TUSSOCK GRASSLANDS AND MOUNTAIN LANDS INSTITUTE

REVIEW

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October 1975 **Editor**—*W. G. Kreger*

Our cover illustration, drawn by Pat Prendergast, depicts the bank erosion conditions encountered in the Torlesse Basin, the site of a co-operative research project described by John A. Hayward on Page 53.

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ON BEING OURSELVES

Kevin O'Connor

New Zealand's young civilisation has had some crises to weather in the past. With a little bit of luck it will still be around to weather some more crises in the future. There are, however, some features about the present difficulties that cause disquiet. One is that the economic framework of our civilisation is pushed askew. Another feature is that the difficulties are not just narrowly economic. They are concerned with our system of values, our priorities, our attitudes to the land that supports us, our attitudes to the past, our attitudes to the future. A third feature is that there is a disposition abroad to bring to many aspects of our problems the latest or almost latest technical contribution at the expense of any sort of reflective wisdom.

What has this Cassandra-like commentary to do with the tussock grasslands and mountain lands? In the first place, the high country shows similar skewed economics, subverted values and technological substitution for wisdom to those which beset the country as a whole. There may be a more subtle connection. As Harry Morton reminded the Physical Environment Conference in New Zealand in 1970, the historian Winthrop Young had suggested some years before that mountains had something rather special to contribute to the stimulation of civilisation. New Zealand might well look to its mountain country and people for signs of realism, identity and a sense of proportion.

In economics we might hope to witness the assertion in word and deed that New Zealand is fundamentally and soundly based on its agricultural and pastoral enterprises. The tussock country is the last great opportunity for the cultural transition from low-producing land to high-producing, high-fertility pastoral land. The ploughable land of mountain valleys and basins is a pastorally-developable resource for arable agriculture, for producing both winter keep and finishing feed for hill country livestock as well as an increasing range of general and special purpose crops.

A sense of proportion and realism would dictate that both the land and water of such mountain valleys and basins be fairly considered for such basic uses before they are pre-empted for the production of electricity for a wasteful and unrealistic urban society.

A modicum of reflective wisdom would suggest that many existing erosion and water control schemes need revision to bring them into line with the real condition of land and water and the uses we are making of each.

A balanced system of values would indicate that a rapid and massive investment in mountain tourism to produce perhaps somewhat fictional overseas earnings should not be at the expense of investment in a less vulnerable and more humanly worthy pastoral industry.

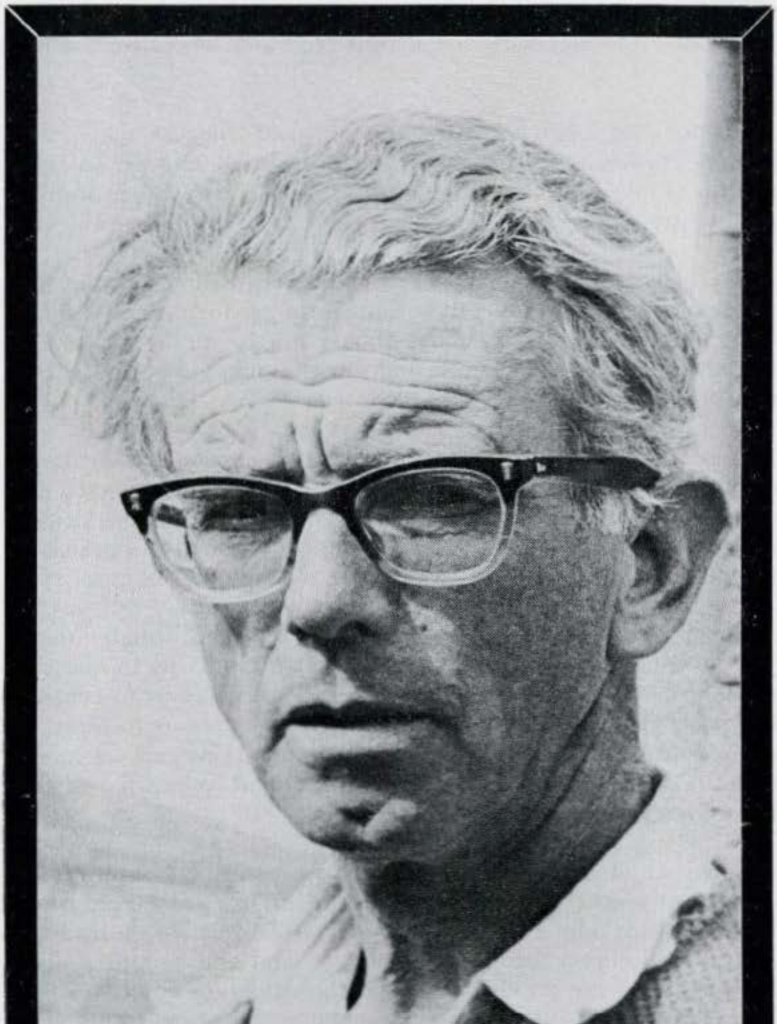
A balanced system of values would also ensure that available capital was being invested productively to produce goods and services, not to accrue capital wealth as land that remains negotiable at the same time as it remains unproductive because it languishes unmatched with labour and working expenditure.

The present liquidity crisis nationally and individually might yet prove very salutary for all of us if it prompts us to question some of our past axioms and adages, if it provokes us to consider our goals and values in the heart, if it encourages us to think on what manner of people we are, how the mountains and sea mould us in the image of our land, if we grow content to be what we can be as a sea-girt, mountainous island people.

This issue of *Review* marks the passage from the Institute ranks of our first journalist, Joe Runga. His legacy to the Institute is one which perhaps only a Maori could give, a *Review* with a tradition of craftsmanship, a feel for the unity of land and people, a pride of worth that no amount of neglect or slighting could weaken. Joe Runga had little literary experience when he began with *Review*. He wrote little for publication but he edited fastidiously. He was at his best in interviewing people for the printed records. Readers of *Review* will join in wishing him happiness and success in his new role as a coastal country storekeeper. For each of us in the Institute his quiet ways have not altered the value or timeliness of his philosophy —

Te toto o te tangata he kai

Te oranga o te tangata he whenua.



L. P. Chapman

In appreciation . . .

THE LATE L. P. CHAPMAN, VICE CHAIRMAN

Leo Chapman's death marks something of a milestone in the development of high-country pastoral farming. His well-known work as a member of the Wool Board tends to obscure the very deep influence he had on the study of the grazing animal in its natural environment. Always intellectually inclined, it was the scientific side of pastoral farming which interested him most.

He was elected to the High-Country Committee in 1949 after acting for several years as chairman of the Mid-Canterbury sub-section and became chairman of the Committee in 1953. This was a time when the development of soil conservation, the rabbit problem and noxious weeds — in particular sweet brier — were major concerns of all high-country men. It was also the period when the early negotiations took place which led to the formation of the Tussock Grasslands and Mountain Lands Institute.

In this project he was always a leader and his firm belief that such an organisation was absolutely necessary for the preservation of pastoral farming in the high-country did a great deal to ensure that the project succeeded. One of his convictions was that a proper study of our native grasses was necessary and he would never accept that the only way to improve the production of tussock country was by the introduction of exotic species.

In his address to the eighteenth Grasslands Conference at Lincoln in 1956 he said:

> *"The lesson with regard to introducing species, be they animal or vegetation, into the high-country, should be clear for all to read. The obvious fact is that the moment they are successfully established and have shown their ability to survive, you have lost control of their reproduction and spread."*

In the same address he continued:

> *"It may be useful to define, from the farmer's point of*

view, what is the ideal (high-country) pasture. He wants firstly to retain the protective tussock and among it to have a pasture cover which is palatable and nutritious and which will withstand grazing and not grow rank, which has good frost resistance and winter curing properties, and a proper balance of seasonal production. This ideal pasture . . . could only be achieved by taking into account all the factors of climate, soil, vegetation and the grazing animal."

This type of study and its effect on the future of high-country farming was unlikely, he felt, to be undertaken by conventional research organisations. When the Institute was finally constituted in 1960, he was appointed to represent the Wool Board on its Committee of Management and to his influence the Institute probably owes the board's continued financial assistance.

The high-country had been represented on the Wool Board since its inception in 1945 and it was fortunate indeed that a worthy successor was available to take the place vacated by Mr H. J. Wardell when he retired. It was not long before the same characteristics which guided Leo Chapman's path in other fields led to his appointment to the Wool Research Organisation and, as chairman of it, he became dedicated to the development of one of the most important institutions in world research on wool.

It is significant that his interests always leaned towards research and its application, but I believe that this natural inclination was stimulated by the fact that his property, Inverary, which he developed from very small beginnings, was by no means easy to farm. Situated on attractive-looking hills between the Rangitata and Ashburton rivers, it is much harder country than it looks and it shares many of the problems of climate and vegetation associated with the more remote and higher pastoral runs behind. Winter is long and cold, and heavy snow strikes its exposed ridges every few years. It was the challenge of this environment, I believe, which drove him constantly to use his brains to solve the problems which he shared with all high-country farmers. From his initiative all of them have gained.

There are but few who combine their love of the pastoral life with their interest in the scientific solution of its problems. He was above all a thoughtful man. His passing will leave a gap which will be difficult to fill. — *David McLeod.*

PHOTOS: G. H. SCALES TRANSPARENCIES

Typical view of the experimental area showing Merino ewes grazing poor quality vegetation in winter.

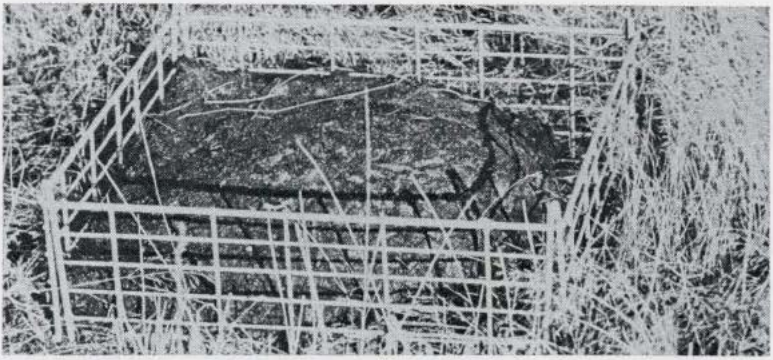
UREA SUPPLEMENTS FOR MERINO EWES

Dr G. H. Scales and P. J. Scott

Tara Hills High Country Research Station, Omarama

Runholders have often expressed interest in the use of urea supplements on tussock country but have not adopted this practice because of the lack of information on the economic benefits.

In the 1970 September issue of this journal, Dr K. T. Jagusch discussed urea feeding of ruminant animals and drew attention to the fact that urea was not a protein but rather a relatively inex-



Intake of urea-cereal supplement was regulated by the hardness and salt content of the block.

pensive substance containing a high proportion of nitrogen, the building block of protein.

Ruminant animals are fortunate in that they have rumen micro-organisms capable of using nitrogen for protein synthesis and, as a result, many attempts have been made to utilise sources of nitrogen which are cheaper than plant proteins in ruminant feeding.

Urea can be fed either as a liquid (urea-molasses), as a block (cereals and/or salt) or can be sprayed onto forage, silage or hay, with or without an energy source. Energy sources such as molasses or cereals are generally added to urea supplements since rumen micro-organisms require a readily available energy supply for the utilisation of urea.

Although partial replacement of protein with urea in feedlot rations has received considerable attention, the greater application of urea feeding has been with straws and low quality roughages such as exist in the arid regions of Australia. Responses have generally been confined to severe drought areas where forages are less than 4-5 percent protein and animals lose weight. Supplementation with urea-molasses or urea-cereal blocks under these conditions has reduced liveweight loss and increased survival rates.

There is no information on the use of urea supplements in the tussock grassland environment of the South Island. Owing to the unimproved nature of the vegetation and severe frosting in many inland areas, much of the winter forage is low in protein, which suggests that a response to urea may be likely. In an attempt to provide some information on the value of urea supplements in the high country environment, an experiment was conducted in the winter of 1973 and 1974 at the Tara Hills High Country Research Station near Omarama. The mean annual rainfall is 510 mm with an average of 157 ground frosts per year.

Ewes licking the urea-molasses supplement off a revolving plastic ball located on top of the container.

In 1973, a total of 120 six-tooth Merino ewes was weighed and allocated to a control group and two urea supplemented groups— a urea-cereal group and a urea-molasses group. The urea-cereal preparation (Stockade) contained 7.5% urea, 24.5% salt and minerals and 68% barley, while the urea-molasses supplement (Promax) contained 12.2% urea, 86.5% molasses and 1.3% minerals. Both preparations were manufactured and supplied by Feed Services Ltd, England. All groups were offered salt to avoid possible bias resulting from salt contained in the urea supplements.

Supplementation commenced in mid-July and ceased 113 days later in early October, immediately prior to lambing. All groups grazed low quality fescue tussock grasslands (4.5% protein) at five ewes per hectare. Observations on liveweight changes and lambing performance continued until 21 January. The liquid urea-molasses supplement was fed in containers fitted with floating plastic balls in order to limit consumption, while the blocks were fed in weld mesh containers as shown in the accompanying photographs.

In the 1974 experiment, comparisons were restricted to the urea-cereal and control groups at a stocking rate of 3.2 ewes per hectare. Supplementation commenced in July and continued until early December when all ewes were shorn.

RESULTS

Ewes fed the urea-cereal block in the 1973 experiment consumed 90g of the supplement per day (6.7g urea) compared with 129g of the urea-molasses supplement (15.7g urea). Although the intake of the urea-molasses supplement is comparable to levels reported in many Australian studies, the intake of the cereal block may have been limited by its hardness and high salt content (16.7%). Both these characteristics provide an effective method of regulating consumption since urea can be toxic if consumption is excessive or too rapid.

In 1974, the consumption of the urea-cereal block fell to 43g per day (3.2g urea) or about one-half of the 1973 consumption. However, there was more pasture available with protein contents as high as 12%. Under these conditions ewes are unlikely to seek out additional nitrogen from the urea supplement.

Urea-cereal supplemented ewes consumed more salt (15g per day) than the control ewes (10g per day), although the largest proportion was derived from the supplement (80%) and not the salt blocks offered to all groups.

Ewes supplemented with the urea-cereal block gained 0.9 - 1.2 kg more liveweight during winter than control animals but statistical analysis showed these differences to be due to chance. Urea-molasses supplementation failed to improve ewe liveweights.

The absence of a liveweight response to urea supplementation differs with much of the supplementation work on low quality forages. However, most of this work has been conducted with sub-maintenance rations containing less than 5% protein. The fact that the ewes in the present study were gaining liveweight would indicate that forage protein levels were adequate and urea supplementation was unnecessary.

Urea supplementation had little effect on ewe wool weights and lamb liveweight gains in both 1973 and 1974. Although supplementation increased birthweights, responses were variable and not consistent between years. Weaning weights of all groups were similar.

The effect of urea supplementation on the reproductive performance of ewes in 1973 and 1974 was variable. Although lamb mortality appeared to be reduced by supplementation, the differences may well have been due to chance.

CONCLUSION

It is concluded that the feeding of urea supplements under the experimental conditions described has little application for increasing the productive performance of Merino ewes grazing fescue tussock grasslands in winter. While it can be argued that a response may occur under more severe grazing conditions such as exist under high altitude snowgrass country, it must be remembered that even in severe grazing conditions there is generally a limited amount of green-pick available. Only a small amount is required to render urea supplementation a waste of time and money.

MACRO-ELEMENT AND TRACE ELEMENT NUTRITION OF SHEEP GRAZING TUSSOCK GRASSLAND

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In a recent study it was found that the levels of macro-elements and most trace elements in the herbage of tussock grassland grazed by sheep were adequate to meet their mineral requirements. A significant response to selenium and a smaller response to iodine in terms of growth rate were the only evidence of trace element deficiencies.

The crude protein levels of the tussock grassland plants were low but appeared adequate to meet protein requirements of the sheep.

The high country of the South Island covers an area of about 3 million hectares on which are grazed about 1.7 million sheep (Hughes 1973). Recent survey results (Hughes 1973, Hughes *et al.* 1974) recorded lambing percentages of the order of 85 percent in high country sheep.

However, in some seasons the growth rate of young stock is poor when compared to the sheep grazing on lowland country. In contrast to the pasture lands of the lowland farming areas of New Zealand, relatively little is known about the macro-element and trace element composition of the grazable plants of the high country tussock grasslands.

In recent years attempts have been made to develop tussock grasslands by oversowing and topdressing with fertilisers to increase the dry matter production and stock carrying capacity. At present there is little information on how these developments and subsequent grazing by sheep affect the botanical composition, the level of macro-elements and trace elements in the plants, and the influence of diet on blood plasma element levels of the sheep.

From 1970 to 1973 the divisions of applied biochemistry and grasslands of the DSIR carried out an investigation on the diet

Note: Although the term mineral is commonly used to describe the inorganic fraction (e.g. ash) of plants and animals, in this communication the term element will be used to describe the essential nutritional components of the ash as these chemically are defined as elements not minerals.

and mineral nutrition of sheep grazing tussock grassland (Grace and Scott 1974; Scott and Maunsell 1974; Grace, Maunsell, Scott 1974). This communication summarises the findings and presents data on the levels of macro-elements (sodium, potassium, magnesium, calcium, and phosphorus) and trace elements (iron, manganese, zinc and copper) in the grazable plants and in blood plasma of sheep grazing undeveloped and developed tussock grassland.

Results from investigations where sheep were supplemented with selenium, iodine, cobalt and copper on developed tussock grassland are also included.

THE EXPERIMENT

The experimental area was made up of two adjacent blocks of similar aspect and topography. One is a recently developed tussock grassland of 67 ha and the other an undeveloped tussock grassland of 77 ha. These areas are situated on Ribbonwood Station, Omarama, North Otago. The predominant slopes run north to northeast extending from outwash flats at 640 m altitude up to ridges at 1040 m. Soils are of the Omarama and Kaikouran steepland series and the average rainfall is 800 mm per year.

The original vegetation on both blocks was probably similar with fescue tussock, matagouri and bracken on the lower slopes and snowgrass on the upper slope. Recent development of the improved block began in 1966 with oversowing of the middle and lower slopes with ryegrass, cocksfoot, timothy, white clover, red clover and alsike clover. In the five-year period before the experiment, it received a total of 1 tonne/ha of fertiliser — principally superphosphate but including proprietary mixtures—and was rotationally grazed in conjunction with two adjacent blocks at about seven sheep per ha.

During the experimental period a group of hoggets were set stocked on each block at about 0.7 hoggets per ha. Higher stocking rates were periodically attained on the improved block by including it in the usual rotation of paddocks for the main hogget flock.

The weights and blood element composition of the experimental animals were measured at two to three monthly intervals for a year, together with an assessment of the plant species available on the two sites, and the element composition of the major species.

Since marginal deficiencies of trace elements are not clearly detected from the chemical determinations of the herbage, the investigation was extended by supplementing those sheep grazing developed tussock grassland with selenium, iodine, cobalt and copper singly and in various combinations. Their growth rates were compared with unsupplemented controls. This later study commenced in April 1972 and concluded in May 1973.

RESULTS AND DISCUSSION

(a) Sheep Performance

During the investigation the general health of the sheep and the weight gains recorded were satisfactory. In the first eight months the hoggets grazing the undeveloped and developed tussock areas gained 14 kg and 18 kg respectively so that the final average body weights in May were 43 kg and 47 kg — an 8 percent superior body weight for sheep on the developed tussock grassland block. Also, the overall stock carrying capacity of this block was much higher. Both groups lost weight during the winter.

Seasonal trends in body weight and weight gains in the trace element supplement study were similar to those observed in the 1970-71 study. However, the sheep supplemented with selenium grew significantly faster (9 percent) when compared to the unsupplemented controls, such that the liveweight of the selenium supplemented sheep was about 6.5 percent heavier from February to April.

Although the oral dosing of selenium (5 mg per sheep as $Na_2SeO_4 \cdot 10\,H_2O$) was started in April 1972 and continued at intervals of six to eight weeks for the next 13 months, the improvement in weight gains was not seen until about five months later in the late spring and summer when all animals made rapid weight gains.

The small increase in liveweight as a result of supplementing the ewe hoggets with selenium is nevertheless significant. Selenium studies on Romney Marsh sheep (Hill *et al.* 1969) showed that a 4 percent improvement in liveweight at the time of mating was associated with an extra 35 kg of wool and 8 lambs per 100 ewes. The importance of selenium supplementation to breeding ewes was also shown by Scales (1974) who observed that dosing Merino ewes with 5 mg of selenium about 17 days before mating and prior to lambing significantly reduced the number of barren ewes, and lamb mortality from birth to weaning.

A smaller growth rate response to iodine was also observed during the late spring and summer after a single intramuscular injection of iodine (as 1 ml of poppyseed oil containing 40 percent I_2). It is interesting to note that soil iodine content is known to reach its lower value in the brown grey, yellow grey and yellow brown earths of the inland basins.

Table 1. Mean level of macro-elements and trace elements in blood plasma of sheep grazing tussock, hill and lowland grasslands.

Grassland	Sodium	Potassium	Calcium	Magnesium	Phosphorus	Iron	Copper	Zinc	Manganese
	(milligrams per 100 millilitres)					*(micrograms per 100 millilitres)*			
Tussock (*Omarama*)	**352**	**17**	**8.9**	**2.2**	**6.4**	**154**	**106**	**84**	**3.1**
Hill (*Wairarapa*)	**318**	**18**	**9.8**	**2.0**	**7.0**	**157**	**78**	**60**	**4.0**
Lowland (*Manawatu*)	**355**	**19**	**8.6**	**2.1**	**6.5**	**235**	**121**	**60**	**2.8**

No significant growth rate responses to copper or cobalt supplementation were observed.

(b) The levels of macro-elements and trace elements in the blood plasma of sheep

The levels of macro-elements and trace elements in sheep grazing developed and undeveloped tussock grasslands compared to those grazing North Island hill and lowland pastures are shown in Table 1.

No significant differences were observed in the plasma levels of macro-elements or trace elements when comparing sheep grazing the developed and the undeveloped tussock, or the hill or the lowland grasslands. The developed and undeveloped tussock grassland data were combined for presentation in Table 1.

(c) Plant levels of macro-elements and trace elements

The levels of macro-elements and trace elements in 10 selected plants growing on the developed and undeveloped tussock grassland blocks as well as those found in the mixed pasture of North Island hill and lowland grasslands are shown in Table 2.

Table 2. Levels of macro- and trace elements in the grazable species from tussock, hill and lowland grasslands.

	Sodium	Potassium	Calcium	Magnesium	Phosphorus	Iron	Copper	Zinc	Manganese	Crude protein (% DM)
	(% DM)*					(ppm)†				
Tussock grassland										
Dicotyledonous plants (herbs) (4)	**0.36**	**2.8**	**1.5**	**0.32**	**0.42**	**576**	**7.2**	**39**	**150**	**12**
Non-tussock grasses (4)	**0.21**	**2.1**	**0.6**	**0.21**	**0.40**	**446**	**4.2**	**31**	**197**	**8**
Tussocks (2)	**0.11**	**0.3**	**0.3**	**0.08**	**0.16**	**200**	**0.8**	**12**	**100**	**5**
Wairarapa mixed hill pasture	**0.18**	**3.6**	**0.5**	**0.19**	**0.47**	**800**	**5.0**	**40**	**160**	**18**
Manawatu mixed lowland pasture	**0.25**	**2.9**	**0.7**	**0.20**	**0.41**	**200**	**8.8**	**25**	**75**	**22**

* percent dry matter
† ppm = parts per million

Since there were only small differences between the element levels in most plants, regardless of whether they grew on the developed or undeveloped tussock area, these data were combined for presentation in Table 2. Small seasonal changes and habitation site effects on the element composition of plants growing in the tussock grassland were also found.

Generally speaking, the content of macro-elements (particularly sodium and calcium) were higher in the herbs (dicotyledonous plants) compared to the non-tussock grasses while the element levels in the tussock grasses were very low. With the exception of potassium, the level of macro-elements and trace elements in the non-tussock grasses growing in the tussock grassland are similar to those of the mixed pasture on North Island hill and lowland grasslands. Consideration of the seasonal availability of different species and their elemental composition suggest that availability to stock is lowest during late spring on developed blocks and in summer on developed blocks.

CONCLUSION

An important conclusion is that the level of macro-elements and trace elements (except selenium and perhaps iodine since marginal deficiencies of these elements were detected) in the dicotyledonous plants and non-tussock grasses are high enough to meet the macro-element and trace element requirements of the grazing sheep, assuming that their dry matter intake is adequate to maintain body weight. This is borne out by the fact that the growth rates of the sheep were satisfactory and the levels of elements in the blood plasma were normal and similar to sheep on other grassland areas.

Although the copper levels were low, and in some cases would not meet the copper requirement of the sheep, in some non-tussock grasses the selection of a mixed diet by the grazing sheep must have maintained an adequate copper intake since no marginal copper deficiency in terms of growth rate was observed. Similarly, the element levels in the tussock grasses are very low but element deficiencies are unlikely because only limited amounts of these plants are eaten and the diet of the sheep is made up mainly of plants with a much higher element content.

A marked difference between the tussock grassland plants when compared to the mixed pasture of the hill and lowland grassland is the low nitrogen or crude protein content of these plants. However, the protein requirements of the sheep would appear to be just met by the tussock grassland plants as a crude protein level of 8 to 10 percent in the diet is considered to be minimal for growth and reproduction.

In view of the report of MacRae and O'Connor (1970), that supplementing of chaffed tall tussocks with a high crude protein leaf meal improved the nutritive value and acceptability of the tussock diet to the sheep, there would be a definite advantage in increasing the crude protein level of the diet available to the grazing sheep by introducing clovers into the tussock grassland.

ACKNOWLEDGEMENT

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WHAT SHEEP EAT ON DEVELOPED AND UNDEVELOPED HIGH COUNTRY

by J. G. Hughes
Tussock Grasslands & Mountain Lands Institute

What do sheep eat when faced with a variety of plants?

In 1970 the DSIR and the Tussock Grasslands and Mountain Lands Institute began an experiment on J. S. and R. S. Dick's Ribbonwood Station at Omarama, North Otago, to see if there was any link between the mineral composition of what sheep ate on developed and undeveloped tussock grassland, the mineral composition of their blood, and their performance measured as body weight change.

The results of this experiment have already been published in the *N.Z. Journal of Agricultural Research.*

They are the subject of a companion article in this issue of *Review.*

The Institute's part in the experiment was to find out what plants the sheep grazed throughout the season on each of the two experimental blocks — one developed, the other undeveloped.

LAND, PLANTS AND ANIMALS

Plate 1 shows the location of the two blocks. Both were steep sunny faces running up to about 1000m. The undeveloped vegetation was short tussock grassland at lower altitudes; tall tussock grassland at higher altitudes. Rainfall is usually less than 800mm each year. The undeveloped block of 77ha (190ac.) was stocked throughout the season with 50 hoggets. On the 67ha (165ac.) developed block, besides a similar basic 50 hoggets, extra sheep were added from time to time to keep control of the more vigorous vegetation. There was a peak grazing pressure in late summer. It was especially high on the developed block.

This block had been burnt in 1965 to reduce the amount of matagouri, then the lower three-quarters were oversown and top-dressed with "Ariki" ryegrass, H1 ryegrass, cocksfoot, timothy,

PLATE 1—Showing the developed and undeveloped blocks on Ribbonwood Station where the experiments were carried out.

and white, red and alsike clovers. It had been regularly topdressed since. By the time of the experiment, the major difference in the vegetation between the two blocks was the greater abundance of white clover, cocksfoot, perennial ryegrass and yarrow on the developed one.

OPTIONS

There are three most common ways of finding out what a sheep is eating:

1. By making a surgical opening in the sheep's gullet (an oesophageal fistula), periodically removing the plug (or cannula) to collect a sample, then assessing the composition of the food which drops out;

2. By assessing which species are grazed from among the vegetation at particular sites (at points or within frames) on an area;

3. By identifying fragments of cuticle (the thin waxy outer layer of plants) chemically separated out of sheeps' dung. Cuticle stays largely undigested as food passes through the sheep.

PLATE 2—The specially-equipped microscope with which faecal cuticle identification was made. The camera allows colour photographs to be taken of the specimens for comparative purposes.

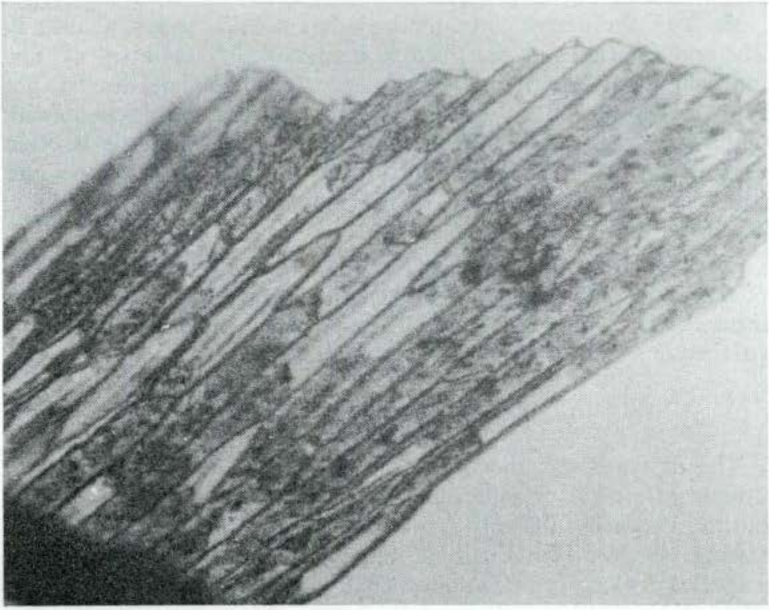

PLATE 3 (above) shows the cell structure in faecal cuticle while PLATE 4 (below) shows the reference cuticle displaying the same cellular characteristics. The specimen in this case is ***Celmisia gracilenta.***

Each of the above three methods has points for and against it. The one we used was the third method, called faecal analysis. The supreme advantage of this technique is that the animal itself is not disturbed and is free to roam, graze and select its food at will. Only its dung is collected. Consequently, faecal analysis is often used to learn what plants wild animals eat. One of the early and still most notable pioneers of the method is a New Zealander, Dr Barbara Hercus.

However the risk with faecal analysis is that part or perhaps all of the plant cuticle of some species may be digested while passing through the alimentary tract. Also, working out how much of a particular species has been eaten is difficult.

GETTING DATA

The first job was to collect, identify, mount and photograph a sample of cuticle of each of the 121 different plant species on the blocks. Preparing the tiny fragile pieces was a long and often frustrating job. We were fortunate in getting a microscope fitted with a special device (an interference contrast condenser) which allowed slight differences in cell imprint pattern, "hairs," breathing pores (stomata) and other small features on the cuticle to be seen as different colours. The microscope and camera are shown in Plate 2.

While the plant reference set was being built up in the laboratory, samples of sheep droppings were being collected every month in the field. Earlier, sheep distribution on the two hill blocks had been recorded to check that no important congregation site was left out in dung sampling.

In the end, except for one extra site on each block, we collected dung from long sampling strips close to the line transects on which the DSIR scientists were from time to time assessing the changing abundance of each plant species.

Back in the laboratory, we treated the dung so that only the small fragments of undigested cuticle in it remained. The search for a good method was long — especially to find one which would break down hard, dry sheep pellets without also destroying the fragile bits of cuticle.

But once this was done, we could compare the appearance of cuticle fragments in the dung with the appearance of known cuticle in our reference collection. We could then estimate the abundance of each plant species in the sheep's diet. In all, we recognised fragments of 49 different species.

Plates 3 and 4 show examples of cuticle from dung, and cuticle of the same species from the reference collection.

WHAT WE FOUND

First we found that the diet of sheep varied between the developed and undeveloped blocks.

Second we found that there was only a poor link between the field abundance of plants available to sheep and their abundance in the sheeps' diet. These two conclusions are brought out in Tables 1 and 2 which (because of limited space) list only the 12 most important species of the many recorded.

Table 1 Comparison of Importance of Species in the Diet with their Importance in the Vegetation Available—Developed Block

Field Abundance	Rank	Diet Abundance
Browntop	1	Perennial ryegrass
Sweet vernal	2	Cocksfoot
White clover	3	Browntop
Matagouri	4	Catsear
Fescue tussock	5	White clover
Chewings fescue	6	*Hieracium praealtum*
Cocksfoot	7	Storksbill
Notodanthonia	8	Hawksbeard
Yarrow	9	*Notodanthonia*
Catsear	10	Red clover
Suckling clover	11	Yarrow
Perennial ryegrass	12	Suckling clover

This table shows that, on the developed block, the deliberately introduced species of ryegrass, cocksfoot and white clover were not only abundant in the field but also important species in the diet. Both ryegrass and cocksfoot may have been actively sought compared to other species since they were higher in the diet abundance list than in the field abundance list. The popularity of the flatweeds catsear, *Hieracium praealtum,* storksbill and hawksbeard is especially notable because, except for catsear, they were not very abundant in the field. Besides, because of their shape, they are difficult for sheep to bite.

Browntop, although the most abundant grass even on this developed block, was obviously less acceptable to sheep than ryegrass and cocksfoot. Yarrow, sheep's sorrel, and white clover all had diet rankings about the same as their field rankings. Perhaps their popularity was simply due to their availability.

Some plants such as tussock, matagouri and sweet vernal, all plentiful in the field, were avoided.

Many other species not listed here but of moderate field abundance were also rarely, if ever, found in faeces. Included in these were plants such as flannel leaf, sedges, bracken fern, *Geranium* and tough little shrubs like *Cyathodes* species, Strathmore weed, *Coprosma* and *Muehlenbeckia.*

Table 2 Comparison of Importance of Species in the Diet with their Importance in the Available Vegetation—Undeveloped Block

Field Abundance	Rank	Diet Abundance
Fescue tussock	1	Browntop
Browntop	2	*Notodanthonia*
Sweet vernal	3	Catsear
Matagouri	4	*Hieracium praealtum*
Catsear	5	Blue tussock
Notodanthonia	6	Hawksbeard
Hieracium praealtum	7	Blue wheat grass
Cyathodes fraseri	8	Plume grass
Chewings fescue	9	Sheep's sorrel
Sedge species	10	Storksbill
Bracken fern	11	Snow tussock
Hawksbeard	12	Cocksfoot

This table shows that on the undeveloped block browntop was not only plentiful in the sward but popular in the diet. Obviously some native grasses such as blue tussock, blue wheat grass and plume grass, although not common, were actively sought on this block compared with the developed block where other grass species were available. The flatweeds were again high in popularity. The low position of cocksfoot in diet rank and the complete absence of white clover and perennial ryegrass in this "top twelve" for the undeveloped block could be due only to their being scarce or absent.

Again, as in the developed block, some unattractive plants such as fescue tussock, matagouri, *Cyathodes,* sedge, and bracken fern were, although plentiful, almost completely rejected.

Our third finding was that the proportion of different plant species in the diet changed from month to month.

This can be seen from Tables 3 and 4 in which for clarity I have grouped our monthly data into seasons.

The numbers are the average rank position of the plants compared to all the other plants found in the dung for a particular season. For example, rank place "1" for cocksfoot in spring/sum-

Table 3 Changes in Order of Importance During the Season of the 20 Most Popular Species in the Sheep's Diet—Developed Block.

Species	Spring/Summer 1970/71 (Growth Period)	Autumn 1971 (Maturation)	Winter 1971 (Senescence)	All Months
Perennial ryegrass	2	1	1	1
Cocksfoot	1	2	2	2
Browntop	3	5	4	3
Catsear	4	4	3	4
White clover	6	3	9	5
Hieracium praealtum	5	11	7	6
Storksbill	7	7	6	7
Hawksbeard	11	8	5	8
Notodanthonia	12	6	8	9
Red clover	8	9	10	10
Yarrow	9	13	14	11
Suckling clover	21	10	15	12
Sheep's sorrel	14	14	13	13
Blue wheat grass	22	12	11=	14
Blue tussock	25=	15	11=	15
Chewings fescue	10	19=	21	16
Alsike	13	18	16	17
Plume grass	16	16	17	18
Yorkshire fog	15	17	20	19
Hieracium pilosella	18	23=	18	20

This table shows that on the *developed* block all plants varied between seasons in their proportion in the sheeps' diet due to their changing acceptability or availability. Some native grasses such as blue wheat grass, blue tussock and *Notodanthonia* fell away markedly in the diet from spring onwards as they became more mature and less digestible. Except for suckling clover and hawksbeard, introduced plants tended to increase in the diet with the advancing season. The most important plants however did not vary much in popularity through the year.

mer means that cocksfoot was the most abundant plant in the sheep's diet of all species for that season.

WHY SHEEP SELECT THEIR FOOD

There are many reasons why sheep choose to eat or avoid particular plants. We can detect what they have eaten; it is very much more difficult to guess why they chose to eat it — or didn't choose to eat a different plant growing nearby. Indeed, some scientists now think that sheep (and other animals) may well rank plants not in order of how much they like them, but in order of how much they

Table 4 Changes in Order of Importance During the Season of the 20 Most Popular Species in the Sheeps' Diet — Undeveloped Block

Species	Spring/Summer 1970/71	Autumn 1971	Winter 1971	All Months
Browntop	1	3	4=	1
Notodanthonia	3	2	1	2
Catsear	2	5	2	3
Hieracium praealtum	4	8	3	4
Blue tussock	5	6	4=	5
Hawksbeard	6	1	7	6
Blue wheat grass	7=	4	8	7
Plume grass	7=	7	9	8
Sheep's sorrel	9	9	10	9
Storksbill	11	11	6	10
Snow tussock	10	10	17=	11
Cocksfoot	14	13	12	12
Suckling clover	15	12	14=	13
Chewings fescue	12	19	17=	14
Yorkshire fog	16	16=	11	15
Haresfoot trefoil	13	20	14=	16
Hieracium pilosella	17	24=	13	17
N.Z. wind grass	19	16=	17=	18
Native broom	22	15	20	19
Red clover	25	14	14=	20

This table also shows the variation on the *undeveloped* block in the proportion of different plants between seasons. For example, the rank position of browntop in the diet fell from spring to winter while, on the other hand, the rank position of *Notodanthonia* rose.

Blue wheat grass, hawksbeard, Chewings fescue and *Hieracium praealtum* also showed marked changes in popularity between seasons. If anything, there tended to be greater variation in the position of the more important plants on this undeveloped block between seasons than between the top plants on the developed block. This could have been due to there being fewer highly acceptable species of plants (such as cocksfoot, perennial ryegrass and clover) on the undeveloped block — and thus more reason for the sheep to pick and choose between what was available.

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dislike them, or parts of them. They may choose the least tough, the least prickly, those emitting the least repulsive odour or containing the least disagreeable taste-affecting chemicals.

All kinds of factors may influence their choice: sight, smell, taste, touch, age and physiological status of the sheep, possible demand for certain minerals, their previous experience, soil physical and chemical status, plant association, plant shape, climate, time of season, time of day, difference between plant parts and the effect of grazing pressure on availability.

We can be sure only that, faced with a certain range of choice or *field abundance,* sheep find certain plants acceptable and the combination of availability and acceptability results in certain amounts of different plants being selected for their diet. This we measure as *diet abundance.*

CONCLUSIONS

There is not enough room in this article to discuss why the sheep on "Ribbonwood Station" may or may not have chosen the plants available to them at any time.

However, some points can be made:

(a) Preference for particular plants seemed to be closely related to their stage of maturity and relative digestibility at particular times of the year. Introduced grasses and clover ranked high in diet abundance;

(b) Availability of particular plant was also an important factor in the sheeps' choice of diet. When there was insufficient introduced grass and clover to satisfy demand, the sheep turned their attention to more fibrous species;

(c) The proportion of particular plants in the diet was not necessarily related to their abundance in the field. Fibrous or woody plants, even if plentiful in the field, ranked low in diet abundance or did not appear at all in faeces;

(d) Taste differences appeared to be less important than tissue toughness in selection;

(e) The relatively high degree of preference shown for several flatweeds could have been related to their relatively high mineral content;

(f) On the developed block, perennial ryegrass, cocksfoot, browntop and white clover were the principal items of diet other than flatweeds.

On the undeveloped block, mainly browntop, *Notodanthonia,* blue tussock, blue wheat grass and plume grass together with flatweeds were chosen.

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COMMON AND BOTANICAL NAMES OF SPECIES IN THE TEXT

Alsike	*Trifolium hybridum*
Blue tussock	*Poa colensoi*
Blue wheat grass	*Agropyron scabrum*
Bracken fern	*Pteridium aquilinum* var. *esculentum*
Browntop	*Agrostis tenuis*
Catsear	*Hypochaeris radicata*
Chewings fescue	*Festuca rubra*
Cocksfoot	*Dactylis glomerata*
Coprosma	*Coprosma petriei*
Cyathodes species	*Cyathodes colensoi* *Cyathodes fraseri*
Fescue tussock	*Festuca novae-zelandiae*
Flannel leaf	*Verbascum thapsus*
Geranium	*Geranium sessiliflorum*
Haresfoot trefoil	*Trifolium arvense*
Hawksbeard	*Crepis capillaris*
Hieracium pilosella	*Hieracium pilosella*
Hieracium praealtum	*Hieracium praealtum*
Matagouri	*Discaria toumatou*
Muehlenbeckia	*Muehlenbeckia axillaris*
Native broom	*Carmichaelia monroi*
Notodanthonia	*Notodanthonia clavata*
N.Z. wind grass	*Lachnagrostis filiformis*
Perennial ryegrass	*Lolium perenne*
Plume grass	*Dichelacne crinita*
Red clover	*Trifolium pratense*
Sedge species	*Carex* species
Sheep's sorrel	*Rumex acetosella*
Snow tussock	*Chionochloa rigida*
Storksbill	*Erodium cicutarium*
Strathmore weed	*Pimelea prostrata*
Suckling clover	*Trifolium dubium*
Sweet vernal	*Anthoxanthum odoratum*
White clover	*Trifolium repens*
Yarrow	*Achillea millefolium*
Yorkshire fog	*Holcus lanatus*

TARA HILLS HIGH COUNTRY SURVEY 1973

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This report summarizes results of a high country survey conducted by staff of the farm advisory and research divisions of the Ministry of Agriculture and Fisheries in the summer 1973/74 on 73 runs in the Mackenzie and Omarama districts. A similar survey was conducted in 1968 and results have been compared with the present survey. The combined districts have been divided up into three areas according to annual rainfall. These include a DRY area (16 stations) with an annual rainfall of less than 510mm (20in), a MOIST area (33 stations) ranging between 510mm and 1020mm (40in) and WET area (14 stations) with in excess of 1020mm rainfall. Although 73 runs were included in the survey district, some of the questionnaire returns were incomplete and, as a result, the total number of runs shown throughout this report does not necessarily add up to 73.

SHEEP SECTION

Numbers and breeds

Sheep numbers in the survey district increased by 10% during the past five years to a total of 0.38 million sheep shorn in 1973. This represents an increase in the average flock size from 5,220 in 1968 to 5,710 in 1973 and a present stocking rate of 1.8 hectares per sheep. As in 1968, ewes comprise 53% of the flock, wethers 25% and hoggets 20%.

The Merino remains the predominant breed, especially in the high rainfall area. With the exception of one runholder who is considering changing from a half-bred to Merino, there was no desire to change breeds.

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* Dr Scales was stationed at Tara Hills when this survey was taken and is now at Winchmore. Mr Currie was at Oamaru and is now at Wellington. Mr Kissick and Mr Donaldson were stationed at Fairlie; Mr Donaldson is now stationed at Masterton. Mr Kissick is deceased.

SHEEP BREEDS (% of stations)

			MEAN
Merino			59
Half-bred			34
	— Merino x Romney	19	
	— Merino x Lincoln	2	
	— Merino x Corriedale	1	
	— Unspecified	12	
Corriedale			7

Sixty-four percent of runholders use the Border-Leicester as a fat lamb sire, 12%, South Suffolk, 6%, Polled or Horned Dorset, 5%, Hampshire and, 4%, Southdown, while 3% use Suffolk, Perendale and English Leicester respectively.

Fertility

The proportion of stations mating 2-tooth and mature ewes is as follows.

EWES JOINED WITH RAMS (% of stations)

	Dry	Moist	Wet	MEAN
Mature ewes	100	100	87	97
2-tooth ewes	58	57	27	51
Overall tailing %	90	83	74	83

Ninety-seven percent of runholders mate mature ewes, although only 51% mate 2-tooths. Up to 73% of runholders in the high rainfall area do not join their ewes to the rams until 4-tooths or older. Thirteen percent are never joined with the ram. Tailing percentages were 16% higher in the dry area than in the wet area. The overall tailing percentage of 83 is only slightly higher than 1968.

The ratio of rams to ewes varied from 30 to 39 in the survey district. Tara Hills trials with mature ewes have shown satisfactory results with one ram per 100 ewes, provided they are older than 2-tooths. It seems that fewer rams (preferably of higher productive merit) could be used without any detrimental effects on ewe fertility.

When asked to rate the improvement of wool weights or ewe fertility in order of priority, 53% of runholders rated wool as the more important while only 4% rated fertility as important. However, many (43%) considered both important. Thirty-four percent of runholders were interested in genetically high fertility (150% lambing) rams. This indicates potential interest in the "Booroola" Merino ram progeny which will be released to the industry as they become available from the Tara Hills evaluation trials.

VEGETATION ON MATING BLOCKS

	% of Stations	Lambing %
Unimproved tussock	49	77
Improved tussock	32	91
Sown pasture	16	86
Lucerne	3	—

Almost half of the runholders mate ewes on unimproved tussock, although many use a combination of mating blocks. Lambing percentages of ewes mated on unimproved tussock tend to be lower than ewes grazing improved vegetation, which suggests that every attempt should be made to make the improved blocks available for mating.

Time of lambing and weaning

Fifty-one out of 69 stations lamb in October (12 in September), although there is a considerable variation within the district. While flocks in the dry area were towards the end of lambing in November, there were still 14% of flocks to lamb in the wet area.

MONTH OF WEANING (% of stations)

	Dry	Moist	Wet	MEAN
Jan	42	28	8	28
Feb	58	62	79	64
March	0	10	13	8

Lambs were approximately 16 weeks of age at weaning. Research at Tara Hills has shown that lambs can be weaned at 12 weeks of age without any detriment to their growth rates if feed conditions are such that early weaning is necessary.

Wool production

The majority of runholders shear their ewes in September (44%) and October (31%), although there is considerable variation within the district. Only 5% of the stations in the dry area shear in December compared with 29% in the wet area. Hoggets are shorn about the same time as ewes while wethers are generally shorn a month later.

Forty out of 71 stations in the survey district shear with blades (dry area 45%, wet area 57%). Mean wool weights of ewes (3.8kg) and hoggets (2.9kg) varied within the survey district, with ewes in the dry area clipping 0.7kg more wool than their counterparts in the wet area. However, wether wool weights (4.5kg) were relatively consistent within the district. Average wool weights in the Omarama district were 0.5kg lighter than in the Mackenzie district.

Wintering sheep

Twenty-eight out of 68 runholders who supplied the relevant information supplement their ewes with hay and of these half winter ewes on unimproved tussock. Research at Tara Hills has shown that Merino ewes can be satisfactorily maintained on 0.68kg of lucerne hay/head/day (approx 2.5 bales/100) and that twice a week feeding has no adverse effect compared with daily feeding.

FLOCK WINTERING SYSTEM (% of stations)

	Improved tussock	Unimproved tussock	Improved tussock + hay	Unimproved tussock + hay	Tussock + grain	Other e.g. roots, nuts
Ewes	8	34	18	23	10	7
Hoggets	10	28	34	11	5	10

Generally, runholders supplementing ewes also supplement their hoggets but a greater proportion of hoggets fed hay are grazed on improved country. This can be compared with the 1968 survey which showed little preferential treatment of younger sheep.

Minerals

Approximately 85% of runholders supplement sheep with salt and of these 95% supplement ewes, 87% supplement hoggets and 57% supplement wethers. Over half the runholders supplement salt all year, 15% supplement in the spring, 17% in summer and autumn and 13% in winter, although many use a combination of these.

SALT AND MINERAL SUPPLEMENTS FOR SHEEP (% of runholders)

	Dry	Moist	Wet	Total
Salt	95	78	87	85
Minerals	79	49	60	59

Of the 60 runholders who use salt, 42 include minerals. Current work at Tara Hills has shown that salt supplementation of ewes grazing lucerne pastures will increase liveweights of ewes and lambs, although wool responses have been variable. Investigations are under way to determine whether responses are likely on unimproved country.

Anthelmintics and selenium

Sixty-two percent of runholders drench their ewes, almost half of these before mating. However many (24%) drench at both mating and lambing. Limited research at Tara Hills has failed to show fertility responses to pre-mating drenching with anthelmintics. Most runholders (95%) drench their hoggets, usually three times a year (range 1-12).

ANTHELMINTICS AND SELENIUM FOR EWES
(% of runholders)

	Pre-tupping	Pre-lamb	Both	No drench
Anthelmintic	29	10	24	38
Selenium	31	9	24	36

Thirty-one percent of runholders dose their ewes with selenium prior to mating and a further 24% dose both pre-mating and pre-lambing. Most stations (91%) dose hoggets with selenium and of these 15% dose once a year, 17% twice, 35% three times and 33% more than four times.

CATTLE SECTION

Number and breeds

Total cattle in the survey district increased by 63% from 8,706 in 1968 to 14,180 in 1973. Only 13% of stations do not run cattle compared with 30% in 1968. The average herd size is 225 (268 dry, 149 moist, 379 wet) compared with approximately 175 in 1968.

Seventy-eight percent of runholders graze Herefords, 17% Angus, 2% Shorthorn and 3% crossbreds. Only six out of 58 runholders who supplied data intend changing their breed and of these, five want to change to crossbreds (exotics, Friesians and traditional breeds). Approximately 42% of runholders intend to increase cattle numbers, but of these only 30% intend reducing sheep numbers.

Time and duration of mating

DATE BULLS OUT (% of stations)

	Oct	Nov	Dec	Jan
Mature cows	4	27	67	2

Approximately two-thirds of mature cows are mated in early December. Runholders in the wet zone mate cows later in the year (87% in December) than in low rainfall areas (56% in December). Heifers are generally joined with the bull at the same time as cows.

DATE BULLS OUT (% of stations)

	60	80	100	120	>120
Mature cows	18	14	20	41	7
Calving %	85	85	84	71	—

Two-thirds of runholders run their bulls with the cows for 100 days and over. Calving percentages do not appear to be reduced on those properties where a 60-day mating interval is used.

Calving Percentages

The ratio of cows to bulls was similar for all districts:

Cows per bull	38	(Range 20 - 90)
Heifers per bull	34	(Range 20 - 50)

The average mating group size varies from 80 in the dry area to 163 in the wet area. Twelve percent of runholders artifically inseminate some of their cows.

CALVING PERCENTAGES

	Dry	Moist	Wet	Mean
Cows	89	90	84	88
Yearlings	82	80	70	78

The average calving percentage has not increased since 1968. Cows in the high rainfall area have slightly lower calving percentages than in the drier areas.

Mating yearlings

Twenty-nine percent of runholders mate yearlings compared with only 3% in 1968. However, up to 46% of runholders have mated yearlings at some stage in the past, but of these, about one third do not mate them now. Approximately half the runholders mating yearlings, mate only the largest.

STOCK HEALTH

Bloat — During the summer of 1972/73, 26% of runholders reported bloat occurring on their properties, although generally only

1% of the herd was affected. Eighteen percent of these runholders reported bloat occurring on lucerne pastures, 25% on red clover, 29% on white clover, 21% on unspecified sown pasture and 7% on improved tussock but none on unimproved tussock.

Lice — Ninety-seven percent of runholders treat cows for lice while 89% treat calves. Of those who treat cows, 64% do so in autumn and 22% in winter. Calves are generally treated at the same time as cows.

Selenium

Only 3 out of 63 runholders (4.8%) dose cows with selenium prior to mating, while 36% dose their calves, usually once (37%) or twice (50%) per year. Calves are dosed most frequently in April, June and September.

Anthelmintics

Only 8% of runholders drench cows with anthelmintics although 46% drench calves. Calves are generally drenched once (39%) or twice (43%) during the year, mainly in late autumn and spring. This often coincides with selenium dosing.

Winter nutrition of cows and calves

WINTERING SYSTEM (% of stations)

	Improved tussock	Unimproved tussock	Improved tussock + hay	Unimproved tussock + hay	Other e.g. grain, nuts
Calves	3	2	34	29	32
Cows	9	28	25	19	18
Calving %	90	86	90	90	83

Approximately 47% of runholders winter their cows on unimproved tussock and of these, less than half supplement with hay. Calving percentages on unimproved properties were higher when hay was fed. A higher proportion of runholders on improved country supplement cows with hay than on unimproved properties.

Spring nutrition of cows

SPRING MANAGEMENT OF BREEDING COWS

	Improved tussock	Unimproved tussock	Sown pasture	Irrigated pasture	Swamp
Station %	32	34	5	3	26
Calving %	88	81	89	—	87

Comparable numbers of runholders in the survey district use either improved, unimproved tussock or swamp from calving to mating. The importance of adequate nutrition is evident by the lower calving percentages on the unimproved properties. This is in agreement with current work at Tara Hills which shows that good spring nutrition is essential for maximum conception rates.

GRASSES AND LEGUMES

Oversowing of grasses and clovers

Only 7.4% of the survey area is classified as improved. However, 86% of runholders intend to increase this area in the next three years, an anticipated increase of approximately 430 ha or 56% of their present improved area.

Seed mixtures vary in composition and amount. Cocksfoot is included in 87% of seed mixtures (100% in dry area) with seeding rates of about 3.0kg/ha. Red, white and alsike clover are used in 73% to 84% of mixtures with seeding rates of approximately 2.3kg/ha. Subterranean and suckling clovers are used only occasionally, their use being confined to the dry and moist areas.

Species		% of mixtures in which species are included	Mean seeding rate (kg/ha)
Clover	— red	73	2.2
	— white	84	2.3
	— alsike	78	2.3
	— subterranean	5	1.1
	— suckling	10	1.7
Grasses	— ryegrass	38	6.5
	— cocksfoot	87	3.0
	— timothy	35	2.1
	— dogstail	8	1.2

Most runholders oversow in the spring (40% September, 31% August) with only 4.5% sowing in the autumn (March). Seed is generally sown alone using a spreader (63%), although some runholders (37%) prefer to mix the seed with fertilizer. There has been a substantial increase in the use of inoculated clover with 71% of runholders using inoculated clover compared with only 34% in 1968. Of those who inoculate, almost half (45%) prefer the commercial pellet while 28% inoculate their own. Less than 20% buy commercially inoculated but non-pelleted seed, while a further 7% inoculate and pellet on the property.

Fifty-eight percent of runholders use greater than normal rates of inoculation, although most of these restrict themselves to double rates only. Ratings of oversowing success are as follows:

RESPONSE TO OVERSOWING (% of stations)				
Results	**Dry**	**Moist**	**Wet**	**Total**
Poor	18	13	0	12
Fair to good	82	63	77	71
Excellent	0	24	23	17

Only 12% of runholders in the survey district consider they have obtained poor results from oversowing. Many runholders noted the importance of adequate rainfall, a requirement substantiated by the good results in the wet area and the poor results in the dry area. The majority (71%) of runholders consider they have fair to good results from oversowing.

Only 6% of runholders do not use fertilizer when oversowing grasses and clovers. Of the 59 who do, most (86%) use sulphurised superphosphate (400) at about 225kg/ha (range of 112 - 450 kg/ha).

Almost 15% of runholders do not use maintenance fertilizers. Of the 52 who use maintenance fertilizers, most (79%) use sulphur super 400, 15% use sulphur super 200 and 6% use straight superphosphate in amounts ranging from 125 to 188kg/ha every 2 - 3 years. Only 12% of runholders topdress annually and none uses more than 250kg/ha per application. August and September are the most common months of maintenance topdressing. Only 50% of runholders in the moist and wet areas include molybdenum in their fertilizer. Eighteen percent of runholders in the dry area use molybdenum.

Cultivated grass-clover pastures

Most runholders (90%) use fertilizers when establishing cultivated grass — clover pastures, the sulphur super 400 mix being the most popular. Application rates of 125kg/ha (37%), 188kg/ha (24%) and 250kg/ha (34%) are most frequently used, only few runholders using more than 250kg/ha. Over 50% of runholders apply maintenance fertilizers annually, 26% every two years and 21% every three years. As with oversowing, August and September are the most popular months of application.

Lucerne

Lucerne establishment represents a problem for many runholders. Twenty-three out of 55 runholders reported unsatisfactory lucerne establishment and production, although the problem was more pronounced in the wet zone (86%) as compared with the dry zone

(17%). Of those who have had problems growing lucerne satisfactorily, 40% attribute this to poor establishment, 31% to a short life of the stand and 29% to invasion of weeds. Approximately two-thirds of runholders have pure lucerne stands, although 35% have tried lucerne grass mixtures. Of the latter, 75% include cocksfoot in the mixtures, 13% tall fescue, 6% ryegrass and 6% timothy.

Method of sowing lucerne

Two-thirds of runholders sow lucerne following a crop, usually oats or ryecorn. While many runholders in the dry area sow lucerne after a fallow (28%), their counterparts in the wet area place no value in this practice (0%).

LUCERNE ESTABLISHMENT (% of stations)

Sod seeding	3
Ex native	10
Ex fallow	20
Ex crop	67

Over half (54%) of the runholders sow lucerne in October, 24% in November and 13% in September. Only a few runholders (10%) sow lucerne at other times of the year. All runholders inoculate their lucerne seed and of these 70% inoculate on the property, 17% use commercially inoculated lucerne, 5% inoculate and pellet on the property while 8% use commercially inoculated and pelleted seed.

Ninety-two percent of runholders use fertilizer when sowing lucerne and of these, half use sulphur super 400, the remainder using either reverted superphosphate or straight superphosphate. Only 27% of runholders use lime (40% in the high rainfall area), usually at about 3.5 tonnes/ha.

FERTILIZER USE FOR LUCERNE ESTABLISHMENT

	% of runholders using fertilizer	**Mean application rate (kg/ha)**
Reverted super	43	200
Super	8	325
Sulphur super 400	49	200

Over ninety percent of runholders use maintenance fertilizers and of these, 78% use sulphur super 400, 13% use sulphur super 200 and 9% use straight superphosphate. Eighty-three percent of runholders apply maintenance fertilizers annually to lucerne. Lime is not used for the maintenance of lucerne. Only 39% of runholders use trace elements on lucerne, molybdenum being used most frequently (94%).

Only 35% of runholders spray lucerne for grass weeds. Over half (53%) of the properties make two cuts of hay per annum, 10% make three cuts, although 36% have only one cut per year. No properties take more than 3 cuts per year.

GENERAL SECTION

Pasture improvement

Only 7.4% of the survey area is classified as improved which represents an increase of less than 1% (3,970ha) since 1968. Of the total improved area, 75% is oversown, 19% is permanent pasture, 6% is lucerne and less than 0.5% is irrigated.

Only six out of 73 properties have irrigated pastures. Sixty-five properties are suitable for irrigation, but only half of these intend to develop or extend their irrigated pasture.

Weeds

Approximately 73% of runholders consider that sweet brier is increasing, especially in the dry area (84%). Of these, 81% consider the increase is due to both plant size and numbers, 13% consider the increase is due to numbers only while 6% consider size alone to be important. Only 8% of runholders reported broom to be increasing, although 43% considered barley grass to be increasing.

Advisory services

When asked if advisory services could be of assistance, 77% were affirmative, 22% undecided and one runholder negative. Thirty-six percent of the runholders who considered that advisory services could be of assistance claimed they were satisfied with existing advisory services (a higher proportion in the wet area), although 64% wanted further consultation with advisory officers.

Field days

Eighty-four percent of runholders considered that a major field day held at Tara Hills every three years was adequate but 90% were in favour of holding small field days on specialized topics in addition to major field days.

RESEARCH PRIORITIES

When asked to list four fields of research that would be of benefit to each property the following response was obtained:

Research topic		**Number of runholders (73 total) including the following topics in their four research priorities**
Weeds — Economic control of:		
Sweet brier	24	38
Matagouri	11	
Hieracium	4	38
St Johns wort	3	
Browntop	2	
Nodding thistle	2	
Broom/speargrass/gorse grass/barley grass	4	
Lucerne establishment		8
Irrigation—stocking rates, integration with run		8
Oversowing and topdressing—establishment, economics		8
Fertilizer maintenance requirements		8
Salt for sheep and cattle		6
Selenium and drenching for cattle		6
Shelter belts and tree establishment		6
Grasses and clovers for dry areas		6
Winter feeding investigations—mechanisation		6
Improved strains of lucerne		5
Oversowing of lucerne		5
Grass grub and tussock grub		4
Grazing management of improved tussock		3
Lucerne/grass mixtures		3
Crossbreeding of beef cows—exotic crosses		3
Sheep fertility and wool weight improvement		3

Thirty-eight out of 73 runholders include the control of weeds in their four research priorities, with sweet brier the major problem. Many runholders listed more than one weed in their priorities. Broom and barley grass were included by only one runholder respectively in the survey district. The next most important priorities were shared equally by eight runholders — lucerne establishment, irrigation, over-sowing and fertilizer maintenance requirements. The high priority given to these topics indicates considerable interest in extending their area of improved country. Animal investigations took second place to weed problems and pasture introduction work, although 12 out of 73 runholders considered work on mineral nutrition (e.g. salt and selenium) important.

In addition to the above topics there were a further 40 topics listed by one or two runholders. Some of these include footrot control, legume persistence, water conservation dams, tussock deaths, inbreeding of cattle, Acheron soils, bowie, selection of bulls and rams, improved calving percentages, increased hay production, burning, fertility of 2-year-old heifers, utilization of snow tussock without burning and revegetation of class 7 and 8 land.

ACKNOWLEDGEMENTS

We would like to thank those runholders whose co-operation made this survey possible. Thanks are also due to J. M. Lockhart, N. A. Cullen, G. H. Davis, D. J. Musgrave and A. J. Allison of the Ministry of Agriculture and Fisheries for assistance in collection of the data and helpful discussion. The co-operation of J. G. Hughes of the Tussock Grasslands and Mountain Lands Institute is also appreciated.

CONFERENCE

Some of the world's most distinguished scientists and conservationists will assemble at Lincoln College early next year for a special 10-day conference under the auspices of the International Union for the Conservation of Nature and Natural Resources (I.U.C.N.).

Forty foreign delegates to the conference, which will formulate guidelines for high mountain resource management and conservation, will arrive in Christchurch 3 February 1976.

They will be joined by 20 New Zealand delegates to discuss and view six areas of high mountain interest: pastoral use, timber resources, water use, landscape preservation, recreational use and ecology.

The New Zealand Government, through the Department of Lands and Survey, will host the overseas visitors during their stay in New Zealand.

PHOTO: J. C. ASPINALL

Willow and poplar poles becoming well established protecting the road, fence and hay paddock on Camerons Flat, Mt Aspiring Station.

THE ROLE OF TREES IN RIVER BANK CONTROL

J. C. Aspinall
Mt Aspiring Station

For many years now we have been attempting to protect river banks from erosion. It is a long, tedious and sometimes heart-breaking job since it takes at least 12-15 years for planted poles and tied-in willow logs to become sufficiently rooted before they can withstand severe pressure from flooding. Our Matukituki River has a wide bed, is constantly changing its course and is subject to violent flooding at any time of the year.

With such an unpredictable stream threatening our better lands, it is essential that any development in the form of grass paddocks,

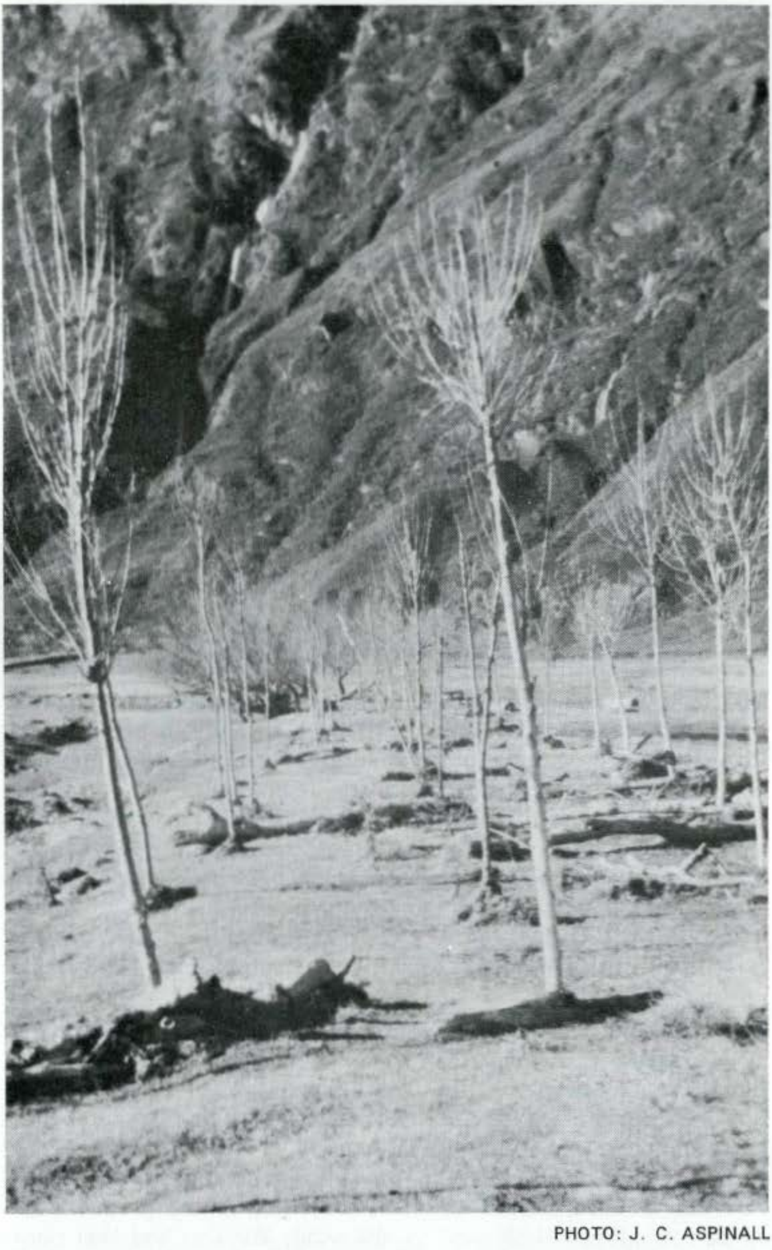


PHOTO: J. C. ASPINALL

One- and two-year old planted poles in the foreground with longer established willows in the background on Wishbone Flats, Mt Aspiring Station.

hay paddocks, haysheds, shelter belts, access roads and top dressed areas on the best of our flats have adequate protection.

The first part of our work, done in co-operation with the catchment board, consisted of a long cable, well anchored, with tie-backs every 20 m or so. As large willows were scarce, we had to use native beech trees wired to the cable, and weighted down with baskets of rocks. Willow poles 3 m x 7.5 cm were poked in among the logs. Providing the tops were beyond the reach of cattle and other hungry stock, or else fenced off, these poles grew, although losses might be as high as 30 percent.

Now that more willows are available on our property we can use a greater proportion of them for logs and weigh these down with rocks. Beech trees are difficult to drag across river beds, have only a short life before rotting and when dry tend to float. However, they do have the advantage of spreading the weight of rock heaps over a larger area than willow trees.

Where banks are not in immediate danger of scouring we have planted many hundreds of willow and poplar poles.

OBJECTIVE

Our long-term objective is to protect the river banks around our flats from erosion by planting poles. These are set in three or four rows and planted 4-5 metres apart, to allow full growth for each tree. Willow roots give a good surface coverage while those of poplar tend to go deeper and provide anchorage. I have measured some willow roots more than 23 metres long 10 years after they were planted as poles. For a start, these do not provide much protection, hence the need for stronger works in danger areas. As they grow older and larger, their effectiveness increases and, even if they do not withstand the full force of the river, they do slow down the rate of damage. This gives one more time for stronger preventive measures.

For the first few years, several hundreds of the poles came from as far as the Cardrona Valley, 48 km off. For ease of handling these were about 10 cm thick and 3 m long so that when planted 0.75 m deep, the tops are above the reach of hungry stock. Unless the ground is very stony, a post-hole auger mounted on a tractor comprises the easiest method for digging holes. The poles must be well rammed to prevent their loosening in the ground when stock rub against them and by the wind. We also find that opossums are very destructive to willows and poplars in spring and early summer. Opossums must be kept under control where such planting is done.

PHOTO: J. C. ASPINALL

These poles are not under pressure from the river at the present time and should be well established if the stream changes course at some future date.

Some 18 years ago we established a 0.8 ha nursery on Cameron's Flat and this now keeps us supplied with up to 1000 poles annually. It contains many varieties of both willow and poplar, some of which are quite quick growing.

POPLAR RUST

Unfortunately last February our nursery was attacked by poplar rust. So far, it is difficult to say what the long-term effect of this will be, since most of the poplars affected merely seemed to lose their leaves a little earlier (March, April) than usual. However *Populus generosa* was the first and the worst affected, and will be cut out completely. Also being removed are *Salix cordata, S. pentandra, S. paperi, S. viminalis,* and *S. medimi,* since all of these are reputed to produce vast quantities of viable seeds.

The rust did not spread as quickly among the more widely spaced river-bank plantings although the most attractive (especially for autumn colour) faster growing hybrids were certainly more susceptible to rust.

In the early stages of our work we had to use many crack willows. These are not favoured because their brittle branches easily break off and can root in undesirable areas further down stream. Booth willow, Tew's willow, *S. daphnoidies* (fast growing and having an attractive bloom on the bark) and *S. gigantea* are good. The one I like best for quick growth, solid root system and brightly coloured bark is basket willow which was given to my father as a few twigs about 40 years ago.

Of the poplars, the hybrids grow the quickest, but until more is known about the effects of rust disease, we may need to depend on older species such as balsams, yunanensis and the lombardy. This would be a great pity for the many hybrids available have most attractive foliage and autumn colours.

For weighting down logs and willows in our earlier work we relied on netting baskets and sausages of stone. We have now decided these consume too much time and labour. Where rock is available — even when large boulders must be drilled and blasted to manageable sizes — one or two men with tip-truck and loader can shift a greater weight of material in a shorter time. A good combination now seems to be rocks of one cubic metre in size to provide weight, combined with smaller stones to fill in the gaps between. This also represents a much simpler means for repairing unexpected flood damage. The principal requirements for quick repair are a plentiful supply on hand of large willows and rock, and the machinery to transport them quickly to threatened areas.

SOME IRRIGATION INVESTIGATIONS IN THE MACKENZIE COUNTRY

D. Scott, P. T. P. Clifford, L. A. Maunsell, and W. J. Archie
Grasslands Division Regional Station, DSIR, Lincoln

There are about 72,000 ha of the Mackenzie Country which could be border dyked or wild flooded, while a further 12,000 ha mostly of the better soils, would require spray irrigation (T.G. & M.L.I. *Review* 27: 1-18). At present less than 1000 ha are irrigated. Water for irrigating 20,000 ha is available from the Tekapo/Pukaki hydro canal.

Climate records shows that the irrigation requirement is 400-500 mm of water per year, with a maximum monthly requirement of 100 mm (4in).

The soils are mainly derived from greywacke with a transition into schist soils in the southeast. Mainly as a consequence of processes associated with the last ice age, the soils vary from shallow gravelly or stony soils to deep soils where materials have been collecting by wind blow or runoff from surrounding hills.

This interim report gives some indication of the problems and potentials found in initial investigations by the Grasslands Division. Two sites are currently being used, one at Maryburn Station and the other at Haldon Station covering the poorer and better soils respectively.

BETTER SOILS — HALDON SITE

At Haldon Station, on one of the best soils (Grampians silt loam), the growth rates and annual production of 11 pure stands and one grass/clover associate are being measured under three rates of superphosphate (0, 250, or 800 kg/ha/yr). Since the grasses are without accompanying clovers they get nitrolime in four applications at 0, 500, or 1500 kg/ha/yr. Sulphur and molybdenum are applied as a matter of course. Irrigation is by the trickle method. Wairau lucerne, Turoa and Hamua red clover, and Kahu timothy are being cut at six-week intervals as in hay production. The remaining eight are considered pasture species and are cut at

TABLE 1 — Comparison of annual dry matter production (tonne dry matter/ha) from irrigated and non irrigated plots at Haldon site in first production year.

	Irrigated	Non Irrigated
Mean	10.3*	4.1
Range	0.8-20.3	0.7-6.8
± se	0.3	0.2

* 1 t/ha DM $\simeq$ 1.4-2.0 ewe equivalents/ha $\simeq$ 40 bales hay/ha

four-week intervals and include Huia and Pitua white clover, Ruanui and Ariki ryegrass, Apanui cocksfoot, Yorkshire fog, 4710 tall fescue and the combination of Ruanui ryegrass and Huia white clover. Harvesting is arranged so that some plots of each species are cut every fortnight to determine how different growth stages respond to climate at different times of the year.

Comparison of irrigated and non-irrigated plots in the year after establishment (Table 1) show an overall $2\frac{1}{2}$-fold increase in production with irrigation. For the four hay species there was a four-fold increase with irrigation. The maximum values are among the best recorded in New Zealand. However, there are areas of these better soil types which receive water by run-off or drainage where production probably approaches that from irrigated areas.

The first two years' results show that even with irrigation there are large differences related to species and fertiliser (Table 2). Legumes outproduced grasses in most instances. Within the legumes highest production was by lucerne and the two red clovers. Although red clovers outproduced lucerne in the establishment and first production year, the indications are that red clovers decline in the second and later years.

The two white clovers and white clover/perennial ryegrass mixture formed a second group. The large response to fertilisers by grasses was probably an effect of the artificial nitrogen rather than of the phosphate. Timothy was the most productive of the grass species.

An extra 3-4 tonne/ha were obtained from moderate levels of phosphate fertiliser. However, it is worth pondering on the 13

TABLE 2 — Species and fertiliser effects under irrigation at Haldon site (annual production t DM/ha).

	Fertiliser			
Species	**Nil**	**Moderate**	**High**	**± se**
Best species (red clovers and lucerne)	13.5	16.7	17.8	0.6
Other legumes (white clovers)	7.3	11.5	12.5	0.6
Grasses	1.5	5.2	12.0	0.4

TABLE 3 — Annual production from Maryburn site in relation to nitrogen treatments.

	Annual Production (t DM/ha)	
Nitrogen Treatments	**72/73**	**73/74**
Nil	4.0	4.8
50 kg/ha N spring	5.2	5.2
50 spring and autumn	5.2	5.4
100 spring and autumn	5.2	5.7
± se	0.5	0.2

tonne/ha achieved from the best legumes with water alone, in the absence of applied fertiliser, especially when we consider the transport costs to these more remote areas.

Irrigation naturally alters seasonal distribution of growth by allowing growth to continue into the summer. This summer growth can be utilised for hay, and summer or autumn feed. While the growth rates are sustained at a high level during summer, there is a rapid rise and fall in spring and autumn so that growth is limited to an effective period of seven to eight months. Even with irrigation, temperature limits the major growth in this region to the period from mid-September to end of March, with no growth after mid-May.

MODAL SOILS — MARYBURN SITE

The Maryburn demonstration area is a co-operative effort between the runholder and Ministry of Agriculture and Fisheries. The soils are a stony silt loam which is poor by the Haldon site standard, but still probably better than similarly textured soils which form a large part of the basin. The area was border dyked in early autumn and sown the following spring in either lucerne, timothy with white and red clover, or ryegrass with white clover, alsike and lotus. The exception was one border in which the Grasslands Division studied different nurse crops, permanent species and fertilisers.

We consider that cultivation of these structureless high country soils must be kept to a minimum. Accordingly, levelling of this border and other preparations were done soon after border formation, with subsequent spring sowing being done with a disc drill.

Autumn or spring sowings of nurse crops of ryecorn, Paroa or Manawa ryegrass with 50 kg/ha of nitrogen and 200 kg/ha superphosphate did not increase establishment of the spring sown permanent species but did make some contribution to feed in the first year.

The five permanent species tried were timothy, cocksfoot, tall fescue, Ariki ryegrass, and lucerne. With the exception of lucerne all were sown with white clover, the first three also with red clover and some lotus.

These were sown with 350 kg/ha molybdic sulphur superphosphate giving the equivalent of a total of 480 kg/ha superphosphate in the year of sowing. Only three light grazings were carried out during the establishment year. A further 300 kg/ha superphosphate were applied in the second spring, and 1000 kg/ha in the third spring. In addition, four nitrogen treatments were applied in the second and third year. These were: 100 kg/ha N spring and again in early autumn; 50 kg/ha N spring and autumn; 50 kg/ha N spring, and nothing.

The permanent grasses and lucerne, though having adequate initial establishment, made only a small contribution to the total production of the stand. For example the two best grasses, timothy and cocksfoot, contributed only 14 percent and 22 percent respectively to production in the third year of their stands and even after the amount of nitrogen added. Lucerne was deleted from the experiment because of its low yields.

The bulk of production was from white and red clover and in many respects the trial was on the management alternatives of these two clovers (Table 3). Overall production was similar in the second and third seasons showing no advantage to increasing superphosphate levels above 300 kg/ha. There was a response in the legume base to applied nitrogen in the second season suggesting an inability of the rhizobia to fix sufficient nitrogen to maximise growth potential at this stage in pasture development. Although several of these nitrogen treatments are uneconomical for farming practice, they were incorporated as a measure of nitrogen availability for production.

Of note was the effect of mechanical disturbance on these soils during border dyking. A considerable amount of the fines from the top of the borders was moved and deposited on the bottom third. Resultant differences in production from these two areas was 3 t/ha.

In conclusion the two main impressions we have from these two trials are:

- The large increases in plant growth, to be achieved by irrigation in these inland basins;
- The importance of legumes relative to grasses, at least during the first few years of irrigation development.

ACKNOWLEDGEMENTS

To the runholders for use of land and to the Ministry of Agriculture and Fisheries.

THE TORLESSE RESEARCH AREA

Written for the participants
by John A. Hayward
Tussock Grasslands and Mountain Lands Institute

In "Hold this Land," Lance McCaskill records something of the early concern for, and debate about, the eroded condition of New Zealand's mountain land. He notes the surveys of Gibbs and Raeside, the descriptions of Zotor and Cumberland, the reports of the 1939 Committee of Inquiry, the 1949 Sheep Industry Commission and the 1954 Tussock Grassland Research Committee. However, McCaskill records little about erosion research.

This is no oversight, but a reflection of our tendency to talk about erosion without seriously attempting to understand it.

In 1962 Cutler wrote: "Nowhere in New Zealand soils literature can one find any measurements pertaining to the stability of soils on steep slopes. Such measurements are necessary and indeed fundamental to studies of soil formation and the stabilisation of eroded soils on steep slopes."

Since 1962, however, studies have been made of certain aspects of high altitude slope stability.

Owens (1967) studied mass movement in the Chilton Valley (Waimakariri Catchment) and found velocity profiles comparable to rates measured in other temperate areas. He suggested that the main cause of soil creep was related to the freezing and thawing of soil moisture. (This was also considered to be the main cause of scree movement recorded at two sites). Gradwell (1960 and other papers) and Soons and Greenland (1970) observed needle ice and noted that the growth of ice needles depends mainly on the rate of heat loss and the availability of water. Hayward and Barton (1969) used movie film to record the disruptive action of needle ice and showed 22 freeze-thaw sequences move surface material up to one metre down slope.

Although soil frost is itself a cause of erosion, it is probably a more important conditioner of soil for removal by wind. Butterfield (1971) measured wind-borne soil at three sites and has provided a better understanding of the factors which influence this loss. From 1964 to 1968 Soons (1971) recorded soil erosion from $4m^2$ plots and found a high degree of variability in the controlling

PHOTOS: W. G. KREGER

The Torlesse catchment. Mount Torlesse, the highest point, is in the background. The sediment trap is 100 metres downstream.

factors. Variability was also a principal feature of Hayward's (1969) study. It was found that erosion could be measured reliably by runoff plots only if a very large number of plots was used. Valuable as these studies have been, they do not satisfy the needs expressed by Cutler.

The lack of information about erosion has hampered those concerned with the management of mountain lands. It has been widely recognised that these lands produce a large proportion of our water resource and that the usefulness of this water is often impaired by large sediment loads and high turbidities. Further, an estimated doubling of New Zealand's population in the next 30 years will result in increased demands for the use of eroded alpine land and greatly increased demands for all uses of the water derived from it.

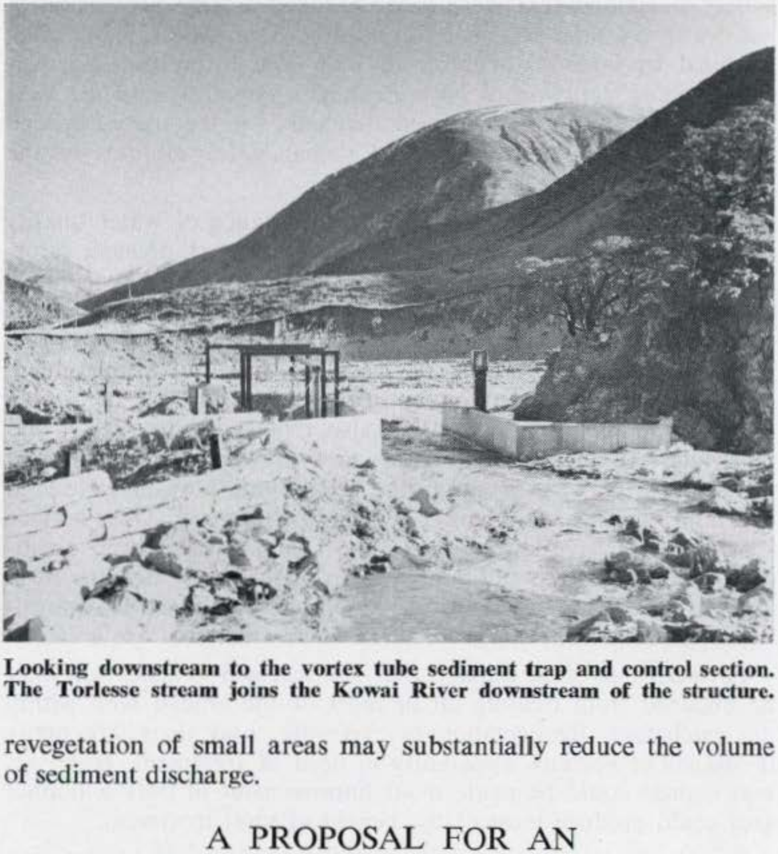
Land managers have stressed the importance of water quality as an objective of management. However, the lack of basic information has meant that only general statements have been made about the likely benefits to be derived from an improvement in the condition of eroded land. For example, soil conservation run plans frequently include the general statement that "an improvement in the condition of eroded, high-altitude land will reduce the supply of debris to the stream and will also reduce the frequency and severity of flooding." A feature of proposals for future land management is the assumption that rehabilitation of unstable land will result in improved channel conditions. However, O'Loughlin's studies (1969) have shown that some channels have been drastically modified by the addition of large quantities of detritus from accelerated erosion. In these unstable channels immediate downstream benefits from upper catchment land treatment are unlikely.

Further, it is often implied that downstream benefits will only be obtained from treating all or most of the eroded land within the catchment. Revegetation is expensive, and there are many thousands of hectares apparently in need of treatment. However, real savings could be made if an improvement of only a limited area could produce most of the benefit of total treatment.

Conversely, the search for lower-cost techniques of revegetation (Holloway 1969) could be less important if the area in need of treatment could be shown to be substantially smaller than previously thought.

It is a common observation, both here and elsewhere in the world, that some parts of a catchment are more important than others as sources of stream sediments. For example, in times of flood, stream beds and margins may be the most important sources of sediment. Hence it is possible that in many catchments the

Two open tubes are imbedded in the floor of this controlled section of stream channel. Bed sediments fall into the tubes and are discharged through the sidewall into a steel basket in the work pit. When the basket is full, it is removed and weighed. The sediment is then dumped back into the stream below the structure.

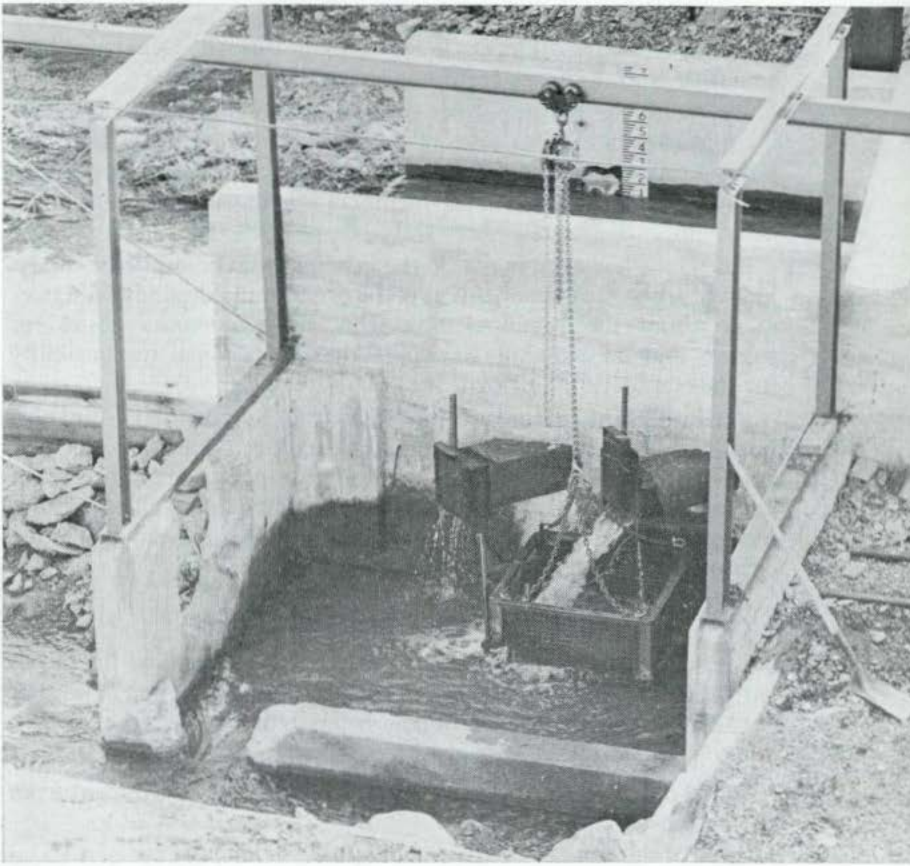


Looking downstream to the vortex tube sediment trap and control section. The Torlesse stream joins the Kowai River downstream of the structure.

revegetation of small areas may substantially reduce the volume of sediment discharge.

A PROPOSAL FOR AN INTERDISCIPLINARY STUDY

In review, two things become clear. First, until information is available about sources and quantities of stream sediment, revegetation for erosion control of mountain lands will be confined to trial sites. Second, understanding the complex relation between land erosion and stream sedimentation needs skills from hydrology, engineering, geomorphology, physics, geology, meteorology, soil and other sciences.



The Torlesse Stream vortex tube sediment trap showing the work pit.

It was, therefore, resolved to set up a co-operative, inter-disciplinary study in one catchment in an attempt to understand its behaviour and likely response to treatment. From the outset this project was designed as a study in understanding the many aspects of catchment behaviour. It was not intended to be an investigation in which treatments would be applied and the responses to treatment monitored.

The original participants in this proposal included Dr D. J. Painter (N.Z. Agricultural Engineering Institute, Lincoln College), Dr A. J. Sutherland (Civil Engineering Department, University of Canterbury) and Dr J. M. Soons (Geography Department, University of Canterbury). Also associated with the proposal were Dr W. McCave (N.Z. Institute of Nuclear Sciences), Mr A. Ryan

(N.Z. Meteorological Service), Mr R. D. Dick (North Canterbury Catchment Board), Dr D. W. Ives (Soil Bureau, Department of Scientific and Industrial Research) and the author.

By focussing the expertise of scientists of different disciplines on this one catchment and by freely exchanging ideas, data and interpretations, it was hoped that a group could produce better answers than its component members could yield by working in isolation.

There are few arguments on the benefits from co-operative study. However, the success of this type of programme depends on agreement about the principal objectives, on a common desire for success and on individual scientists having personal responsibility for the conduct of their own studies.

An important feature of this study was its potential to involve post-graduate students from several faculties. One aim was that students should concentrate their talents in one area instead of working at a variety of locations. By sharing travelling, equipment, and other facilities, it was hoped to make real savings in the cost of doing research.

AIMS AND OBJECTIVES

The main aim of the Torlesse project is to understand the physical processes operating in an eroding mountain catchment so that predictive models for catchment behaviour can be developed.

To achieve this aim, five primary objectives were agreed to:

1. To determine the quantity and rate of loss of sediment from the catchment;
2. To determine the origins of stream sediment;
3. To determine rates and mechanisms of soil erosion;
4. To determine rates and mechanisms of channel erosion;
5. To predict likely responses to changes in land and channel management.

It was jointly agreed that the first objective had highest priority. For component studies to have real relevance each must be able to relate its findings to the catchment's total erosion and sediment output.

THE SELECTION OF A STUDY AREA

Many catchments were considered and judged against the following criteria:

1. The area had to be a moderately to severely eroded mountain catchment;
2. The area had to be close enough to Christchurch to allow

gauging parties to reach the catchment in time to make observations during storms and to record sediment discharge during floods;

3. Access had to be certain in times of flood;
4. The catchment had to be small enough to —
   (a) allow the hydrologic effects of a variety of surface conditions to be studied and
   (b) produce manageable peak discharges;
5. The catchment had to be large enough to allow studies of channel behaviour;
6. The catchment outfall had to be stable and suitable for a gauging and sediment measuring station (i.e. the establishing of a control section would not alter the hydraulic behaviour of the channel).

A 385ha catchment on Brooksdale Station of south-east aspect on the Torlesse Range was chosen as the one most closely meeting all criteria. It is a steep basin ranging in altitude from 760m to about 2000m in just over 3 km. It is about 80 km from Christchurch. Traditionally the basin has provided summer grazing for sheep, but it will be retired from grazing under a North Canterbury Catchment Board conservation run plan.

STUDIES COMPLETED OR IN PROGRESS

Objective 1

To determine the quantity and rate of loss of sediment from the catchment.

Stream Sediments

Mr John A. Hayward, Tussock Grasslands & Mountain Lands Institute.

A vortex tube sediment trap and base hut were built by staff of the Institute with financial support from the Nuffield Foundation. The design, function and first results have been described by Hayward and Sutherland (1974) (continuing).

Wind-borne Sediments

Mr E. J. B. Cutler (Soil Science Dept., Lincoln College).

Dust traps have been set up within the basin to assess the importance of wind erosion as a mechanism of soil loss from the catchment (continuing).

Objective 2

To determine the origins of stream sediments.

Mr R. Martin from Geography Department, University of Can-

The velocity head rod is a quick way of estimating a stream's velocity. Such estimates are needed for the stream flow and stream energy studies being carried out within this project.

terbury, studied grain size and nature of stream bed material in an attempt to understand the importance of subcatchments as contributors of bed load sediments (completed).

John A. Hayward, R.P. Stratford, Tussock Grasslands and Mountain Lands Institute.

Investigations of source areas of suspended and bed load sediments. Preliminary results indicate that a majority of stream sediments are derived from very small local areas of stream channel and riparian land (continuing).

Objective 3

To determine rates and mechanisms of soil erosion.

Mr R. H. Dick, D. H. Saunders and others, North Canterbury Catchment Board. Land inventory survey, land capability plan, and erosion assessments (completed).

Prof. J. M. Soons, Mr R. D. Baldwin from Geography Department, University of Canterbury, studied the occurrence, form, and sedimentology of a number of rock debris slopes and the factors which may affect their stability (completed).

Dr B. P. J. Molloy, Botany Division, Department of Scientific and Industrial Research. An investigation into the pre-European history of the basin with emphasis on changes in vegetation and slope stability (continuing).

Objective 4

To determine rates and mechanisms of channel erosion.

Dr A. J. Sutherland, Civil Engineering Department, University of Canterbury.

Dr T. R. Davies, Department of Agricultural Engineering, Lincoln College.

Laboratory studies of sediment entrainment, transport and deposition are being undertaken at the University of Canterbury and Lincoln College. While these are not necessarily specific to the Kowai River, they supplement field studies within the Torlesse project (continuing).

J. A. Hayward, R. J. Blakely, Tussock Grasslands & Mountain Lands Institute. Investigations into relations between channel morphology, channel stability, and the dissipation of stream energy (continuing).

Objective 5

To predict likely responses to changes in land and channel management.

Most watershed studies assume that catchments which have similar size, soils, vegetation, etc., will show similar responses to changes in land management. However, because of the problems in testing the validity of this assumption the participants are of the opinion that findings are likely to be extrapolated with greater confidence if they are made on the basis of measurable physical properties of the watershed and its resources. To this end several participants are directing their attentions to definitive descriptions of the watershed.

GEOLOGY

Mr David Bell, Mrs Jocelyn Campbell, Geology Department, University of Canterbury, descriptions of the geological characteristics of the basin.

Mr M. Mardin, chronology of fan and terrace deposits within the Kowai River system (continuing).

Mr Lindsay Main, geological structure of the Torlesse catchment (continuing).

VEGETATION

Dr G. T. Daly, Plant Science Department, Lincoln College, a description of plant communities and processes within the Torlesse catchments (continuing).

SOILS

Mr R. D. Dick and staff, North Canterbury Catchment Board, reconnaissance survey of soils (completed).

Mr P. H. Tonkin, Soil Science Department, Lincoln College, site descriptions and soil processes (continuing).

SURVEY & PHOTOGRAMMETRIC CONTROL

Mr D. Gordon, Civil Engineering Department, Canterbury University, aerial photo control and topographic mapping of the Kowai river catchment (continuing).

ANIMAL GRAZING BEHAVIOUR

Mr R. P. Stratford, Mr J. G. Hughes, distribution of sheep grazing within the Torlesse catchment (completed).

CONCLUSION

This is an exciting project. The individual studies are stimulating, but it is the interaction between participants that is most rewarding.

Erosion and stream sedimentations have been found to be extremely complex and variable phenomena. Even at this early stage it is clear that former models are gross oversimplifications of the real behaviour of steep and mountain lands.

At present our understanding of catchment behaviour and the likely response to treatment is largely qualitative. For the immediate future much of our effort will be directed toward more quantitative assessments.

ACKNOWLEDGMENTS

The participants wish to express their real gratitude to Maurice and Helen Milliken and to the Trustees of Brooksdale Station for their interest, tolerance and assistance with this project.

To the Nuffield Foundation the participants express their gratitude for a grant of $3000 towards the cost of the vortex tube sediment trap, base hut and facilities.

To Mr Alan Ryan and staff, Meteorological Service, N.Z. Ministry of Transport, Christchurch, for early warnings of storm events.

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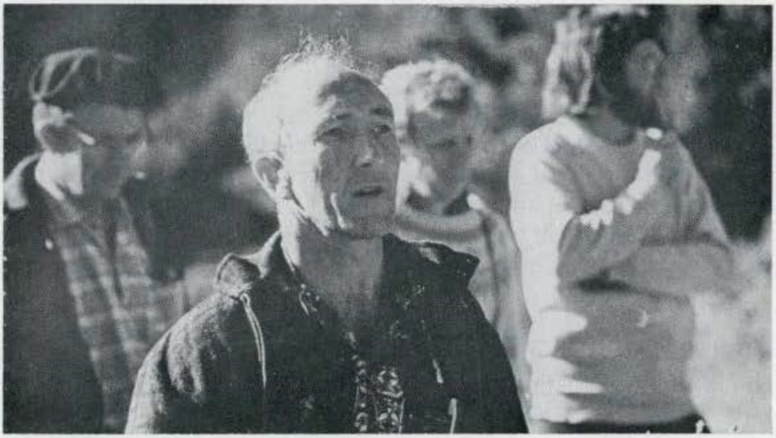


Alan Nordmeyer, Forest and Range Experiment Station, Rangiora, discusses results of his experimental work in the Craigieburn Range.

REVEGETATION OF MOUNTAIN LANDS

Those involved in mountain land management received a practical insight into the problems associated with revegetation in April this year.

A residential course at Lincoln College was conducted by the Tussock Grasslands and Mountain Lands Institute for staff of catchment authorities and other land management bodies. The purpose of the course, held from 7 to 11 April, was to inform and to encourage an exchange of information that would, in turn, lead to sound revegetation proposals.

Dr K. F. O'Connor, Institute director, ran the course with assistance from other members of TGMLI and from invited officers of the New Zealand Forest Service, Department of Lands and Survey and the Water and Soil Division of the Ministry of Works and Development. The course was held under the auspices of the Water and Soil Division.

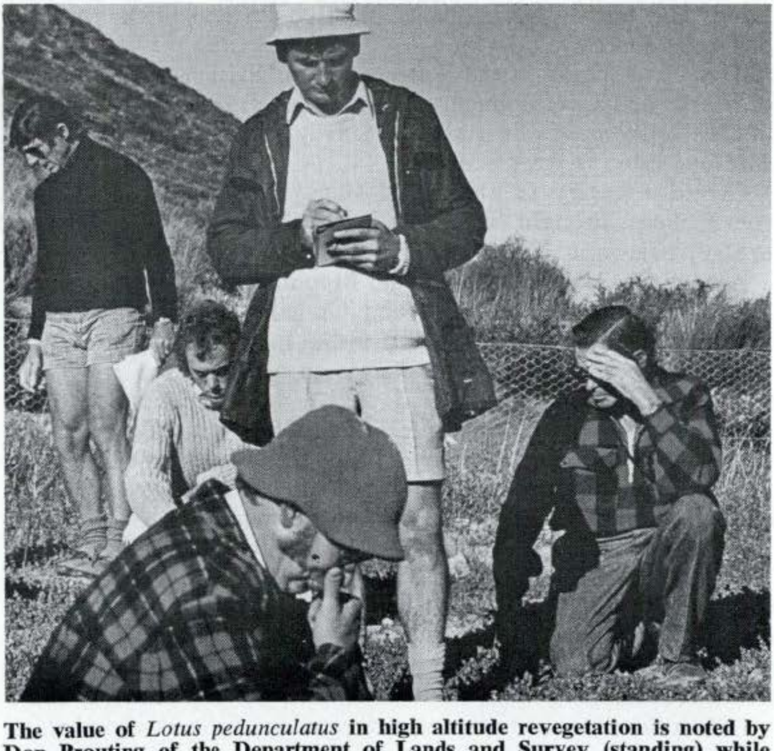
Thirty participants in the course — including two women — were drawn from the Ministry of Works and Development, the Marlborough, North Canterbury, Otago and Southland catchment boards, the Waitaki Catchment Commission, the Department of Lands and Survey, the New Zealand Forest Service, the Ministry of Agriculture and Fisheries and Victoria University of Wellington.

On the first day, the structure and objectives of the course were outlined and participants were briefed on agency policies covering mountain land management and revegetation objectives. After a short history of revegetation experience, the participants were presented with an outline of the problems and opportunities associated with revegetation placed in geographic perspective.

Next on the agenda was a detailed discussion of the location of revegetation projects and the identification of zones of instability or of possible vegetation influence. In this phase the question was posed: why and where do we attempt — or not attempt — to revegetate?

On the second day of the course, site definition, selection and interpretation was covered, including the application of Land Capability Unit principles. Specific topics included criteria for revegetation site selection, the ascribing of priorities among selected sites and vegetation aids to site selection.

Following the discussion of sites, the course turned to materials and methods. Typical subjects were the desirable characteristics of



The value of *Lotus pedunculatus* in high altitude revegetation is noted by Don Prouting of the Department of Lands and Survey (standing) while others look closely at the situation.

fertilisers and plant materials for herbaceous revegetation.

Armed with the theory presented in the first two days, the participants moved into the field the third day. They were grouped into "syndicates," each faced with the assignment of drawing up proposals for a real piece of eroded mountain land. Practical questions were answered in the field by staff of the Forest and Range Experiment Station of New Zealand Forest Service and Department of Lands and Survey.

Opportunity was taken to inspect revegetation experiments at the Craigieburn headquarters of the Forest and Range Experiment Station.

Following the field exercise, each syndicate presented its proposals back in the classroom. These proposals were, in turn, constructively criticised and related to administrative policies of the national organizations involved.

Particularly invaluable were the experience and knowledge of such people as Ash Cunningham of the Forest Service, Napier; Alan Nordmeyer, Gordon Baker and Nick Ledgard of the Forest and Range Experiment Station, Rangiora; Don Prouting of the Lands and Survey Department; and Rod Prickett of the Ministry of Works and Development.

Tony Warrington of the Water and Soil Division of the Ministry of Works and Development, and Ian Mitchell from the head office of the Department of Lands and Survey ably brought the administrators' views to the discussions.

Gerald Frengley of the Farm Management Department, Lincoln College, brought his expert knowledge of economic analysis to the participants.

Among Tussock Grasslands and Mountain Lands Institute staff involved were John Hayward and Graham Dunbar. Peter Williams, a doctoral student attached to the Institute, also gave participants the benefit of his experience in assessing soil conditions from vegetation indicators.

Few, if any, left the course feeling that they had all the answers for immediate application to the complex problems of revegetation. But they all appreciated the opportunity for inter-agency liaison and most probably felt themselves better equipped to define the problems in their own immediate districts.

Perhaps of special value was the way the course was developed so that participants could first learn to assess the agronomic possibilities of revegetation within a cost constraint and then move on to consider the wider environmental implications including possible afforestation, water regime and sediment regime influences.

Definition of objectives for revegetation plans is expected to improve as a consequence of the course.

PHOTOS: G. A. DUNBAR TRANSPARENCIES

Grazing lands with remnant forest at 1500-2000m in the Western Pyrenees.

ASPECTS OF GRAZING USE IN THE PYRENEES

G. A. Dunbar
Tussock Grasslands and Mountain Lands Institute

The Renault climbs steadily on the road winding up through the dense beech forest. Cloud is about us and finally engulfs us as we reach the summit. But then, almost immediately, we burst through into sunshine and see open grassland as we leave the influence of the moisture-bearing sea breezes. If we continue to descend another 1000 metres we will soon pass through lands parched by high summer.

No, we have not just crossed over the alpine backbone of the South Island of New Zealand, even if the Föhn wind effect is similar to our north-wester. We are not even in the southern hemisphere, for the beech forest is European beech, *Fagus sylvatica*, the pass we have just crossed is at 1640 metres, and there are no familiar tall tussocks gathering the mist in the forest clearings.

The "bell sheep" from a flock of the Rasa breed recently returned from mountain grazing. The flock will lamb in autumn to supply the Christmas market.

This is the western or Atlantic end of the high Pyrenees, or Piriñeos as we should call them on the southern, Spanish flank.

FERTILE

Here there are no shingle screes fingering down the mountainside, no shattered greywackes. Soils generally are far more fertile than in our steeplands and seldom more than moderately acid. Legume species occur naturally in the grasslands. Strains of red, white and alpine clover, and of *Lotus* grow up to 2000 metres altitude and, together with turf-forming grasses and other herbs, form a dense protective ground cover.

It has not always been this way. The upper limit of natural forest cover is at about 2300 metres and natural fescue dominant grassland (*Festuca scoparium*) occurs above this altitude. In the alpine region of moderate to high rainfall, most of the grassland on the sunny, southern slopes has been induced. On mid slopes the 1500 mm of rainfall would have supported beech and fir forest but much of this has been gone for about 400 years. Despite these centuries of close grazing by domestic stock, there is little evidence of active erosion. Admittedly, many of the slopes are moderate by our standards, but parent material is probably the major influence

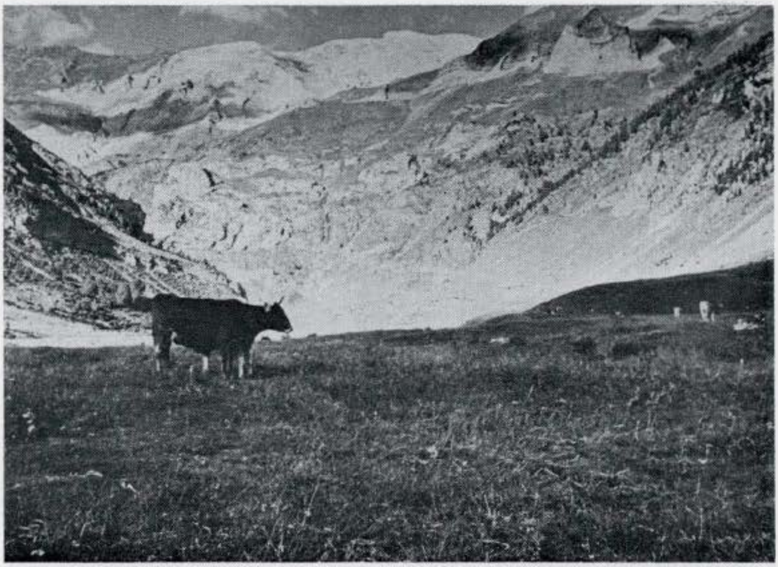
Older buildings in the mountain village of Hecho. The rounded chimney is a feature of this part of the Pyrenees.

in this stability. Occasional stark exposures of limestone dip slopes bear testimony to the nature of the geology.

Many of the pasture grasses are similar to our own adventive species: fescues, danthonia, sweet vernal, dogstail and bentgrasses, while herbs such as *Calluna, Potentilla* and *Euphrasia* add variety and colour. One European grass common in the Pyrenees is still, fortunately, rather scarce in New Zealand. This is mat grass (*Nardus stricta*), perhaps more commonly known by its generic name Nardus. Nardus runs to seed very early and becomes dry and unpalatable at the beginning of June. Free ranging mobs of horses, less frequent now than of old, are said to have helped keep Nardus in check. In early spring horses scratching in the snow for food uncover the grass and graze before it runs to seed.

OWNERSHIP

These mountain grazing lands belong to the village communities. The grazing herds and flocks, however, usually belong to someone from well outside the community. The flocks in particular will take part in a traditional system of transhumance. With some Spanish friends one evening I watched a large band of sheep descending to the valley floor to camp with their two herders for the night. There were 1280 sheep in this particular flock, owned by a 19-year-old



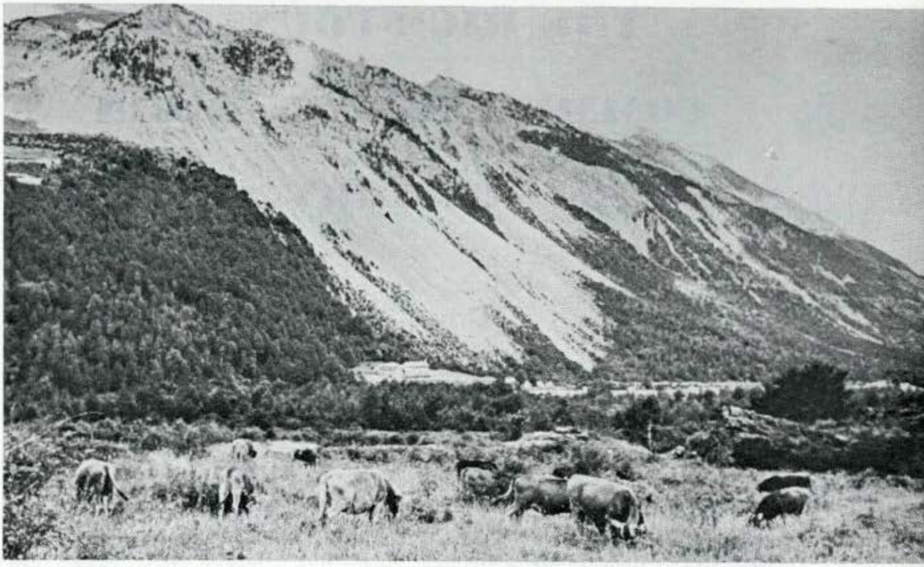
Summer grazing by cattle, mainly Brown Swiss, in the Central Pyrenees. The valley floor at 1700m has abundant clovers. ***Pinus uncinata*** **at the top right is at the limit for forest.**

slaughterman in the city. They belonged to a breed called Palomar, selected for their meat rather than for wool or milking.

As of tradition, the ewes had wintered on the plains, and had lambed there in winter. The lambs, fattened on milk and grass, had been sold at about 20-25 kg live weight before the flock had been moved on foot to the mountains. A few ewes would lamb at the end of the mountain grazing in September to provide fresh lamb for the Christmas market. Sold at about 15-20 kg live weight, these lambs would fetch a very good price in the cities, bringing in about \$1.75 (N.Z.) per kg live weight.

As with many mountain sheep in Europe, wool yield is not very highly regarded. For this particular flock the yield was only about 1½-2 kg per head. The men had shorn the flock themselves with blades, averaging a little over 100 per man, in a day stretching from daylight to dark. For their year's work with the flock these shepherds earn about 30,000 pesetas (about \$375 N.Z.), plus keep.

On the grazing lands of the particular community we visited, some 13,000 sheep grazed over an area of 4000 hectares, ranging from 1500-2000 metres altitude. For the four-month period from early June to late September, grazing intensity is about 3.2 sheep per hectare. The village community will receive in rent about 12 pesetas (15 cents) per head of sheep. Not a large return per hectare,



Limestone scree, not greywacke, is a feature of this mountain scene near one of the highest mountains of the Central Pyrenees, Monte Perdido. The forest is mainly European beech.

but for a community leasing grazing to 13,000 sheep, a return of \$1,950 N.Z.

PATTERN

Frequently the grazing pattern set is for cows to graze ahead of the sheep — progressively moving up in altitude. Cows belong to a beef breed with individual herds of about 70 per owner, probably Brown Swiss, Charolais crossed with Piriñaico Red or possibly the black Avilena. Again it is unlikely that they will belong to anyone in the village community.

It is not surprising, perhaps, in these times that it is becoming more and more difficult to find men to herd the flocks, even in a country which has traditionally provided herders for other parts of the world. Fewer herders means less mountain grazing which, in turn, means less money coming into the villages from the grazing leases. Thus, the decline in the village communities, marked already by a movement of young people to the cities, is accentuated. Perhaps the answer lies in attempting to develop a system where the village lands are grazed by village stock or in developing a no-herding system of use. It would certainly be a pity and rather a waste of resources to see pastoral use disappear completely from this pleasant, productive land.

THE HIGH-COUNTRY COMMITTEE — AN EARLY HISTORY

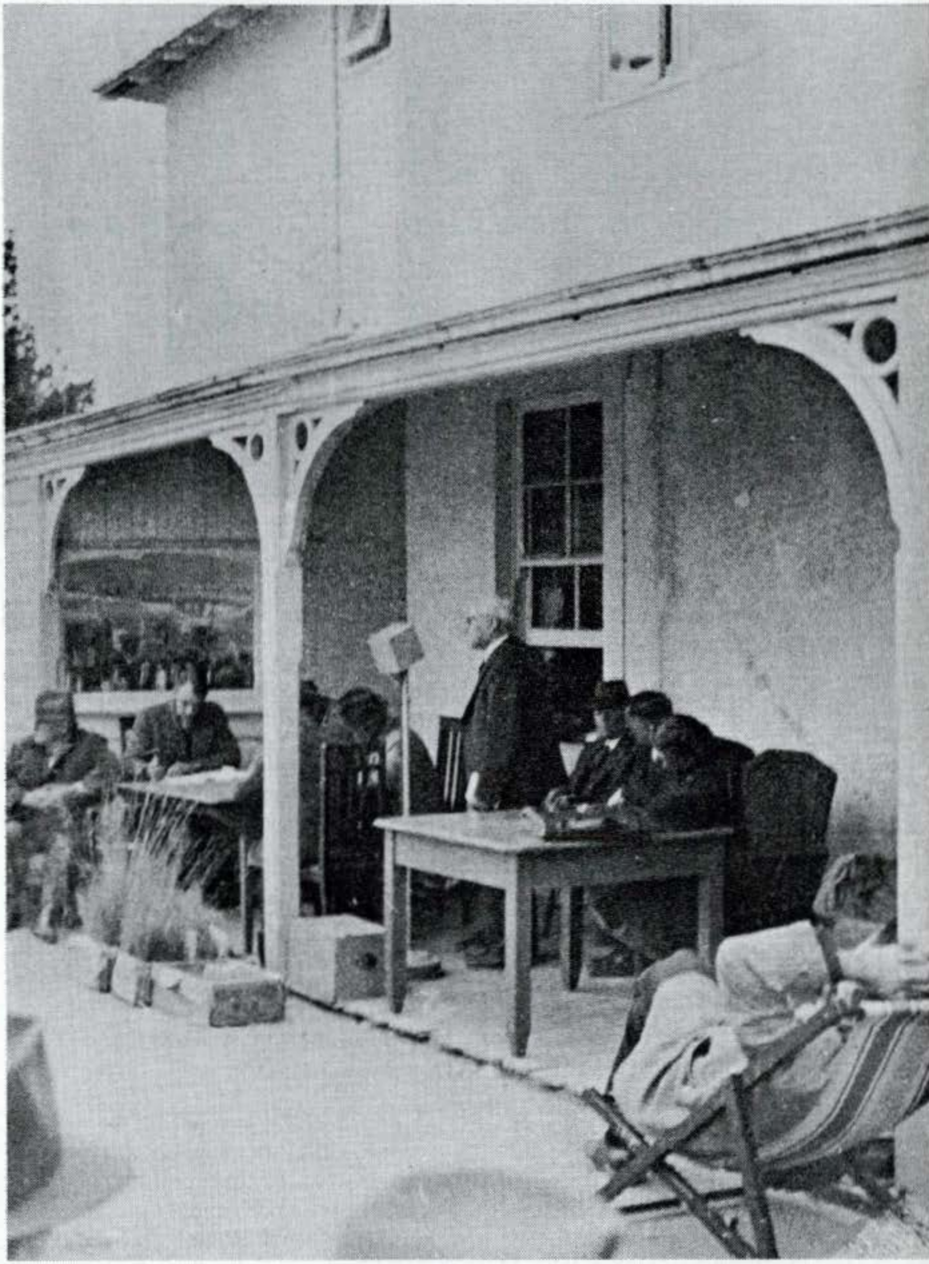
David McLeod

It would surprise many people to learn that the High-Country Committee of Federated Farmers was first constituted as an advisory board to the Minister of Lands. It might even surprise the Minister himself — although care has always been taken by successive chairmen to meet each Minister as soon as possible after his appointment and establish a relationship.

After the depression years of the early 30's, farming generally began to recover, but the fine wools upon which the high-country depended almost entirely rose to satisfactory levels only briefly and the long years of decay had taken their toll of maintenance and investment. Besides the economic factors, there was another very disturbing one: 80 years of extensive grazing by sheep and by rabbits and other noxious animals had reduced the virgin fertility of the mountain grasslands to a point at which their productivity was falling.

Altogether, there was a very real danger of high-country farming becoming an uneconomic industry.

There were few influential men sufficiently interested to try to remedy the situation and it would be fair to say that none had any idea what the remedies might be. There were two, however, who were prepared to take the initiative: Mr T. D. Burnett of Mt Cook Station, the Member of Parliament for Temuka, and Mr R. C. Todhunter of Blackford and Lake Heron. Between them they arranged a meeting of runholders at Tekapo on 19 April, 1939, to which the Minister of Agriculture, Mr Lee Martin, was invited. At this meeting it was agreed that such a gathering should be held annually and the "Press" report states that the Minister promised to attend, although the writer's recollection is that he said that the problems outlined mainly concerned the Minister



HON. LEE MARTIN, Minister of Agriculture, on the porch of Tekapo House addressing the first meeting of the High-Country Committee. T. D. Burnett M.P. is seated at far left.

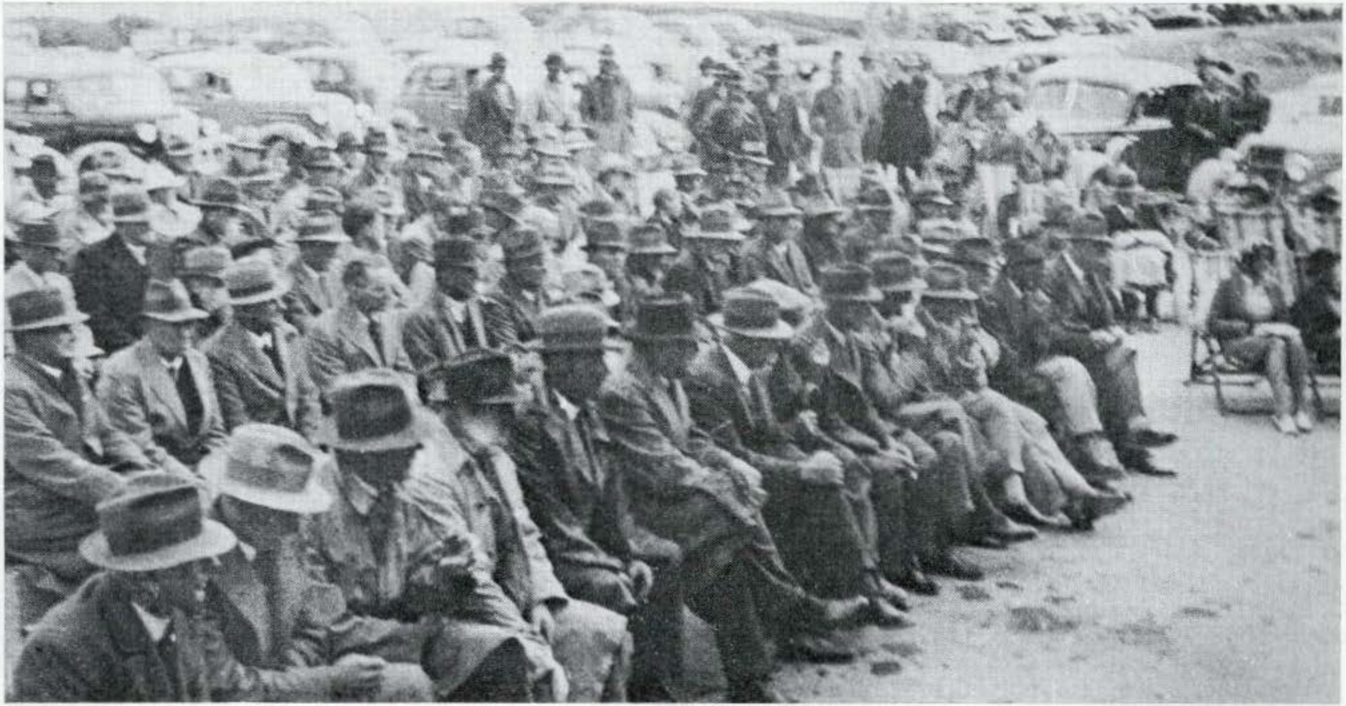
T. D. BURNETT

R. C. TODHUNTER

of Lands and not himself. A runholders' committee was elected consisting of:

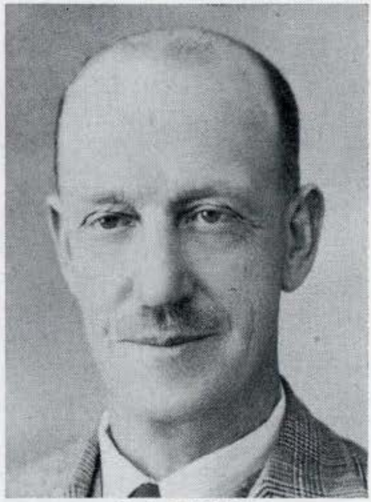
A. P. H. Burbury, Chairman, Glynn Wye.
C. A. Parker, Secretary, Holbrook.
A. J. Murray, Woodbank Station, Clarence Bridge.
J. McKenzie, Walter Peak Station, Queenstown.
D. Jardine, Kawerau Falls Station, Queenstown.
W. Scaife, Glendhu Station, Wanaka.
E. C. Latter, Cloudy Range Station, Waiau.
H. C. Acton-Adams, Clarence Reserve.
F. E. Fairweather, Wairau Valley.
D. McLeod, Grasmere Station, Cass.
W. J. A. MacGregor, Mt Linton Station, Ohai.
J. S. Hazlett, Burwood Station, Mossburn.
P. O'Malley, Mt Pisa Station, Wanaka.

The following year the second such meeting took place on 18 and 19 April and, thanks to the work of this committee, it was extremely well attended. High-country men and some of their wives came from every province from Marlborough to Southland. On this occasion the Minister of Lands was the chief Government representative, attended by Mr McMorran, Under-Secretary for Lands, and the commissioners of Crown lands for Canterbury and



RUNHOLDERS at the first meeting of the High-Country Committee at Lake Tekapo in 1939. Many slept in tents as accommodation was limited.

W. SCAIFE



C. A. PARKER

Otago. The Tekapo Hotel was able to contain only the official party and some of the more important delegates, and the remainder, which included the writer and his wife, were housed in tents in the adjacent Public Works camp.

Preliminary discussions took place before the arrival of the ministerial party and, in order that people today may understand the thinking of that period, it will be necessary to explain some of the background of these discussions.

ADMINISTRATION

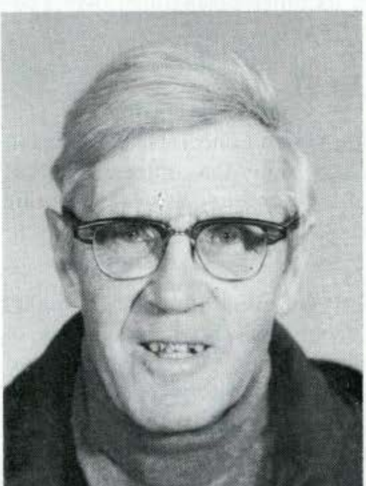
The economic situation has already been described but, since there was no means of raising the world demand, and thus the price of wool, the only approach to the problems of the area was through administration and research. The Department of Lands and Survey was the main administrative body and it had grown up as an organisation charged with surveying Crown lands and offering them on various tenures to eager seeking tenants. This had been accomplished for many years by a simple system of leasing them to the highest bidder at auction. All the senior local administrators — the commissioners of Crown lands — came from the Survey Branch of the department and there was no incentive for any officer to interest himself in the pastoral use or profitability of the land concerned, as long as the rent was paid.

In the Mackenzie Country particularly there were wide variations in the level of rent per sheep between different properties which many of the tenants considered unjustified by the productivity of the land. The leader of the attack from this district was Mr C. A. Parker of Holbrook who objected to paying four shillings per sheep when other tenants were paying as little as 7d. He had prepared a list of the Mackenzie Country runs comparing their relative rents, areas and carrying capacity in 1895 and 1936.

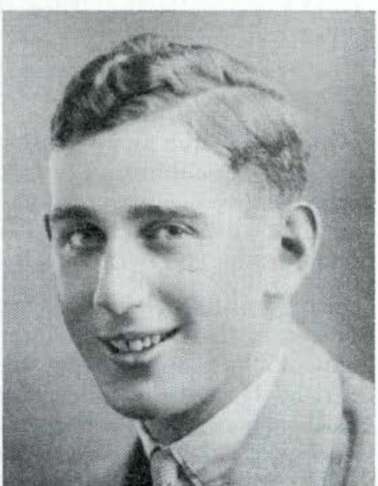
The commissioners of Crown lands were assisted in their administration by land boards in each district and it was claimed that none of the members of these boards had any knowledge of the high country.

PROPOSALS

What emerged from these discussions was a proposal that there should be a separate land board for pastoral and small grazing runs which, together, comprised the majority of high-country holdings. It was also suggested that a tribunal should be set up to revalue and review the rents for Crown land during the currency of the leases which varied considerably in their durations. A third demand was that, at the termination of a lease, the Crown should take over and pay for the outgoing tenant's improvements if there was no immediate incoming tenant. This reflected the very real fear of properties becoming unsaleable or being abandoned as in



D. MC LEOD



H. C. ACTON-ADAMS

J. S. HAZLETT

H. ACLAND

the case of Molesworth in 1937. The practice in such cases was for the Lands and Survey Department to offer the lease for selection, loaded with improvements, as valued by the Crown, at a rent fixed by the Crown. If the property failed to find a tenant, the value of the improvements was reduced but the rent remained the same. In other words, the Crown's equity was maintained and that of the old tenant reduced. This proposal became known in the department as the Todhunter clause from its chief protagonist, Mr Todhunter.

RESEARCH

On the research and extension side which concerned the Department of Agriculture, it was claimed that the officers of that department were equally ignorant of high-country pastoral farming and their advisory staff were fully occupied in servicing conventional farming in lower country.

The Minister rejected the request for separate land branches but agreed that he would accept an advisory board consisting of high-country runholders representing each of the provincial land districts. He also agreed to appoint a high-country man to each land board as seats became vacant. So was born the High-Country Committee as an advisory board to the Minister of Lands and in a letter from Mr Burnett to the Minister dated 17 June 1940, the following names were submitted:

D. R. ROWE, secretary of the High-Country Committee from 1949 to 1970, is second from the left in the front row of this picture taken in 1926 of the shepherd's mustering gang at Kawarau Falls and Glencoe stations when he was head shepherd. Third from the left in the front row is Dickson Jardine, member of the original committee formed in 1939.

W. H. NICHOLSON

W. MACHIN

Southland	W. J. A. MacGregor
Otago	John McKenzie Willis Scaife Arthur Munro
Canterbury	C. A. Parker R. C. Todhunter D. McLeod
Marlborough	A. J. Murray

The Minister was informed that, when the pastoral runholders and small grazing runholders had compiled a register and agreed upon an electoral basis, the board or committee would be elected.

This proved to be an impossible task and the system of nomination has persisted to this day. It was some years before vacancies permitted the appointment of members to land boards but this was done eventually and remained the custom until the land boards were superseded in 1948. But it still remains in the form of advisors to the land settlement committees.

Mr Todhunter was elected as the first chairman of the committee and held the position until 1944. It was not long before other important issues engaged the committee's attention. When war broke out in September 1939, an agreement was made between Britain, Australia, New Zealand and South Africa by which all wool was taken over by Britain and paid for by valuations under a price scale known as the Bareme. It was immediately agreed that the Bareme was very unfavourable to the finer wools, being based on the demand immediately prior to the war. Mr Todhunter was a prominent member of the Canterbury Sheepowners' Union and several meetings were held with Mr Henry Acland, its president, and Mr W. H. Nicholson, the secretary, to discuss what pressure could be brought to bear to give some more equitable premium to the finer wools.

Very few people know now that a change was in fact made about 1942 by which the New Zealand authorities stole a very small amount from the crossbred producers to add several pence a lb to the returns of the Merino and other finewool growers. The subject was far too hot for publicity and was never publicly discussed.

The next vital issue was the passing in 1941 of the Soil Conservation and Rivers Control Act.

Everyone is used to the system now but the horror with which high-country men regarded the creation of catchment boards on which ignorant men elected by city voters could dictate the use of pastoral land can only be imagined.

Fortunately, several far-seeing and intelligent men arose to chair the new boards and it was not long before Mr William Machin

P. R. WOODHOUSE

H. WARDELL

of the North Canterbury board and Dr Randall Woodhouse of the South Canterbury board, were holding discussions with the High-Country Committee about their proposed policy. Nonetheless, there was considerable alarm at Dr Woodhouse's suggestion that no lease should be renewed by the Lands and Survey Department without inspection and consent by the catchment board, and the writer had a perennial argument with him as to whether or not there should be any compensation for runholders whose grazing rights were modified by order of a catchment board.

The present system of subsidies for offsite grazing when land is retired is a vindication of the High-Country Committee's viewpoint on this question.

In June 1944 a meeting was held in Timaru to open discussions with a new Minister of Lands, Mr Skinner. At this meeting, Mr Todhunter resigned as chairman and the writer took his place and a notable new face appeared. Mr H. J. Wardell arrived with a carefully documented case setting out the need for a greater adjustment of fine wool prices to restore the profitability of the high country. He was obviously too good a man to leave outside an organisation and when, a year later, we nominated him for the newly created Wool Board, his wide knowledge and meticulous presentation gained him a rather unexpected seat. He went on of course to become chairman of the board and an ever ardent advocate of a satisfactory "relativity" between the price of Merino wool and the coarser qualities.

DISPOSAL

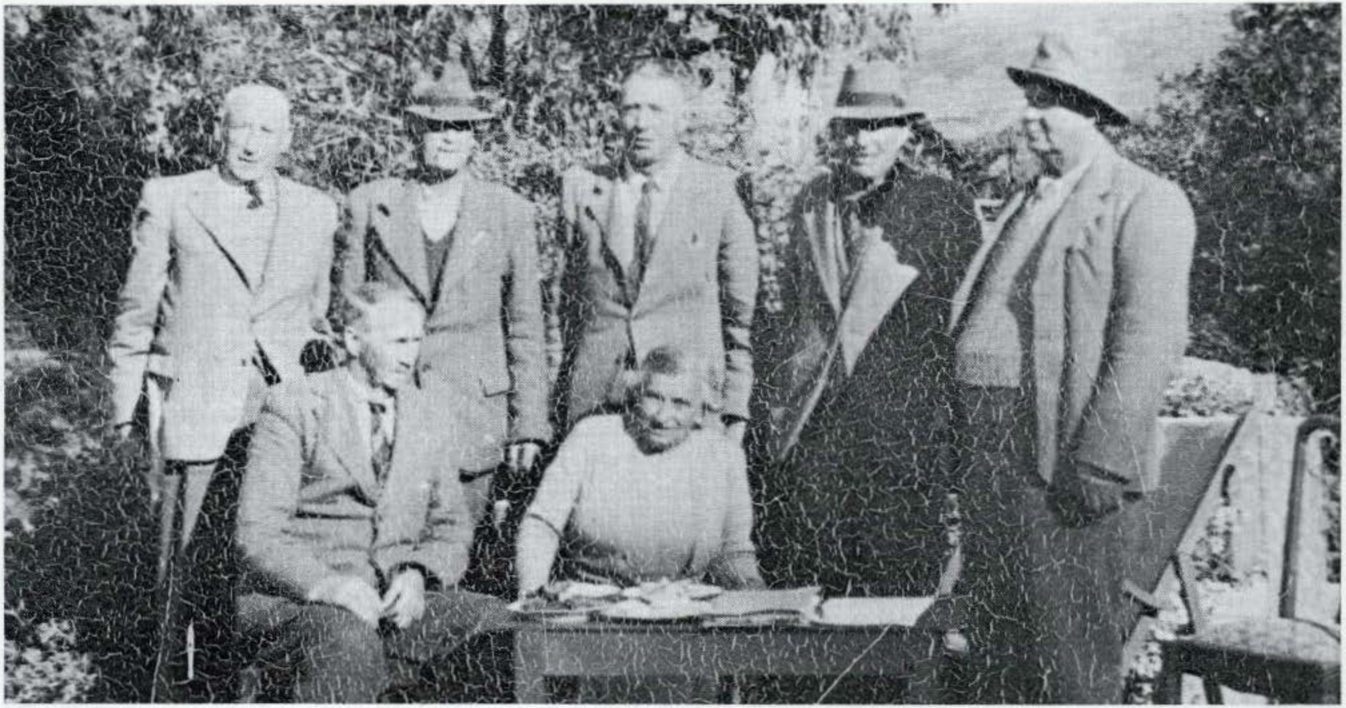
Events followed each other rapidly during the years 1945 and 1946. Just when we had hopes of some improvement in the fixed price of fine wool, the British Government asked for a conference to discuss the future system of marketing and the disposal of the huge stockpile of wool acquired during the war years.

Almost at the same time, the Sheepowners' Federation and the Farmers Union — two separate and none too friendly organisations — wisely decided to amalgamate and Federated Farmers was born.

It is distressing to those who took part in this combination, which did so much during the vital years which lay ahead to make the farmers' voice a strong and united one, to watch the attempts being made today to redivide it into "squatters and cockies."

Up until this time the High-Country Committee had been financed very informally, at first by its members paying all their own expenses and working for love of their country.

In 1945 the Mackenzie runholders voluntarily levied them-



THIS historic picture was taken at Mt Nicholas Station in 1948. Standing (from left) are Hugh Craswell, Hugh Mackenzie, John Hunt, John Mackenzie and Major Peter Mackenzie. Seated are Alec Mackenzie and Mrs Alec Mackenzie.

G. H. GRIGG

C. F. SKINNER

selves two guineas each and subscribed this sum to the committee to help with its expenses. This welcome donation inspired me to write to as large a number of runholders as possible and ask for similar contributions. The need was urgent because a proposal, postponed by the outbreak of war in 1939, for a Royal Commission on the sheepfarming industry had been revived by the poorer hill-country farmers of the North Island. This would require the collection of evidence on behalf of the high country and the preparation of the most elaborate and convincing submissions. This was an expensive and time-consuming business necessitating travelling, secretarial work and typing. The response was generous, amounting to £190 for the three years, 1945 to 1947.

When Federated Farmers was incorporated in 1946 we had already had many discussions with the president of the Sheepowners' Federation, Mr Gilbert Grigg, and had received assurances that we would be welcome to join it as a part of the Meat and Wool Section. It was at this stage that our present organisation of district subsections of the Meat and Wool Section, with representation by delegates at the provincial level and representation by the chairman at national level, was worked out.

As the current chairman, I was offered a place on the Dominion Lands Committee and even one, which I refused, on the Dominion Council.

Nobody could have expected a more generous welcome and, equally important, it envisaged a reasonable measure of our expenses being paid by the federation.

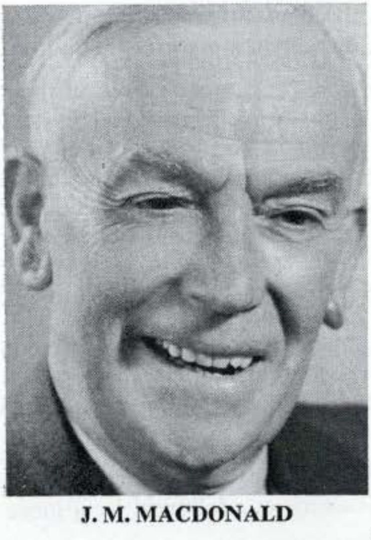
All I had to do was to ask the Minister of Lands if he would still accept us as his "advisors" now that we were "the High-Country Committee of Federated Farmers." To this request he consented in rather guarded terms.

The preparation of our case for the Royal Commission on sheep farming kept us busy for many months and one very cheering piece of news was that one of our original members, Mr Willis Scaife, was appointed to the commission. We knew that we could rely on one understanding judge.

ANXIETY

I need not describe the case which was prepared but there were certain aspects of it which are worth recording. Besides the specific cases of what we considered mal-administration, there was a demand for the Lands and Survey Department to take action to amalgamate, or regroup, uneconomic holdings. This reflected the anxiety of the smaller lessees with the price of wool at its war-time level. This demand died abruptly when the price rose after the end of the war and reached its peak in 1950-51. Uneconomic units became prosperous overnight.

One of our requests was for a fund which could be set aside



J. M. MACDONALD

D. M. GREIG

E. M. RELPH

C. G. CRAN

tax-free to provide against snow losses and the commission's approval led to the subsequent setting up of the Snow Loss Reserve Scheme.

The commission was half-way through its hearings when, to the astonishment of everybody, the Minister introduced into Parliament the 1948 Land Act.

It seemed obvious that the Lands and Survey Department was determined to show how ill-fitting the committee's criticisms were when they were preparing such an enlightened piece of legislation.

The members of the commission were furious and broke off their sittings so that some of them could go to Wellington and protest to Mr Skinner. It was ironic that the most vociferously indignant was one of the Labour Government's appointees, a former trade union secretary, Mr R. Eddy. They got no change out of Skinner and the bill and the commission went ahead.

CONTACTS

There was no doubt, however, that times had changed and, when Mr D. Greig became Director-General of Lands, the contacts between the department and the High-Country Committee became frequent and friendly.

The appointment of Mr John Macdonald as the first officer with special responsibility for pastoral country was followed by a more elaborate pastoral lands organisation with a chief pastoral lands officer and four district officers.

We owe to Mr E. M. Relph, for five years (1957-1962) the first chief P.L.O., backed by Mr C. G. Cran, one of our committee members who was appointed to the Land Settlement Board, the system of low rents in exchange for light stocking — the system which the department is now trying to abandon.

The Korean war produced the wool boom of 1950-51 and the writer, as chairman of the High-Country Committee, attended the meetings which planned the Wool Retention Scheme by which 33-1/3 percent of wool realisations was frozen in tax-free and interest-free accounts. It was at a North Canterbury High-Country Subsection meeting that Mr R. Free, a Christchurch accountant, proposed the scheme for spreading repayments over a fixed period which, ultimately, the Wool Retention Committee was persuaded to accept.

Unfortunately, the waterside workers' strike in 1951 stopped all sales of wool while the boom was at its peak and when sales were resumed the following spring the market had subsided to quite moderate levels. This was hard on many high-country runs whose wool was not ready for sale before autumn, by which time the sales had stopped.

In the early fifties, the committee began a campaign which, after nearly 10 years of negotiation, ended in 1960 with the creation

R. FREE

R. M. D. JOHNSON

of the Tussock Grasslands and Mountain Lands Institute. It had been a constantly recurring theme since the first Tekapo meeting that the high country was inadequately served in scientific research and the meetings which were held at Lincoln College between representatives of the Government departments concerned, Lincoln College staff and members of the High-Country Committee finally achieved their aim — an Institute dedicated to the development of high-country pastoral farming. The funds were to be provided by the Soil Conservation Council and its charter was weighed heavily in the direction of soil conservation. Its first chairman was Mr R. M. D. Johnson, chairman of the North Canterbury Catchment Board.

UNIQUE

This article is not a history of the High-Country Committee so much as the story of its inception and its early growth, for the benefit of the younger high-country men who only know it as their branch of Federated Farmers. Its organisation and its methods are very different from the rest of Federated Farmers because of its unique position in relation to the Minister of Lands and the right which this conveys to approach the administrator direct.

Its best work has always been done quietly from behind the scenes and has depended upon the tact, wisdom and ability of its chairman and members. It is significant that such a small organisation has provided two notable members of the Wool Board, a member of the Royal Commission on sheepfarming, two members of the Land Settlement Board, two chairmen of the Tussock Grasslands and Mountain Lands Institute and a member of the Land Use Advisory Council. It is also significant that this committee, born of distress and despair, can now boast that high-country pastoral farming is the fastest growing portion of all New Zealand farming activities.

Messrs T. D. Burnett and R. C. Todhunter deserved well of their country, as the Romans used to say.

Acknowledgement

Sincerest appreciation is extended to those many persons, agencies and organisations who co-operated so whole-heartedly in furnishing photographs—many of them quite rare—to illustrate the foregoing article on the early history of the High-Country Committee. Special gratitude is extended to the Christchurch *Press* for permitting access to their photographic files and use of the pictures obtained therefrom.—*Editor.*

ANNUAL REPORT OF THE

TUSSOCK GRASSLANDS AND

MOUNTAIN LANDS INSTITUTE

FOR THE YEAR 1973/74

PROGRESS IN WORK PROGRAMME

Although no new research sectors have been introduced into the approved work programme, substantial progress has been made in existing sectors, and salient features are summarised below:

EROSION SECTOR

The Torlesse sediment source and transport study has given substantial information, especially in the discharges monitored after the August 1973 snowstorm and the frequent minor storms of autumn 1974. Improvements were made in the sediment weighing apparatus, and studies were developed on changes in storage of riparian detritus and changes in channel gradients brought about by storm flows and sediment movement. Papers presented at the Hydrological Society Conference dealt with stream and sediment behaviour as measured by the vortex trap and flume, and the development of a solar heater to prevent freezing of gauging equipment. Sediment discharge has been found to exhibit an irregular wave behaviour, indicating the likely role of sediment supply from different riparian sources as a controlling factor.

REVEGETATION SECTOR

Subalpine field studies have been maintained throughout the South Island. A large scale oversowing by the Department of Lands and Survey at Tarndale was also monitored. Several years' research findings were reviewed in a paper prepared for the International Soil Congress at Moscow.

Studies of different lines or provenances of the native plume grass have been maintained at Haldon Station in the Mackenzie Basin and at Hunua and Coopers Creek in North Canterbury. Different lines of plume grass and different varieties of lucerne and other introduced plants have been studied for their responses to lime and phosphate on different soils, as a way of evaluating differential aptitude to soils of differing maturity. Progress has been made in applying these techniques to *Chionochloa* (tall tussock) species. Field studies of differential responses of *Lotus pedunculatus* and other legumes to levels of applied phosphate have been continued at several locations.

SYSTEMS SECTOR

The field and laboratory survey of tall tussock macro-element composition by a Ph.D. student, Mr P. A. Williams, has been completed and results are being compiled in a series of papers. His intensive study of mineral cycling in tall tussock systems at Paddle Hill Creek in the South Ashburton Catchment has nearly been completed. Sustained spring snow-pack before the departure overseas of one of the hydrologic collaborators has prevented the conclusion of geophysical and related hydrological appraisal of the Paddle Hill Creek Catchment.

INSECTS SECTOR

Results of several years of study of population ecology, diet, and grazing pressures of three species of alpine grasshoppers have been reported in a series of published papers. Localities from Nelson to Otago which were selected by a survey of observers as likely to have high grasshopper densities were assessed. Results have revealed the significance of grasshopper damage on slow-growing alpine vegetation. Insects infesting tall tussock flowers were studied as in previous years and the completed assessment of their significance to reproduction of tall tussock in the field will shortly be published.

MANAGEMENT SECTOR

The Institute work on diet selection by sheep, intensified in a field study at Brooksdale near Porters Pass, has involved comparison of three techniques of estimation of sheep diet: direct observation of pasture quadrates to determine specific frequency grazed and ungrazed; botanical identification of ingesta recovered from oesophageal fistulae in free-grazing sheep; and botanical identification of plant cuticle remains recovered from faecal pellets of free-grazing sheep. This programme has been carried out by Mr J. Stevens as a M.Agr.Sc. thesis project, with technical assistance from the Institute.

At Coopers Creek in North Canterbury the Institute has co-operated with Miss J. Radcliffe, Ministry of Agriculture and Fisheries, in monitoring the available dry matter and grazing pressure on sunny and shady slopes of an oversown and topdressed tussock grassland. The Institute also determined sheep diet by cuticle analysis of faecal samples collected twice monthly. This experiment is continuing, Institute attention being given principally to diet selection and measurement of available dry matter.

At Mesopotamia, Institute staff have measured the influence of time of closing of winter country from stock on the level of herbage available in the following winter and early spring. Early closing (midsummer) of a semi-improved fescue tussock grassland has resulted in a higher accumulation of dead herbage than from autumn closing but the only benefit in living material has been in more rapid growth of cocksfoot in early spring. Mr B. Allen, graduate student at the Biochemistry Department at Lincoln College, has evaluated the different components in terms of feed quality and these combined results will be prepared for publication. The field experiment is being continued with half the paddocks oversown with legumes and re-topdressed.

With assistance from the Department of Lands and Survey, the Institute carried out and published a survey of principal weeds on the Molesworth runs. The report indicates the importance of *Hieracium* as a weed threat.

Institute staff have collaborated with manufacturers and the New Zealand Agricultural Engineering Institute in preparing an Internal Report evaluating livestock weighing scales and in designing studies of animal behaviour with respect to fences.

RESOURCES SECTOR

Institute staff have completed the survey of pastoral production and pastoral land utilisation for all the high-country runs for 1972/73. Results of this survey have been published in the Institute's "Review" and a tabulated comparison of results for the years 1965-67 and 1971-73 also has been prepared for publication. Runholders' attitudes to deer control and their involvement in tourism have been surveyed and summarised results have been submitted to the Caucus Committee on Control of Noxious Animals.

Physiognomic classification of the vegetation in the Manorburn Experimental Basin has been carried out and transects established. A reference collection of the vegetation has been lodged with Botany Division, DSIR. Transects have been maintained in three silver tussock areas of South Canterbury. Re-assessment has begun of previously studied tall tussock areas to estimate influences of changes in grazing pressures and culture.

EXTENSION

There have been three issues of the Institute's "Review" and displays have been arranged at field days and shows. Potential revegetation areas have been visited at the request of Lands and Survey officers and with New Zealand Forest Service personnel and considerable numbers of specialists have visited Institute co-operative experimental projects. Lectures have been given by Institute staff for occasional courses and conferences.

Publications have been exchanged with some hundreds of overseas institutions and visitors to the Institute have come from Peru, the United States, Canada, Australia, Scotland and Africa. The Institute has become a member of the International Union for Conservation of Nature and Natural Resources (IUCN) and arrangements have begun at the Union's suggestion to host a workshop conference on the Conservation of High Mountain Resources at Lincoln College and in South Island mountain localities in February 1976. The National Commission for UNESCO has approved the designation of the Waitaki Catchment as an Integrating Unit for the national contribution to the international programme Man and Biosphere (MAB) and has allocated $1,200 per year for two years to assist the collation of information and special studies by graduate students on particular aspects of the relationships between man and his environment.

CO-ORDINATION OF RESEARCH

From its inception, the Institute has had as one of its objects "to provide a centre to facilitate the co-ordination of all research aimed to protect and improve the tussock grasslands and mountain lands." How is the Institute fulfilling this object?

THE CO-ORDINATION PROBLEM

Co-ordination of research is a vexed topic. It is an idea vigorously espoused by some and avoided or played down by others. Some consider it not only desirable but essential; others question or even reject its value. In part such disagreement arises from differences in interpretation. Although the essence of co-ordination is "arranging in harmonious relationship," different people put different emphasis on the arrangement. For some people, co-ordination implies direction; for others it implies a democratic consensus; for others it is interpreted merely as collation. Practising scientists tend to be more wary of directive co-ordination than do those persons with operational responsibilities who are dependent on the results of scientific research. Nevertheless, many, if not most, scientists will co-operate readily with scientists in other organisations if it is apparent this will advance the pace, chances of success or utility of their own work.

There are difficulties in attempting to have a high proportion of inter-organisational collaboration in the work programme of any scientific organisation. A multitude of co-operative projects on different planes and with persons in different organisations leads to complexities that make tidy administration of scientific organisations difficult, if not impossible. Some scientific organisations are like many university departments, discipline-oriented. Others, such as some of the divisions of DSIR, have a blend of discipline-oriented and programme-oriented work. While there are many opportunities for collaboration among these different kinds of organisations, there are perhaps as many opportunities for breakdown of orderly workable arrangements.

Those bodies with responsibility for advising Government or its agents on allocation of funds and staff may have different kinds of problems. Where the advisory body is concerned with national scientific effort, it has several responsibilities, including ensuring effective coverage of the essential fields of research without unnecessary overlap, counselling the investment of funds and human talents and skills in order to obtain the highest possible dividend in both scientific knowledge and public utility, and ensuring that the problems which prompt the research are in fact answered by the research. These responsibilities often lead to a sensitivity to duplication of effort by different organisations. Where a body has responsibility for a particular objective, its criteria of research efficiency may be somewhat different. Zeal to have research for a particular programme objective achieve the greatest possible efficiency may, however, result in some duplication and may foster such a degree of self-sufficiency as to easily generate isolationism.

CO-ORDINATION NEEDS IN TUSSOCK GRASSLANDS AND MOUNTAIN LANDS

A wide range of human objectives in the use of science itself makes co-ordination difficult. Such a wide range of objectives now exists in the research being applied to the tussock grasslands and mountain lands. In the past the concern of the Institute has been to promote the involvement of scientists in the high-country environment so that the tussock grasslands and mountain lands received adequate attention in the national research effort. Twenty years ago there were only one or two scientists whose research was concentrated on the high-country environment; now there are more than twenty. Yet the concern remains that this environment must still receive an appropriate share of the national research effort.

There is now a wider range of skills in the national scientific manpower. The mountains need a share of some of the newer skills. There is now a widening understanding that the high-country is a great resource for pastoral production and that this resource has been but little tapped. The high-country needs research in pastoral development, not in proportion to its past or even its present production, but in proportion to its potential.

The tussock grasslands and mountain lands have at the same time come to be seen as an immense and varied recreational resource. This demands new research especially to define their recreational capabilities and to ensure the harmonious development of pastoral enterprises and public recreation. It has become necessary to understand the natural landscape, in some cases to preserve the natural order, and everywhere to design the pastoral development so that the variety of these rural environments provides a wealth of stimulating visual experience.

In recent years, the mountain lands especially have awakened a new effort at conservation because of their role as water-producing lands. Increased research into that role is warranted so that water production from them can be safeguarded. Research is needed to discern the localities and conditions under which improvements in land management can lead to better water-producing regimes and, perhaps of equal importance, the circumstances in which land management will be hydrologically ineffective. Perhaps of most lasting significance, the tussock grasslands and mountain lands are becoming recognised as an outstanding opportunity and responsibility to conserve, respect and learn from nature. They warrant a greater share of national research effort to understand the principles and practicalities of a steady-state, sustained-yield ecology and economy. Such an understanding may have a value to land management in the future far beyond the limits of the tussock grasslands.

THE INSTITUTE'S RESPONSE — FACILITATING CO-ORDINATION

One of the apparent paradoxes of the tussock grasslands and mountain lands is, therefore, that within the region there is an urgent need for intensive agronomy, hydrology and animal husbandry research to promote change at the same time as there is need for research to understand things as they are. With so many different objectives to be served, with such widely different human attitudes to be accommodated, effecting co-ordination is not easy. It would be more difficult were we to misrepresent the nature of co-ordination.

The essential meaning of co-ordination has been referred to as "arranging in harmonious relationship." Obviously, if there is more than one purpose to be served, co-ordination is not bending everything to serve one purpose to the distortion of others. Clearly, the fact that several purposes have something in common does not make the common object dominant, no matter how essential it may be. The co-ordination of research depends, therefore, on recognition of the primary purpose of each research programme as much as it depends on recognition of the elements common to them.

The Institute has attempted to promote co-ordination by providing opportunities for scientists of different organisations or different disciplines to serve their own purposes while yet having some aspects of their work in common. Sometimes the common element is a common overall purpose; sometimes it is the same collection of basic data. It may be simply the sharing of the same site or vehicle or facility such as a hut or an enclosure. The common use of information, transport, equipment or facilities can achieve economies. It can also produce gains in that the dividend from projects done together may be greater than the additive value of them done separately. Most important of all, these co-operative exercises have a human value in deepening or widening the interest or talent of the scientists and technicians involved. Such exercises, like all human activities, are not without their hazards, but Institute experience in recent years is that their positive values greatly outweigh the attendant risks.

The Institute has not found it necessary to formulate any firm schedule of rules for involvement in co-operative enterprises in research in the tussock grasslands and mountain lands. A guiding principle of all Institute research projects is that they should contribute to this object of facilitating co-ordination of research. In practice, Institute co-operative research projects exist at one or more of six levels of co-ordination. These levels are enumerated and illustrated by recent activities. They are, however, conceptual levels and a single project may involve co-operation with different personnel on more than one level.

Level 1. Establishing and maintaining contact with appropriate personnel in other organisations to enhance the value of a project. *Examples*: grasshopper density survey; pastoral run production surveys.

Level 2. Making use of common location with some sharing of facilities, but not with direct involvement of one research project with another. *Examples*: grasshopper population ecology studies at Craigieburn State Forest; plume grass studies at Grasslands Division field station at Haldon, Lincoln College hill farming property at Hunua, and Ministry of Agriculture and Fisheries field station at Cooper's Creek.

Level 3. Designing and operating projects to run jointly, making use of common facilities but with each agency retaining independent responsibility for each particular project. *Example*: sediment and channel behaviour studies at Torlesse Creek by Institute staff, jointly planned with University engineering, geological and geomorphological studies in the same locality.

Level 4. Designing and operating projects in which a particular contributory role is undertaken by personnel in a co-operating organisation. *Example*: mineral composition studies of tall tussocks with co-operation in analyses by Ministry of Agriculture and Fisheries and Grasslands Division of DSIR.

Level 5. Designing and operating joint and mutually dependent projects, making use of common facilities and data with a view to common or sequential publication. *Example*: grazing behaviour and diet selection studies at Ribbonwood by the Institute in relation to studies of mineral composition of available herbage and of blood plasma of sheep by scientists of DSIR.

Level 6. Fusing talents and resources on an agreed basis for pursuit of common research objective, involving joint use of facilities, data, and shared responsibility for a project as a whole. *Examples*: Feed quality studies at Mesopotamia with Biochemistry Department of Lincoln College; Cooper's Creek pasture studies with Ministry of Agriculture and Fisheries.

This practice of the Institute has evolved on the basis of Institute policy that the role of co-ordinating research is to be achieved by having Institute staff participate in co-operative research. Such co-operation can greatly help the work of collating research information and making it available to others. Research effort itself could, however, compete with collation and extension activities for the time and energies of the small professional staff of the Institute. The Management Committee is concerned that growth of Institute professional staff has not kept pace with the increasing demands being placed on it in recent years. Highly trained and competent research assistants and technicians have been recruited to the Institute in the last five years. Their involvement in the research programme of the Institute has allowed professional staff to maintain valued contacts with colleagues in many different centres and agencies. With the small staff of the Institute and with diminishing resources available for non-salary expenditure at the present time, the prospects for this programme of co-ordination are rather bleak.

In assessing the present situation, the Management Committee can only judge by what it might have been had the present policy not been put into practice. It is confident of the high estimation in which the Institute is held by the majority of those involved in studying, administering and producing from the tussock grasslands and mountain lands. This high regard has been earned by the Institute both by its research and investigatory work and by its efforts at collation and extension of information. By its objects as approved by Cabinet 14 years ago, the Institute is not free to concentrate solely on a research role or on a public information role. For its effective functioning as "a centre to facilitate the co-ordination of all research aimed to protect and improve the tussock grasslands and mountain lands," as well as to fulfill its other objects, the Institute must very soon enjoy a modicum of growth.

A. S. Scaife, Chairman
for the Committee of Management.

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