space permits the mention of one item only. A satisfactory mechanical technique for the deep planting of willow poles on steep unstable scree has been developed. This has opened the way to the thorough testing of those species of willow that showed promise in earlier trials. Results to date are most encouraging. The stabilisation of certain types of scree at altitudes up to 3,500-4,000 ft, using willows, should soon be possible.

**CONCLUSION**

It would be fair to say that a substantial amount of progress has been made since 1956 but we have still a long way to go. By employing the classical techniques of site preparation perfected overseas, the species we already have, and very heavy rates of phosphatic and nitrogenous fertilisers, we could in fact already restore a cover of vegetation to almost any eroded site at altitudes up to 5,000 ft. The main problem, however, is not how to do the job irrespective of cost but of how to do it at a price the country can afford to pay. The research task will be completed only when present margins between the costs of land treatment and the national ability to pay have been reduced to vanishing point.

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