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CONTENTS

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COVER: An historical site, the DSIR and MAF irrigation trial on the southbank of the Maryburn, Maryburn Station in the Mackenzie Basin. On the basis of capital and annual costs it is thought that borderdyking is the most economic system, but a consequence on the thinner soils is the removal of topsoil, as well as the costs of levelling and full pasture renewal. On thin soils it is yet to be proven that borderdyking is in total cheaper than spray irrigation where adequate gravity-head is available for the latter. Here a spray system, and dyking as it can be afforded, is a possible compromise. Such a trial is already installed on one station. Methods of minimum levelling, with imported filling and embankment materials also bear investigation. The need for further research is evident but in the meantime the hydro-power developments will make the waters of the Basin available to many runs in the Mackenzie. In this issue Mr I. G. C. Kerr and D. W. Ives discuss the prospects for irrigation there.

Photo: W. F. Rennie—DSIR

Prospects for Irrigation in the Mackenzie

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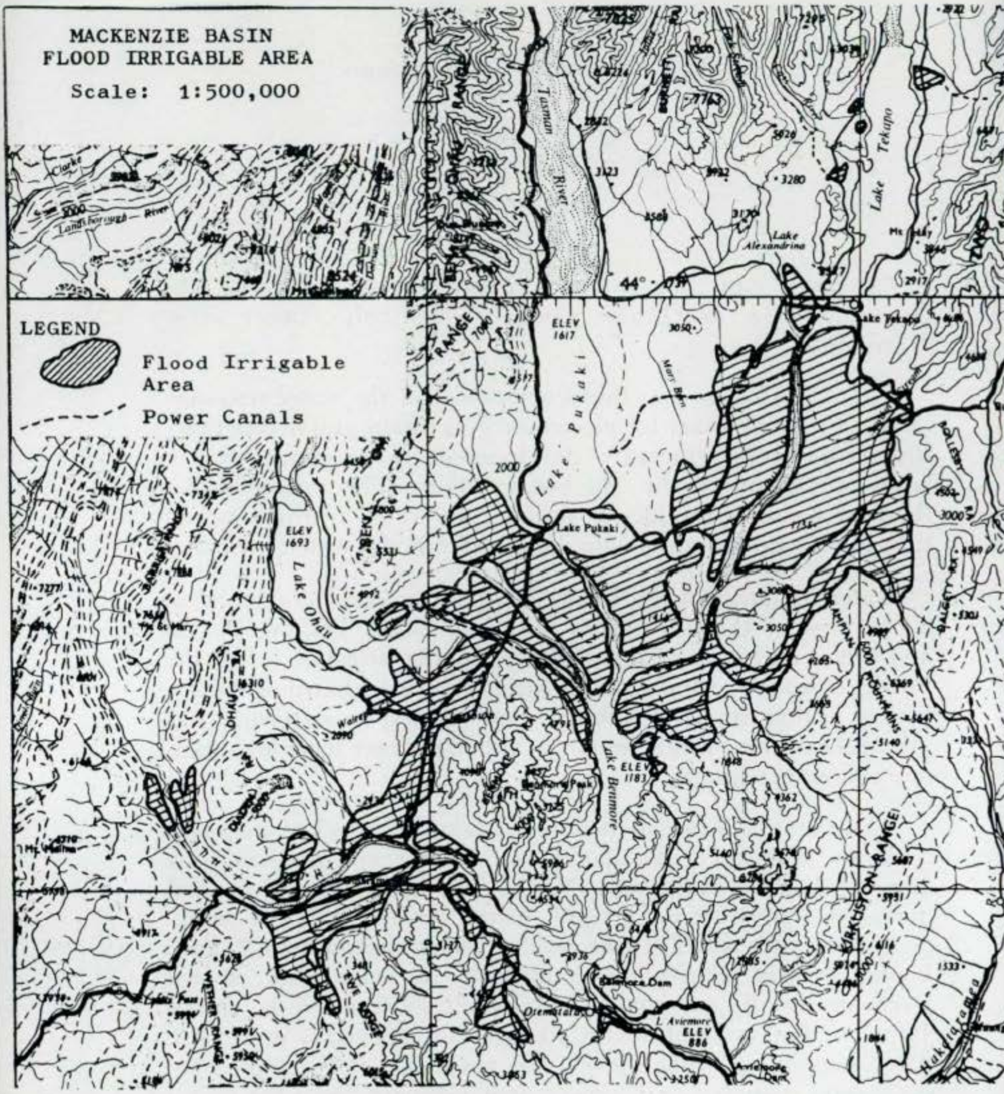
The long, hot, dry summers which are a feature of the climate of the Mackenzie Country invariably initiate ideas of irrigation.

It is fortuitous that the development of the water resources of the Upper Waitaki for electricity generation also makes practicable the complementary development of irrigation over a large proportion of the Mackenzie Plains. The reason is that the power canals are ideally situated for water distribution and that the added storage in the lakes extends the water resources.

Water resources of the Upper Waitaki are considerable. Some 95 percent of these resources flow into Lakes Tekapo, Pukaki and Ohau and in the Ahuriri River. Smaller streams such as the Forks, Irishman, Maryburn, Twizel, Edwards, Sawdon, Grays, Stoney, Omarama, Quailburn and Wairepo contribute significantly to the overall resource, although most have low minimum flows in summer.

Storage of water in the major lakes is achieved *naturally* by snow and ice accumulated each winter and *artificially* by dams at Lakes Tekapo and Pukaki. The higher power demand during winter results in a greater water throughput for electricity generation with a fall in lake levels to their minimum in August. Under present generating conditions, the maximum storage levels are usually regained by snow melt and rain by the end of January. The latest these are likely to be reached is mid-April. After maximum storage levels are reached water not used for generation is spilled until power demand increases at the beginning of winter. When the present developments for hydro-electricity generation in the Upper Waitaki are completed, substantially less water will be spilled than is the case at present.


MACKENZIE BASIN
FLOOD IRRIGABLE AREA
Scale: 1:500,000
LEGEND
Flood Irrigable Area
Power Canals
Tasman River
Lake Tekapo
Lake Alexandrina
Lake Pukaki
Lake Ohau
Lake Benmore
ELEV 1617
ELEV 1693
ELEV 1183
ELEV 886
Benmore Dam
L. Aviemore
Aviemore Dam
KIRKLISTON RANGE

With the trend for greater industrialisation the pattern of demand for electricity is changing so that there is a lessening difference between winter and summer demands. But since the winter-summer differences are also climatic in nature, the margin for complementary utilization of water for irrigation and electricity generation is not unlimited.

Yet, even with increasing competition for water, its use in the Upper Waitaki for irrigation as a complement to electricity generation—to the extent that is practicable in the Mackenzie-Omarama district—would be a multiple use of water with few equals.

Soils and their Suitability for Irrigation

In the production of their report on the 'Water Resources of the Mackenzie Basin' (1966), the Interdepartmental Committee apparently gave little thought to either the availability or significance of detailed soil survey information. Despite this lack their report was used to determine the provisions for irrigation water, stock water etc. in the 'Water Right' for electricity generation issued by Order in Council to the Minister of Electricity. The provision for irrigation was for a maximum of 520 cusecs or 140,000 acre feet in any one season from waters of Forks Stream, Lake Tekapo, Lake Pukaki, Lake Ohau and flowing therefrom into Lake Benmore.

A conservative estimate of 1 cusec per 100 acres for the deeper, finer-textured soils indicates that this provision is only sufficient to allow effective irrigation of 52,000 acres (20,800 ha).

At that time, 1966, general information on the soils of the whole Mackenzie-Omarama plains area was available on maps at a scale of one inch to four miles (approx. 1:250,000), and for selected areas information on the soil pattern as determined by officers of the Soil Bureau was available, on request, in much greater detail.

Subsequently, land inventory surveys undertaken by the Waitaki Catchment Commission and semi-detailed soil surveys conducted by the Soil Bureau (DSIR), have now provided information, on maps, at scales ranging from one inch to one mile to 1:25,000. Such soil and land use capability information must serve as the basis for assessment of water requirement in any planning for irrigation.

FIGURE 1: Looking north across the Tekapo outwash surface to Lake Tekapo. Mt John on the left in the middle distance. Soils of the Acheron 'family' occur over the patterned Tekapo outwash surface in the foreground. Deeper soils of the Twizel 'family' occur over recent flood silt from the Edwards Stream centre right running back to centre middle distance. Soils of the Sawdon and Tasman 'families' on the floodplain of the Tekapo River on the left.

(W. F. Rennie—DSIR)

During the course of these surveys it has been possible to separate, identify and determine the characteristics of the many parts of the broad soil units shown on the maps at a scale of one inch to four miles which accompany the General Survey of the Soils of the South Island (New Zealand Soil Bureau, 1967). It is not proposed to discuss these separations here but rather to regroup them into revised soil sets or 'families'. The discussion, and Table below, refer to these revised sets or 'families'.

With its advantages in relation to labour and capital inputs it is generally recognized that automatic flood irrigation using border dykes, where it is practicable, is the most satisfactory irrigation technique for grassland farming and for many crops.

FIGURE 2: High angle oblique aerial photograph showing the detail of sandy ridges and very stony intervening areas which make up the Acheron 'family' on the Tekapo outwash surface. Compare this with figure 1. Very gravelly and stony textures, excessive drainage, low moisture retention and microtopography of mounds and hollows make this soil poorly suited to irrigation without extensive land preparation.

(W. F. Rennie—DSIR)

Where contour is less favourable for dyking, spray irrigation is a useful alternative but one which is restricted in its widespread adoption because of high capital and operating costs. Most of the soils of the terraces and fans of the Mackenzie-Omarama Plains are generally in the 1-3 percent slope range and hence are topographically well suited to border dyke construction. A relatively small area, where slopes are uniform but somewhat steeper, would be suited to wild flooding.

On the basis of inherent physical properties of the soil which are:

texture (proportions of sand, silt and clay),

the distribution of clay within the soil and the underlying gravels,

FIGURE 3: Looking south from the Old Man Range over Tekapo Military Camp towards Hakataramea Pass. The Forks Stream and the Forks branch of the Tekapo outwash surface on the left, the Tekapo River and Tekapo outwash surface beyond in the middle distance. In the centre moraines with Tekapo soils give way to the right to protected areas of outwash with a moderately deep cover of fine-textured soil. These are soils of the Pukaki 'family'.

(W. F. Rennie—DSIR)

the depth of stone free soil over gravels,

the degree of compaction of the subsoil,

level of the water-table,

presence of soluble salts, and

surface slope and micro-topographical detail

the soil 'families' may be grouped in categories of suitability for irrigation. The nature of the landform and its influence on surface slope is a key factor in the determination of the most suitable method of irrigation for a particular soil 'family' (Table 1).

able 1: **Suitability of Soils for Irrigation**
(Soils of flat and gently sloping land)

Category	Soil 'Family'	+Estimated Annual Water Requirement (Inches)
A.	**Soils well suited to irrigation by border dyke methods**	
	1. Well suited:	
	Pukaki	12-18
	Twizel	12-18
	2. Moderately well suited:	
	Mackenzie	24-30
	Sawdon	18-24
B.	**Soils better suited to other methods of irrigation**	
	1. Spray irrigation:	
	Grampians (some)	18-24
	Dobson (better drained)	12-15
	2. Wild flooding:	
	Grampians (some)	18-24
	Dalgety	24-30
C.	**Soils poorly suited to irrigation**	
	Acheron	24-30
	Tasman	18-30
D.	**Soils unsuited to irrigation by any method**	
	Dobson (poorly drained)	
	Waimairi	

The estimated annual water requirement for the soils of each 'family' shown in Table 1 is based on the culations discussed in the text. Consideration has also been given to the minimum volume of water delivered a single application and the number of applications by surface flooding methods required for optimum nt thrift during the growing season.

Raeside (1971) suggested that of the level and gently sloping areas of the Mackenzie-Omarama Plains some 28,500 acres (11,400 ha) are well suited to irrigation and a further 149,200 acres (59,680 ha) of stony and very stony soils with very high rates of infiltration and very low water holding capacities are doubtfully suited for irrigation without further investigation.

Now that these additional investigations have been completed, and although the final report on the soils of the Mackenzie-Omarama Plains is as yet unpublished, it is already apparent that Raeside's estimates were conservative. The area suited to flood irrigation in the Mackenzie-Omarama Basin is in the region of 180,000 acres (72,000 ha) with nearly 25 percent of this area well suited to irrigation by flood methods.

FIGURE 4: A typical view of the surface on which the soils of the Pukak 'family' are formed between Lake Tekapo and Lake Pukaki. These are moder ately deep and deep soils with good moisture retention and low to medium level of nutrients. These soils are well suited to border dyke irrigation.

(W. F. Rennie—DSIR

FIGURE 5: An extensive area of soils of the Pukaki 'family' occurs between th Ohau and Ahuriri Rivers. These soils are all well suited to border dyke irrigation The portion with perhaps the highest potential in this area is just north of th Quailburn where soils of the Pukaki and Grampians 'families' merge with soil of the Twizel and Dobson 'families'.

(W. F. Rennie—DSIR

FIGURE 6: Soils of the Mackenzie 'family' on the southern end of the Tekapo outwash surface. Simons Hill on the west of the Tekapo River and Mt. Cook on the skyline. Mackenzie soils are moderately well suited to border dyke irrigation although they have excessive drainage and low water holding capacities.
(W. F. Rennie—DSIR)

FIGURE 7: Soils of the Mackenzie 'family' on the terraces of the Ahuriri River are ideally situated for border dyke irrigation with water supplied from the Ahuriri.
(W. F. Rennie—DSIR)

FIGURE 8: Soils of the Grampians 'family' have been cultivated and irrigated on Tara Hills Experimental Station near Omarama. Soils of the Dobson 'family' have been improved by drainage and cultivation. In the foreground, soils of the Mackenzie 'family' on terraces of the Ahuriri River. In this location these soils are ideally situated for experimentation on their response to irrigation.

(W. F. Rennie—DSIR)

Between a half and two-thirds of the total area is commanded by Lake Tekapo and the Tekapo-Pukaki and Pukaki-Ohau power canals.

There is in addition a substantial area, probably in excess of 30,000 acres (12,000 ha), which would be suited to spray irrigation. A large proportion of this development would depend on over-coming the engineering problems involved.

Moisture Deficits

The irrigation deficit at Lake Tekapo in an average year is 9.2 in. (232 mm) and in the driest season since 1951 it was 14.8 in. (375 mm).

FIGURE 9: Local irrigation schemes could be used to improve the productivity of good soils such as those of the Grampians 'family'. This area between Grays Hills Station and Big Pass by spray or surface flooding using either small storage dams along the southern flank of Grays Hills or supplied by race from the Tekapo River. Soils of the Grampians 'family' are well suited to irrigation by either method. *(W. F. Rennie—DSIR)*

For pasture on a silt loam (e.g. Pukaki 'family') with 24 in. in effective root depth the amount of water available to plants over the irrigation period is 1.6 in. per foot. Assuming a 50 percent irrigation efficiency the total irrigation requirement for a 9.2 in. deficit is 12 in. per annum. Race losses may be a further 3 in. (25 percent), making a total irrigation requirement of 15 in. (380 mm) per annum.

For pasture on a gravelly sandy loam (e.g. Acheron 'family') the available water is approximately 0.6 in. per foot of root and in consequence the irrigation requirement for a 24 in. effective root depth is 16 in. per annum and with race losses accounting for 4 in. the total irrigation requirement would be 20 in. (508 mm).

In about one year in twenty the maximum irrigation requirement for pasture would be 29 in. (737 mm) for a silt loam and 34 in. (864 mm) for a gravelly silt loam.

Irrigation Performance

The effect of irrigation is both to increase the total herbage produced and reduce the range of production between seasons.

Table 2: Relative Profitability to Dryland Farming

	DRYLAND		IRRIGATION	
SOILS	A (OSTD) *	B (Cultivation)	A (6 su/ac)	B (10 su/ac)
— Suitability for Irrigation	—	high	moderate	high
PRODUCTION (p.ac)				
— Added	1.5	3.0	6.0	10.0
CAPITAL COSTS (p.ac)				
— Land Preparation	—	—	$60	$60
— Pasture Establishment	$10	$20	$15	$15
— Fencing ($12/ch)	6	12	24	24
— Stock Water	1	1	1	1
— Stock ($10/su)	15	30	60	100
TOTAL	$32	$63	$160	$200
ANNUAL RETURNS (p.ac)				
— Gross Margin per S.U.	$5/$9	$5/$9	$5/$9	$5/$9
TOTAL	$7.50/$13.50	$15/$27	$30/$54	$50/$90
ANNUAL COSTS (p.ac)				
— Fertiliser	$2	$3	$4	$4
— Pasture renewal	—	3	3	3
— Labour ($2/su)	3	6	12	20
— Water	—	—	2	2
— Maintenance	—	—	1	1
TOTAL	$5	$12	$22	$30
RETURNS (100 ac.)				
— Capital	$3,200	$6,300	$16,000	$20,000
— Annual Returns	$750/$1,350	$1,500/$2,700	$3,000/$5,400	$5,000/$9,000
— Annual Costs	$500	$1,200	$2,200	$3,000
— Surplus	$250/$850	$300/$1,500	$800/$3,200	$2,000/$6,000
— %	8/27	5/24	5/20	20/30

* OSTD = Oversowing and Topdressing.

Productivity measurements of irrigated herbage grown in the Upper Waitaki district are as yet scarce, but indications are possible.

It is clear that irrigation requires high capital investment and that a high return on investment is possible only if high production is obtained from livestock or that other highly remunerative use of irrigation is made.

It is clear also that rapid and extensive irrigation development by individuals is limited by capital, particularly for additional stock and land preparation.

At Tara Hills irrigated shallow and stony Mackenzie soils are carrying 17 wethers per acre throughout the irrigation season.

In a Grasslands Division D.S.I.R. trial at Haldon Station over 15,000 lb of dry matter per acre was cut over an incomplete season from irrigated herbage grown on a silt loam (Grampians 'family'). When the relative effects of fertilizer and irrigation were compared it was apparent that 80 percent of the productivity was attributable to irrigation. This level of production ranks with the highest in the country.

In a joint D.S.I.R. and Ministry of Agriculture and Fisheries trial on Maryburn Station three stock units per acre have been run in the first season on a partly-grazed irrigated pasture which produced 6,000 lb dry matter on a gravelly fine sandy loam of the Sawdon 'family'. (At Winchmore, on Lismore soils, 10,600 lb dry matter per acre is the average yield from an irrigated shallow silt loam.)

Carrying capacities are difficult to predict on a farm scale but high levels of summer production appear practicable and may well eclipse lowland areas.

Under livestock production the return from irrigation can be compared with over-sowing and topdressing and cultivation by examining the costs and returns (refer Table 2). Each farm situation is unique however and must be examined individually.

FIGURE 10: Looking south towards Simons Pass and the Benmore Range. Maryburn Station and Simons Hill Station are located in the trees on the upper left of the photograph. In the immediate foreground soils of the Pukaki 'family' border Tekapo soils on undulating and rolling topography over glacial moraine deposits. The Maryburn irrigation trial is apparent in the centre middle distance and beyond that an extensive area of soils of the Pukaki and Grampians 'families' which would be well suited to irrigation by either surface flooding or by spraying. *(W. F. Rennie—DSIR)*

Some Advantages

Under present farming systems the value of irrigation to the individual farmer in the Mackenzie is likely to be greatest with its strategic use in hay production, lamb fattening, flushing ewes, small seeds production, and obviously, for increasing overall feed supplies.

A reliable supply of quality forage is essential for stock survival and thrift during the winter on most high country runs.

With at least 200 bales of hay per acre every year under irrigation not a great area is required to meet annual hay requirements, compared with that under dry land conditions. Unit costs are less and quality more readily attainable.

The fattening of lambs (at about 10 per acre) is a certain way of adding to their value and to the annual revenue. A 5-10 percent increase in lambing through flushing ewes at the end of the perennially dry summer has its value in areas where lambing is normally low. A readily obtained 500 lb per acre clover seed crop rewards well those who have planned well.

The growing demand for protein, oil seed and cereal crops presents enormous possibilities for the future.

Arising from the irrigation development in the Mackenzie there are considerable benefits to soil conservation. These are the direct control of soil erosion on areas that are irrigated and indirectly through reduced and perhaps more timely grazing of erodable steeplands.

FIGURE 11: Upper reaches of the Tekapo River showing the abraiding course of that river and indicating how the adjacent Tekapo outwash surface has been formed. Soils of the Acheron 'family' occur on this surface. The photograph illustrates how the micro-topography of this surface has limited its potential for border dyke irrigation. *(W. F. Rennie—DSIR)*

Some Problems

In an area such as the Mackenzie-Omarama district irrigation development, whilst having its considerable advantages, has its problems too.

The capital problems are immediately apparent.

The physical difficulties of border dyking almost structureless soils in a dry and windy environment should not be overlooked. Pre-watering with spray units may well be necessary if climatic circumstances are unfavourable. Tree planting to start well planned windbreaks should take place urgently.

The increased herbage grown under irrigation from October to April will, as development proceeds, require more skill in conservation and utilization of fodder for successful livestock production in the harsh winter environment of the Mackenzie.

Changes in the landscape of the Mackenzie brought about by irrigation development must be carefully considered so that the end result will not be to the detriment of the environment of the area.

The scattered location of areas where demand for irrigation is at present indicated can cause serious planning problems which will be evident when more widespread irrigation development is required. The installation of distribution channels and the layout of irrigation areas need to be well planned so that they are capable of integration as further development proceeds.

The Adequacy of Water

In the event of its full development for irrigation the flood irrigable area served by Lake Tekapo (67,500 acres) would, in the driest of years, require approximately 180,000 acre feet of water. This amounts to 30 percent of Lake Tekapo storage capacity, but 90,000 acre feet would, under the present electricity generating pattern, be regained between mid-April to May each year. In an average year the irrigation water requirement (104,000 acre feet) would be regained fully from January onwards when the lake is normally full.

Similarly, the flood irrigable area served by Lake Pukaki (53,000 acres) would require 147,000 acre feet of water in the driest of years and 85,000 acre feet in an average year. The storage water in Lake Pukaki would normally be regained fully between mid-April and May, including the driest of years, even after the construction of a high dam at Pukaki.

The development of the full irrigation potential of the whole area is unlikely in the near future and in consequence the demand for water for irrigation from the major lakes will not normally compete with its use for electricity generation for a long time in spite of any changes in the pattern of electricity generation.

In the Omarama district, where the Ahuriri and Omarama streams constitute the major water resource, a large proportion of the irrigable area can be served from these streams.

In the Mackenzie district the irrigable area not commanded by the power canals can for the most part be irrigated with water from minor streams such as the Twizel, Irishman, Maryburn, Mistake, Coal, Grays and Stoney streams.

Conclusion

It is a fact that circumstances change with increasing rapidity these days and it is certainly not difficult to imagine large scale irrigation being readily developed in the Mackenzie-Omarama district for intensive livestock, protein, seed and crop production.

The constraints to such development are chiefly ones of motivation, expertise, capital and land tenure and it may take many years for these inevitable adjustments unless some bold and imaginative decisions are made.

It is the responsibility of all those persons and agencies involved to ensure that the inevitable development of the Mackenzie proceeds without ill-considered impediment and without disadvantage to any.

Acknowledgements

The contribution, either directly or implied, by many Mackenzie-Omarama runholders, Ministry of Agriculture and Fisheries (Tara Hills Research Station, Advisory Division), D.S.I.R. (Grasslands Division, Soil Bureau), Ministry of Works (Water and Soil Division, Power Division) and the Waitaki Catchment Commission to this paper is gratefully acknowledged.

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For the last ten years Grasslands Division of DSIR have been testing alsike along with other legumes in the Mackenzie Country. The following article discusses alsike especially in its role as an alternative to white clover.

Alsike Clover in South Island High Country

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Alsike is a prominent legume in the improved tussock country of the South Island.

It was reported by Saxby in 1940 to establish and produce well on the dry tussock country of Central Otago. The late H. W. Sievwright's experiments in the Mackenzie Country in 1949-56 established its use along with white and red clovers.

The continued use of alsike in this region is shown in the records of Mr J. C. Issit, seed merchant, Fairlie. Orders for 1972 spring sowings in the Mackenzie Country amounted to 4,650 kg of alsike and 3900 kg of white clover. Considerable quantities also are purchased through seed merchants in Timaru and Oamaru.

Alsike, an alternative to white clover in the South Island high country.
Photo: P. T. P. Clifford

The bulk of the imported seed comes from Canada. The only other source of importance is a 'local adapted' line originally from Canadian seed sown on Mr R. P. Hosken's Simons Hill Station in the early 1950s. This line has been maintained by Mr Hosken and several other runholders to supply their own needs.

Seed yields of up to 500 kg/ha indicate that there are no serious problems in seed production.

A feature of alsike is its ability to better withstand severe frost and cold than other legumes, particularly in new sowings. Until its present use in the high country had been established, alsike was considered best suited to wet terrain, and was permanent where not continually grazed. Under such conditions it was preferred to red clover for hay, and because of its hollow stem, 'cured' more rapidly than red clover.

Most runholders regard alsike as an alternative to white clover. The remainder of this article compares these two species.

I Establishment and growth on dry sparsely covered soils of low fertility

This work was done on the poorer outwash soils contained in the area south of State Highway 8 and bounded by the Pukaki and Twizel rivers. Rainfall is low averaging between 380-460 mm a year. Results are based on 4 trials carried out over 3 years.

Present knowledge indicates that moisture is the limiting factor to development on this class of country, and our best results were obtained in the 1967-68 season.

Initial establishment of alsike was similar to white clover, but subsequently alsike was less affected by frost heave and insect damage. Production in the first and second year from alsike was superior whether autumn or spring sown, over-drilled or broadcast. Numbers of plants surviving at the end of the second year were similar for both species.

II Establishment and growth on soils of low to moderate inherent fertility, with good natural cover, but no major establishment problem

The site adjacent to the homestead of Wolds Station, has an average rainfall of 510 mm. Established clovers were planted into the natural vegetation and their performance recorded under a range of fertility treatments.

Production was similar from the best alsike and white clover varieties tested. The 'locally adapted line' was slightly inferior to 'Grasslands' Huia white clover. However, there were important differences between the two species in seasonal production. Alsike was generally lower yielding in the spring, but higher yielding in the summer. Yields were similar in the autumn. There was no difference in time of commencement of spring growth. Greater summer yield of legumes is a desirable characteristic, particularly if growth from that season can be carried through for autumn-early winter feeding of stock. This aspect has been discussed in *Review* No. 21, 1971, "The feeding of sheep on part-improved tussock grasslands". Alsike was the major component in the improved block used in this study.

Alsike grew better than white clover at low levels of superphosphate. Survival of plants was 99 percent for white clover and 86 percent for alsike.

III Growth in mixtures with various grasses on soils of moderate to low fertility but with good response to added fertiliser

The site on Ben Ohau Station, was on a terrace soil ploughed out of tussock. A crop of greenfeed oats was taken prior to sowing pastures. 'Grasslands Ariki' ryegrass, 'Grasslands Apanui' cocksfoot, S170 Tall Fescue, and 'Massey Basyn' Yorkshire Fog were sown separately with either alsike or white clovers. Seeding rates of clovers were equivalent to 2.2 kg/ha of viable white clover seed. Grasses were deliberately sown at less than half the seeding rate used in the region for cultivated pastures. The resulting pastures were thus more typical of the balance of clover and improved grass to be expected from development by oversowing and topdressing.

Total herbage production in the first two years was generally higher for alsike than for white clover based pastures. The former were more markedly clover dominant in the first year. By the third year there was little difference in total production, but the alsike pastures were more grass dominant than the white clover pastures.

In conclusion, performance from alsike clover in the Mackenzie Country has been sufficient to warrant its use instead of white clover. It has the major advantages of greater tolerance of cold and is thus able to be conserved as a standing crop for use in the late-autumn and early winter.

The Cattle and Sheep Industry in Colorado

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Colorado is approximately the same size as New Zealand. Altitude ranges between 3,500 ft. and 14,000 ft (1066 m-4267 m), rainfall 10-15 in. (254 mm-380mm). The growing season is less than five months with summer temperatures reaching 45°C. Snow frequently covers the ground in winter and temperatures may often fall below −35°C.

The Sheep Industry

Sheep numbers in the U.S.A. have declined from about 48 million in the 1940s to only 16 million in 1972, less than one-third of New Zealand's sheep population. The industry has specialized in the production of fat lambs, hence wool production has suffered. The breeds in the sheep producing areas of Texas, Wyoming, Colorado and Idaho are of Rambouillet (mutton Merino), Columbia and Targhee origin. The wool clip is usually less than 8 lb (3.63 kg) and is of inferior length and style. The Rambouillet wool count is in the 64's range while the Columbia is usually within the 50's to 60's. Lambing percentages are often less than eighty and are greatly influenced by lamb mortality due to adverse climatic conditions and predatory animals.

Although there is an increase in the use of fencing and sheep dogs for grazing control, the sheep herder is still depended upon for all stock movements. While the constant supervision of mobs of sheep by herders has been an economic alternative to fencing in the more extensive mountain locations, the practice has persisted longer than necessary in many areas.

Colorado state is one of the larger producers of fat lamb in the U.S.A. Feeder lambs, which are generally crosses from the wool breeds, and fat lamb sires such as the Suffolk, Hampshire and Dorset, are trucked into feedlots situated mainly in the corn producing north-eastern sector. Rations containing up to 90 percent concentrates are fed to the three to eight month-old lambs (weighing 40 lb-70 lb (18.1-31.7 kg)) in quantities sufficient to ensure final live weights of about 105 lb (47.6 kg). The cost per lb live weight gain is less than 23 cents (50.6 cents/kg) which represents a profit margin of $3 per head when related to schedule prices of 28 cents per lb (61.6 cents/kg) live weight or $30 per head.

While feedlot produced lamb is tender and of mild taste there is strong consumer prejudice against lamb, for reasons of cost, flavour and to a certain extent tradition. However, many American housewives attempt to cook mutton in the same way they do beef. In view of this it would behove lamb promotion agencies to promote appropriate cooking procedures since "rare" mutton is not conducive to taste or tenderness.

The quality control and export handling procedures used in New Zealand appear to require more attention as the writer had the occasion to sample some New Zealand lamb while in Colorado. Although tender, the carcass was excessively fat and tasted of an unidentifiable odour, possibly incorporated during freezing or storage. In view of the sensitivity of the American consumer towards lamb it is desirable that the New Zealand industry make every effort to achieve quality control.

The Beef Cattle Industry

Beef consumption in the U.S.A. and in New Zealand is similar at about 115 lb per capita per annum, although New Zealand has a higher total red meat consumption. While the American consumer expresses dissatisfaction over high food prices, including beef, their expenditure on food as a percentage of disposable income is only 16 percent.

Compared with 1950 the cost of beef production has increased by 75 percent, while the price paid for slaughter steers has remained relatively static. To offset the decline in per animal returns cattlemen have been forced to increase cow numbers. Since 1940, cattle numbers have almost doubled.

Although Colorado ranks tenth in total cattle the state ranks sixth in numbers of fed cattle marketted. Feeder cattle are shipped in from Oklahoma, Texas and New Mexico for reasons of price rather than quality. Mid western and smaller Colorado feeders, however, buy Colorado raised calves and are willing to pay a premium for "typey" animals to maintain uniformity in their smaller feedlots. Cattle are generally purchased either as calves weighing 400-500 lb (181-226 kg) or as yearlings weighing 800-850 lb (363-385 kg). The latter are fed for 110-140 days to gain approximately 3 lb (1.36 kg) a day. Finished live weights are in the order of 1150-1200 lb (521-544 kg) with carcass weights of about 670 lb (304 kg).

Although the average feedlot capacity is close to 2,500, they range from less than 100 to 200,000. It is significant to note that feedlots with under 500 head capacity comprise 86 percent of all feedlots, although they feed only 18 percent of the total cattle.

Part of the Montfort of Colorado feedlots which contain in excess of 200,000 cattle.

(Photo: G. Scales from a transparency)

Colorado reputedly has the world's largest feedlot. The Monfort of Colorado feedlots in Greeley are two, each with a capacity of about 100,000 head in which the daily turnover of finished cattle for slaughter is about 2,000. This represents a gross output of .7$m per day. The company operates a packing plant which handles its own cattle plus stock from other feedlots. Grain is shipped in from a number of states in company-owned trains. Roughages are grown locally by contract.

The company employs a team of veterinarians with a veterinary and isolation yards.

Least cost rationing is achieved with the aid of computers, the mixing of rations being completely automated. Trucks continue to mix the ration while travelling to the lots, their destinations being double checked to ensure each pen receives the correct ration.

Spray irrigation is used to minimize dust. Manure is periodically heaped and subsequently removed by trucks. It is spread on to cropping land which represents a further source of income to the company. The waste disposal problem is evident when it is considered that about 4,200 tons of wet manure and urine are excreted per acre of feedlot area a year by approximately 360 animals.

The majority of cattle fed are the traditional beef breeds, although increased use is being made of dairy breeds and exotic crosses. It has been estimated that up to 10 percent of the fed cattle in Colorado are dairy breeds or exotic crosses.

The bulk of grain fed consists of corn or sorghum, although mixtures of wheat, barley, oats, milo and millet are often used.

Wheat can constitute up to 50 percent of the grain ration with little ill effect.

Once the cattle are on full feed, grain can comprise up to 100 percent of the ration, but generally the rations contain at least 10 percent roughage. Averaged over a 120 day feeding period a feedlot steer will consume 23 lb (10.4 kg) of feed per day of which 15 lb (6.8 kg) will be grain. Towards the end of the feeding period the ration will increase to 3 percent of live weight, with up to 25 lb (11.3 kg) of grain per day.

Roughages, including corn silage and lucerne hay, are fed in the chopped form.

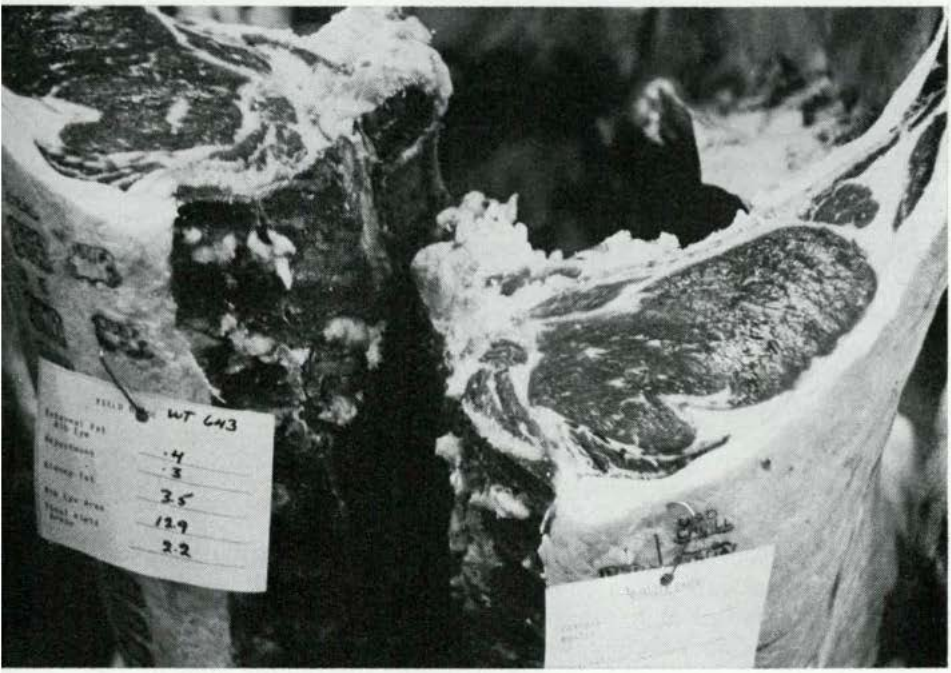
A variety of methods are used to process grains, although the cheapest is to simply crack or roll the grain. Due to the cost, processing grains is becoming a dubious practice and an increasing number of feeders are using whole corn in their rations. Recent research has shown similar live weight gains and economy of gains using whole corn providing the cattle are on full feed and the grain constitutes a high proportion of the diet. Smaller grains are generally processed although, as with corn, recent research has shown little economic advantages of crushing wheat or oats.

A protein supplement, usually in a pellet form, is included in the feedlot ration. Typical protein type supplements will contain 70 percent of either cotton seed meal or soybean meal and 10 percent urea. Minerals together with antibiotics, vitamins and cereals make up the remainder.

Diethylstilboestrol (D.E.S.), until recently, was incorporated with the supplement, but 1972 regulations require that this growth hormone be administered as a subcutaneous implant. Problems with residues from the use of D.E.S. and melengestrol acetate (M.G.A.) have led to other growth stimulators, notably the use of zeranol, a derivative from corn mould which can boost live weight gains in excess of 10 percent.

The efficiency of feed conversion to live weight gain is in the order of 7 to 1. Feed costs range up to 20c per lb (44c/kg) live weight gain or 25 cents (55c/kg) including overhead and handling costs. This may be compared with schedule prices of 30c per lb (66c/kg) live weight, although recent prices have soared up to 45 cents per lb (99c/kg) which represents a substantial profit margin when live weight gains of 300 lb (136 kg) twice a year are considered.

The American feedlot industry is geared to the production of marbled (intramuscular fat) beef with a quality grade of Choice which is difficult to attain without the use of grain. While the American consumer accepts the Choice grade as a minimal standard of quality, there is a surprising lack of information on the relationship of marbling and eating quality and the only positive relationship is that with juiciness. Tenderness and taste have not been shown to be positively increased by marbling and yet the entire feedlot industry is based on the production of this type of product.



The champion carcass at the Great Western Beef Expo, Colorado. This is a cross-section between ribs 12/13 of the Angus steer. The sample was well marbled and had a minimum of subcutaneous fat.

(Photo: G. Scales from a transparency)

There is little doubt that New Zealand farmers have sufficient skill and enterprise to run an efficient feedlot industry, although the long term economics of such a diversion would require careful scrutiny. With the present demand for this product and current schedule prices, however, the outlook is very optimistic.

An interesting feature of the Colorado beef industry is the recent emphasis on cattle improvement programmes in which breeders forward a sample of progeny from one or more bulls to a central feedlot station where they are evaluated for rate of gain and carcass quality. Programmes such as the Great Western Beef Expo and Colorado Beef Cattle Feedlot Test rank bulls in their ability to sire progeny of high performance. Growth rates of 5 lb (2.27 kg) per day have been achieved by individual animals, although average 105 day gains are generally about 3.4 lb (1.54 kg).

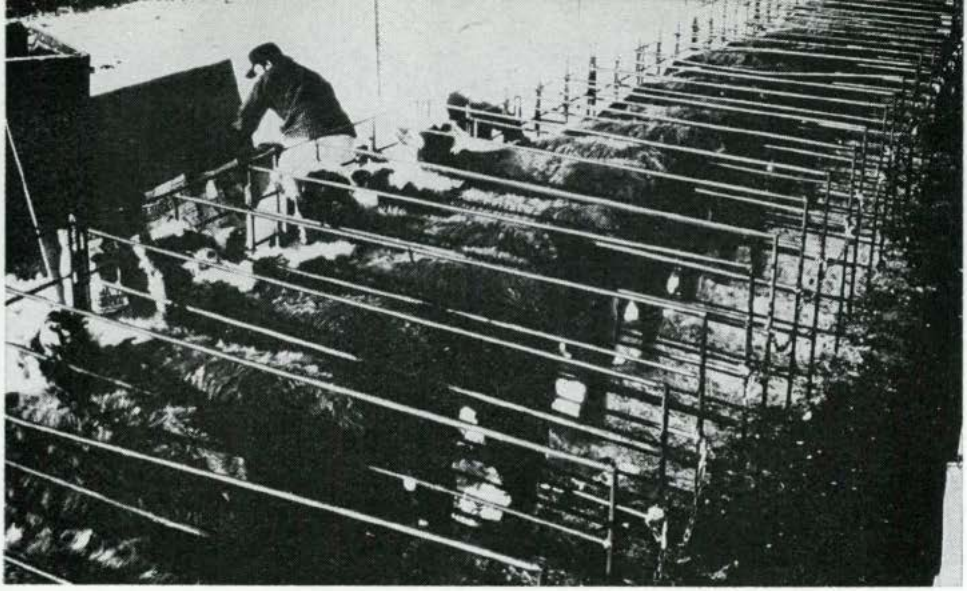
While Angus cattle have traditionally had little difficulty in winning most carcass competitions, often at the expense of growth rates, it is now recognised that there are sires in all breeds capable of achieving both high growth rates and Choice quality grades. The problem is one of identification and it is interesting to note that the 1972 carcass competition winner at the Great Western Beef Expo was a Charolais-Angus steer. In previous years only a handful of the exotic crosses graded Choice, let alone win the competition. The award of the highest lean carcass yield per day of age went to a Limousin-Angus crossbred. Generally the Angus has been preferred in exotic crossing programmes mainly because of the early maturity of this breed. The pressure is on Hereford breeders to identify sires capable of marbling potential.

Range Cattle

The cow-calf industry in Colorado is distributed evenly over the state in an environment similar to many areas of the South Island high country. Calving percentages are in the low eighties and weaning weights slightly over 350 lb (158 kg). Cattle are not housed indoors in winter but require some supplementation, the amount being dependent upon the severity of winter. Surplus calves are either sold as weaners to the feedlots or retained until 18 months of age. The latter decision requires that the weaners be maintained through the first winter.

Small increases in live weight through the winter are considered desirable. A typical supplement on native range would include 1 lb (.45 kg) of dehydrated lucerne cubes and 1 lb (.45 kg) of soybean meal (45 percent protein) daily. Lucerne hay is fed when the ground is snow covered.

Critical examination of range forage nutritive value has enabled ranchers to anticipate periods of nutrient deficiencies and many ranchers use specially prepared supplements containing either energy-based (grains) or protein-based (soybean meal or lucerne) feeds for specific periods of the year when these nutrients are known to be deficient in herbage. Research in the last decade has helped clarify problems associated with balancing energy and protein requirements on the range. Salt and mineral mixes are made available throughout the year.



Winter supplementation trials were designed to determine the energy and protein requirements of range-fed cattle.
(Photo: G. Scales from a transparency)

Sixty percent of the range cattle are Herefords and about 30 percent Angus, although the number of exotic crosses is rapidly increasing. *However, producers of above average purebred cattle have little difficulty in competing with other breeds, including exotics.* The decision of many breeders to retain their purebred herds has not resulted in decreased returns as is often forecast.

Artificial insemination has increased in popularity in the last decade as services and specialized knowledge have improved. While the costs are higher with A.I., the advantages of widespread distribution of high quality genetic material out-weighs this. Normally cows are inseminated for two cycles and a follow-up bull used for the third cycle. The mating period has been considerably reduced from the traditional 100 day interval, mainly because of smaller calves at weaning, and the tendency for late calvers to be dry the following year. Shorter breeding seasons of 60 days have improved overall weaning weights and apart from an initial drop in fertility, have not been at the expense of calving percentages. Mating yearling heifers is generally accepted as an efficient management practice on the more improved properties and ranchers are well aware of the necessity for well grown heifers and increased assistance at calving time.

Colorado cattlemen have the advantage of many years experience and natural selection of cattle. Many ranchers have achieved 95 percent calving and 450 lb (204 kg) weaning weights in 205 days, with purebred cattle grazing native range with minimal supplementation programmes. In most cases this level of production has only been obtained through careful selection and management practices together with a strong dedication to their cattle.

A District Tackles Its Weeds

In 1969 the Noxious Weeds Committee of the Mackenzie Federated Farmers was made a committee of the Mackenzie County Council.

This organisation offers a solution to the problem of regional weed control by providing leadership from within the immediate community as well as encouraging all local interests to participate in the scheme.

With the removal of the weedicide subsidy this year the benefit of bulk buying of weedicide by the Committee assumes great importance among the advantages offered by the organisation. Also, where the task of weed control is beyond the resources of the occupier as is often the case on difficult run country, there is the attraction of entrusting the work to an organisation which can do it cheaply and effectively. The Committee's expertise which is already high can only become higher with subsequent experience. In fact an adjunct to the present scheme is the Council's proposal to set up a weeds information centre.

"It is pleasing to note the emergence of a similar organisation to the Mackenzie Basin Noxious Weeds Committee in the Opihi area and the Committee extends to the Opihi Committee its hopes for success and the offer of any assistance and co-operation it may be able to give. The first steps have now been taken to establish similar organisations covering the lower Waitaki."

These comments in the 1972/73 Annual Report of the Committee are indicative of the progress made by the Committee within its district and the influence it has had outside. This influence has been generated by the efforts of leaders in Federated Farmers, the Waitaki Catchment Commission, the Ministry of Agriculture and Fisheries as well as in the Council. All of these

participants come together at meetings of the Federated Farmers held quarterly besides the set meetings of the Committee. In this way all of those who are taking part in the scheme are aware of what is happening in administration as well as on the land.

In contrast to the above quote the Committee's present Chairman, Mr A. A. Innes (who is also Chairman of the Waitaki Catchment Commission) in 1969 said: "To date we have not caused the death (as a committee) of a single broom bush unless its demise has gone unnoticed."*

Its performance since then has been outstanding when it is considered that the Committee was mooted only the year before under the auspices of the Council and the Commission.

The Commission's interest in the Mackenzie region was principally because the Basin is the headwaters of the Waitaki River and was a potential source of weed infestation of country lower down.** At the time the Department of Agriculture drew attention to the incidence of weeds in the Basin but there was then little community participation involved in weed control although individually a lot was being done compared with other districts.

Modest beginnings, yet in 1970 the Committee administered the spraying of 92 acres of broom and numerous scattered bushes. The cost of weedicide that year varied from $16.60 to $26.45 an acre, and application by aerial means $10 an acre, ground application $45.90.

In 1971 about 194 acres of broom and gorse were sprayed at a cost of $30.77 an acre by helicopter on 132 acres and $30 an acre ground application on 62 acres.

In 1972 some 244 acres of mainly broom and gorse were sprayed, including a small area of brier. This cost $30 an acre by helicopter on 218 acres and $60 an acre for ground control on 25 acres.

The 1973 programme proposes dealing with 274 acres of broom and gorse at an estimated $38 an acre for broom and $46 an acre for gorse.

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* Innes, A. A. 1969 : *Report on the progress of the Mackenzie County Council Advisory Committee for eradication of broom.* Rev. Tussock Grasslds Mount. Lands Inst. *17* : 22-4.

** Innes, A. A. 1973 : *District Co-operation for weed control.* Rev. Tussock Grasslds Mount. Lands Inst. *26* : 2-4.

Thus more than 500 acres of broom and gorse have had initial coverage within three years of the scheme. This is well on the way to control of the priority weeds, broom which was surveyed at 670 acres and gorse at 90 acres infestation before the programme started.

There are still 5,500 acres of brier to be tackled. Also, the Committee are now giving consideration to the St Johns Wort, nodding thistle and barley grass problems.

As was pointed out by Mr Innes at the 1973 high country field day the success of the scheme largely depends on community co-operation and this includes the participation of both crown and private interests. Such co-operation has been given by everyone called upon so far and the process of the County meeting the initial charges of the work and subsequently recovering these through the committee appears to be fully satisfactory.

The scheme was accorded the compliments of interdepartmental Weeds Committee which visited the district in late 1972, and in view of the interest shown by other districts the Committee's proforma† for establishing a like organisation is reproduced here.

1. Noxious Weeds Committee

1.1 The purpose of a Noxious Weeds Committee is to ensure that efficient and effective control of noxious weeds is achieved in the area the Committee represents.

1.2 The first step in the formation of a Noxious Weeds Committee is for the County Council to convene a meeting of representatives of all persons or agencies likely to be involved.

1.3 Membership of the Noxious Weeds Committee should include all or any of the following:
County Council (Chairman, 2 members, Clerk, Noxious Weeds Inspector).
Federated Farmers (Chairman, 4 members).
Ministry of Agriculture (Livestock Instructor, Advisory Officer).
Lands Department (Commissioner, Field Officer).
Catchment Authority (Chairman, Soil Conservator).
Ministry of Works (Resident Engineer).
Any other appropriate organisation (e.g. N.Z.E.D., Borough etc.).

† Drafted 5th June 1973 by the Committee Secretary Mr I. G. C. Kerr.

2. *Noxious Weeds Survey*

2.1 So as to be able to assess priorities and organise a control programme the Committee should arrange for a noxious weeds survey to be carried out if one does not already exist.

2.2 This survey should be carried out jointly by any or all of the following:

(a) County Noxious Weeds Inspector.

(b) Livestock Instructor, Ministry of Agriculture and Fisheries.

(c) Farm Advisory Officer, Ministry of Agriculture and Fisheries.

(d) Field Officer, Department of Lands and Survey.

(e) Soil Conservator of Catchment Authority.

2.3 The areas and location of significant noxious weed infestations should be marked on N.Z.M.S. 1 Topographical Maps (1/63,360).

2.4 The responsibility for control should be established after reference to N.Z.M.S. 177A Cadastral Maps (1/63,360), preferably with areas of Unoccupied Crown Lands, and Crown Reserves distinctly marked.

3. *Unoccupied Crown Land*

3.1 Application should be made early each year by the County Noxious Weeds Inspector and the Livestock Instructor, Ministry of Agriculture and Fisheries, to the Regional Livestock Instructor for funds to control noxious weeds on unoccupied Crown land, Crown reserves etc.

3.2 The control of noxious weeds on unoccupied Crown land is conditional on similar control, where necessary, being undertaken by the adjacent land occupier.

3.3 The control of noxious weeds on unoccupied Crown land, Crown reserves etc., is carried out by the County Council who are reimbursed by the Ministry of Agriculture and Fisheries.

4. *Publicity*

4.1 All land occupiers and organisations in the Committee's area should receive a newsletter:
explaining the purpose of the Committee;
showing the overall extent of the noxious weeds infestation in the area;
indicating what control measures the Committee recommends and the costs involved;
giving an outline of the Committee's priorities and programme;
urging support for and co-operation with this Committee.

4.2 All land occupiers and organisations affected should be notified of the approximate extent of infestation of various species of noxious weeds that they are responsible for.

4.3 A continuing programme of publicity in the form of newspaper articles, talks, demonstrations, reports, newsletters etc. is necessary to maintain interest.

5. Organisation

5.1 The County Council should appoint the Noxious Weeds Committee as an Advisory Committee of the Council so that the Committee can if need be enforce its decisions through the County Council.

5.2 The function of Committee members is to promote co-operation and action from appropriate persons and organisations.

5.3 Because the Noxious Weeds Committee is a co-ordinating committee it does not have any expenses apart from postage etc.

5.4 The annual noxious weed control programme should be organised and adopted by the Committee and carried out under the supervision and assistance of the Noxious Weeds Inspector with help from the Committee members.

5.5 Information concerning the intended participation by land occupiers or organisations in weed control operations should be collected and co-ordinated following discussions with or visits by an appropriate Committee member.

5.6 So as to achieve economies in weed control operations it is recommended that, once individual requirements are known, the County Council purchase in bulk any materials required and hire directly any equipment needed, and recover the costs from the persons and organisations involved.

5.7 To achieve the desired results it is necessary for the Committee to adopt specifications involving a high standard of workmanship by chemical applicators involved in weed control operations.

5.8 The County Noxious Weeds Inspector should undertake an intensive programme of demonstration, dissemination of technical information and advice to farmers, contractors and others engaged in weed control operations so as to ensure general adoption of the most satisfactory weed control techniques and to avoid injury, damage, wastage or pollution.

5.9 All secretarial and accounting duties should be carried out by the County Council.

A Contribution to Soil Conservation

Thirteenth Annual Report

of the

Tussock Grasslands

and

Mountain Lands Institute

1973

Personnel at the Institute

The end of 1972 saw the retirement from the Management Committee of its Chairman of recent years, Mr David McLeod. Mr McLeod, as a nominee of the High Country Committee of Federated Farmers, has been a member of the Management Committee since its foundation. His service has been outstanding in wisdom of leadership and in clarity of discernment of the issues with which the Institute has been faced. His vision and constancy both in the affairs of the Institute and in other matters affecting high country farming have been in no small measure responsible for the melding of interests of the high country farming community with those of the nation at large. This meld has been most clearly expressed in a common concern for resource conservation realistically incorporated with increased productivity and greater economic and social welfare of all users of tussock grasslands and mountain land resources.

Mr John Wardell has been appointed to succeed Mr McLeod as one of the High Country Committee nominees. Mr Arthur S. Scaife was elected by the Committee of Management as its Chairman for 1973 with Mr L. P. Chapman elected as Deputy Chairman.

Although there have been some changes in technical personnel of the Institute because of departures for travel overseas or pursuit of higher studies, no changes have occurred in the professional composition of the Institute.

The Director visited Europe for five weeks late in 1972. He spent a week at Montpellier, France, as a member of the expert working party on the Grazing Lands Project of the UNESCO Man and Biosphere programme, two weeks in visits to mountain research and watershed management operational areas in Switzerland and two weeks as the New Zealand delegate to the Science Commission of the General Conference of UNESCO at Paris.

The Evolution of the Institute's Work Programme

The objects of the Institute from its foundation have been:

(*a*) *To investigate the various aspects of management of the tussock grasslands and mountain lands;*

(*b*) *To develop techniques to bring about a more protective and stabilising cover of vegetation, so as to mitigate erosion and the choking of river channels with detritus, to minimise flooding, and to safeguard production;*

(*c*) *To provide a centre to facilitate the co-ordination of all research aimed to protect and improve the tussock grasslands and mountain lands, and to make this information readily available to all interested people and organisations;*

(*d*) *To foster and undertake research where necessary, in appropriate fields not otherwise covered.*

Different groups of people may have different interpretations of these objects. Recent annual reports of the Institute have given some attention to the adaptive evolution of the Institute's role in the tussock grasslands and mountain lands. The 1972 Annual Report was presented under the theme, "The Institute at Work in a Changing Scene". There could be little doubt that such a body as the Institute would change in function somewhat as it grew from two or three people to a dozen in less than a decade. Indeed, change was expected. Thus in November 1964, Dr Donald A. Williams, Administrator of the Soil Conservation Service of the U.S. Department of Agriculture, in his Report on Soil Conservation and Rivers Control Organisation and Administration in New Zealand wrote:

> **"The Tussock Grasslands and Mountain Lands Institute is serving a useful purpose for the high mountain farmers. There may be a need for somewhat more attention to research provided such efforts are integrated with other efforts."**

Initially there had been a reluctance by the Institute to engage in research. By the mid sixties Institute studies had begun on aspects of revegetation. These were followed by studies of pastoral production, soil loss by erosion and insect ecology.

During the last three years new research activities have been introduced, including grazing animal behaviour, growth and chemical composition of native grasses, watershed and channel behaviour, management and improvement of tussock grassland pastures, land evaluation for different purposes. Some of these projects involved original initiatives in research. Some of them were the formalisation in research projects of the scientific interests of members of the Institute stimulated by their co-ordinating, extension and advisory roles amongst persons and organisations concerned with the tussock grasslands and mountain lands. All of them have been consciously developed to a state where each now constitutes an Institute contribution to a co-operative project. This situation is shown in the accompanying schedule which lists the projects in which the Institute is involved in a research function in each of several sectors.

Sector	Major Projects	Co-operating Agencies
Erosion	Torlesse Sediment	Geography Department, School of Engineering, University of Canterbury; North Canterbury Catchment Board; Soil Bureau, DSIR; Botany Division, DSIR; Agricultural Engineering Department, Lincoln College
Revegetation	Sub-alpine field studies	Water & Soil Division, Ministry of Works; Catchment Authorities; Lands and Survey Department; N.Z. Forest Service
	Plume grass studies	Grasslands Division, DSIR
	Native grass nurseries	Plant Science Department, Lincoln College; Grasslands Division, DSIR
	Soil-plant adaptation studies	Ministry of Agriculture and Fisheries; Grasslands Division, DSIR; Soils Dept, Lincoln College; Soil Bureau, DSIR

Systems	Paddle Creek Hydrology appraisal	Agricultural Engineering Department, Lincoln College; Geological Survey, DSIR; Soils Dept, Lincoln College; Geography Dept., University of Otago
	Tall tussock productivity	Botany Department, Geography Department, University of Otago; Botany Division, DSIR; Grasslands Division, DSIR; Botany Department, University of Canterbury; Botany Department, Victoria University
Insects	Grasshopper studies	N.Z. Forest Service and numerous others
Management	Animal behaviour studies	Applied Biochemistry Division, Grasslands Division, DSIR; Ministry of Agriculture and Fisheries
	Feed quality studies	Biochemistry Department, Lincoln College; Applied Biochemistry Division, Grasslands Division, DSIR
	Coopers Creek pasture study	Ministry of Agriculture and Fisheries, Biochemistry Department, Lincoln College
Resources	Pastoral run production survey	Economic Service, N.Z. Meat and Wool Boards
	Land evaluation	Soil Bureau, DSIR
	Vegetation condition and trend studies	Water and Soil Division, MOW; Lands and Survey Department; Catchment Authorities.

This schedule of activities would seem to indicate that Institute research activity is wide rather than deep. In truth some topics are being studied in some depth, notably grasshopper population ecology, erosion and sediment transport, mineral ecology of tussock grassland plants. Most research projects which are listed represent the active contact zones for the Institute's role as "a centre to facilitate the co-ordination of all research aimed to protect and improve the tussock grasslands and mountain lands". The Management Committee has already perceived from its reviews of the variety and complexity of such research that such a role is most effectively achieved by the staff participating in co-operative research programmes.

The level of co-operation in the foregoing list of projects varies according to the nature and circumstances of the individual project. At the most intensive co-operative level, officers of the Institute are collaborators in a jointly funded project with another research organisation. At the least intensive level a common experimental site is shared by individual scientific organisations who are responsible for funding their own projects. The Institute contributes to the research effectiveness of other parties by sharing information on recent developments in research in different sectors of the country. This has involved visits to both field and laboratory, informal discussions and semi-formal workshops. One of these last organised by the Institute has concentrated on the energy relationships of soil and vegetation in mountain grasslands. Other symposia participated in during the last year have dealt with soil-plant-water relations and with nutrient cycling.

Most members of the Institute spend an appreciable amount of time in extension activity. This sector represents nearly a quarter of total expenditure and a larger proportion of total professional work effort. This service is maintained not only to high country runholders and catchment authorities. Increasing demand for information and advice is evident from planning officers for local authorities, officers of Lands and Survey Department in various fields and the general public at large.

A Contribution to Soil Conservation

The last year has been marked by the publication of a history of soil conservation in New Zealand, written by the first director of this Institute*. It is not inappropriate therefore to review the current contribution of the Institute to the soil conservation movement in New Zealand.

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* McCaskill, L. W. 1973: *Hold This Land,* A. H. & A. W. Reed, Wellington 274 pp.

There can be little doubt of the significance of the tussock grasslands and mountain lands to the national soil conservation movement. The most recent review by the Soil Conservation and Rivers Control Council includes the South Island high country region as a whole as one of the five priority regions in a national assessment of the severity of erosion. More recently the Chairman of that Council has identified the South Island high country as "the no. 1 soil problem area in New Zealand". The purpose of this report is a fulfilment for the present of the objects set out at the beginning, to make available the fruits of investigation and research on management, protection and improvement of tussock grasslands and mountain lands and therein to interpret the current contribution of the Institute to that function which is comprehended under the title "soil conservation".

Soil conservation, like good wine, defies definition. It is a matter of the spirit of stewardship at the same time as it is the formulation and practice of a code of rational use of natural resources. When L. W. McCaskill, writing the introduction to the history of soil conservation in New Zealand, was tempted to pose for himself the question, "What is soil conservation?" he had recourse to the Eleventh Commandment which W. C. Lowdermilk has wistfully composed for a further-seeing Moses:

> "Thou shalt inherit the holy earth as a steward, conserving its resources and productivity from generation to generation. Thou shalt safeguard thy fields from soil erosion, thy living waters from drying up, thy forests from desolation, and protect thy hills from over-grazing by thy herds, that thy descendants may have abundance forever".

With the aim of developing such a soil-conservation consciousness, McCaskill joined the aims of forming policy and practice of soil conservation: "to have soil conservation recognised as an inseparable part of flood control, to aim at having every acre of land used within its capability and treated according to its needs".

Soil conservation so understood is the responsible function not of one organisation but of the whole society including all its persons and organisations. It is not a resource management objective on its own but an essential ingredient of any resource management for any purpose whether farming, mining, forestry, recreation or urban settlement.

USING RESOURCES WITHIN THEIR CAPABILITY

1. A Statement of the Underlying Principle

Over the last quarter century of its history the soil conservation movement in New Zealand has been founded on the principle of using land within its capability. In general terms this principle can be expressed as follows:

Where a particular use of a certain kind of land exceeds the inherent capability of the land to sustain that use, the land resource degrades and soil erosion usually ensues. Such a use is therefore to be excluded from the range of permissible uses for that kind of land. The particular use may sometimes be modified by incorporating different degrees of conservation practice so that such a use does not lead to degrading of land and soil erosion. Subject to such restrictive modifications the particular use may be permitted. In some situations conservative modifications of the use are not feasible and the use must remain excluded from the range of permissible uses.

2. Land Use Capability Classification for Resource Use Planning

On the foundation of this principle and an American system of land classification based on it, a Land Use Capability Classification system is now widely used in New Zealand. The national implementation of this capability classification, in a special way the responsibility of the Water and Soil Division of the Ministry of Works, is actively participated in by the Catchment Authorities and is in part used by other government agencies as a guide for the implementation of resource management programmes. Some terms used in the classification are now entering the common vocabulary of runholders and of other farmers, of deerstalkers, foresters, engineers and the general public, even though there are some instances which betray an imperfect understanding of the classification system and the principle on which it is based.

From its inception this Institute has acknowledged the significance and validity of the principle of using land resources only in accord with assessed capability. For many years it has

employed a Planning Officer whose responsibilities include various tasks associated with the development, improvement and more effective application of this principle to the resource use problems of the tussock grasslands and mountain lands. A great deal of the past and current work of all the staff of the Institute has been designed to:

(a) determine the capability of different classes of land for different uses;

(b) identify the character and location of specific uses;

(c) analyse current experience and experiment to discern ways in which land use can be amended so that it is in accord with the established capability;

(d) devise novel ways of treating land of different classes to achieve conservation.

To provide a perspective for the Institute's work in this field a general outline is given of developments of Land Use Capability Classification in recent years and of further possible developments being evolved in the Institute to promote more effective planning for multiple use.

3. Application of Land Use Capability Classification to Tussock Grasslands and Mountain Lands

The general Land Capability Classification used in New Zealand has been a valuable framework for soil conservation operations in the tussock grasslands and mountain lands as well as in other sectors of this country. It may continue in such a role for many years to come. However, it must be emphasised that this classification is only a framework, a skeleton which must be fleshed out with the details of practice and sinewed with the decisions of management. It must likewise be emphasised that any capability classification is only as good as the knowledge of the basic land resources themselves and of their behaviour in particular uses.

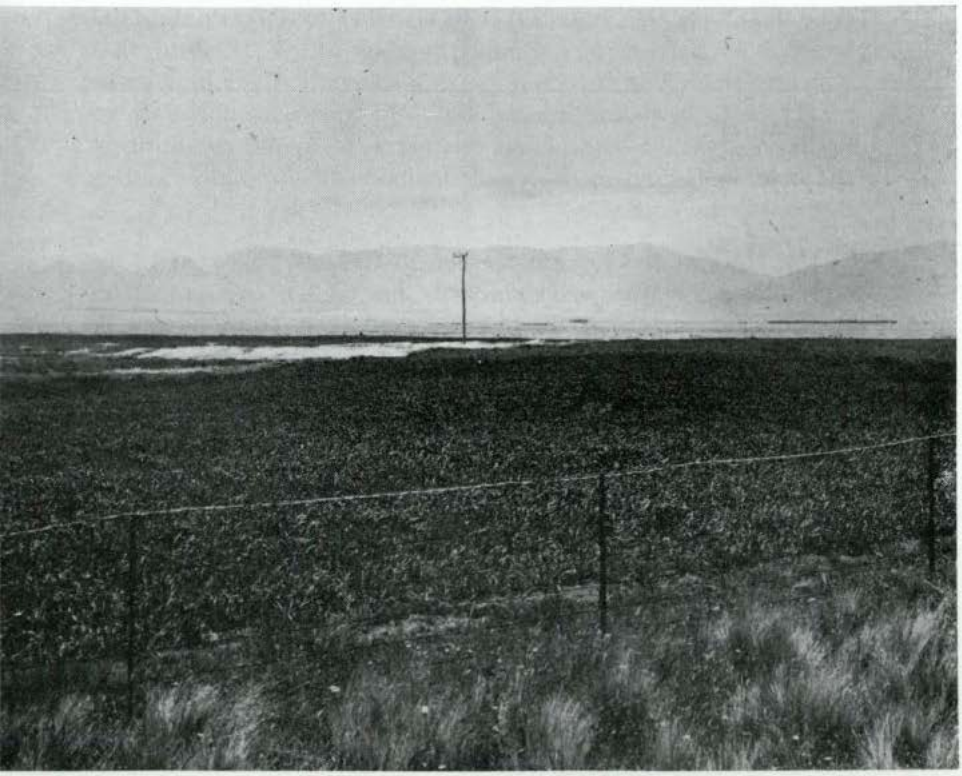
In New Zealand the principal land uses with which it has been concerned are arable agriculture and pastoral agriculture. Although four capability classes (I-IV) are suited with different limitations to arable agriculture, land of these four classes has also been used to a considerable extent for pastoral purposes along with land of the four non-arable classes (V-VIII).

(a) Arable land

In the tussock grasslands and mountain lands there is very little Class I land and only little more Class II land. Much of the Class III and IV land occurs within the boundaries of Pastoral Lease properties and until recently there has been little inclination on the part of runholders to seek approval to cultivate such land. With increasing levels of topdressing on terraces, downlands, fans and river flats, and with increasing attention to the quality of livestock nutrition in the high country, there is now much more runholder interest in cultivation of suitable land, especially for the production of supplementary stock feed. Conservation practices for arable land of different classes are therefore becoming important. The Institute has a considerable volume of material to collate in order to establish valid codes of essential practices for the arable use of Class II, III and IV land in the tussock grasslands. A particular feature of interest is that some land cultivated after thorough top-dressing and grazing management exhibits less propensity to suffer wind erosion than when cultivated from unimproved grassland. Some flat land at present classed as VI, unsuitable for cropping use, appears to be similarly improved by pastoral development.

"Much more runholder interest in cultivation of suitable land, especially for the production of supplementary stock feed."

Barley grown for cereal hay, The Wolds Station.



(b) Non-arable land

The classification of non-arable land in the tussock grasslands reveals generally small proportions of Class V land, substantial proportions of Class VI and Class VII and widely varying proportions of Class VIII. In the steeper gorge runs, especially in Canterbury and Marlborough, very substantial proportions of runs are determined as Class VIII by interpretation of the land inventory record obtained by conservation survey. Thus they are interpreted as lacking capability for sustained grazing use, generally because of extreme erosion hazard, even with the most stringent conservation practices. Such Class VIII land and some adjacent land has been progressively retired from regular grazing use over recent years by a variety of processes, including management adjustments within the run, boundary adjustments with renewal of leases, and retirement fences under Conservation Run Plans. The use, rehabilitation and management of such land retired from grazing use have been the subject of Institute investigations from the foundation. Recent progress in this sector is outlined later in this report.

In the broad area of concern dealing with non-arable land in the tussock grasslands, most of which has been under traditional grazing use for 100 years or more, collective use experience should enable the skilled land classifier to separate the land which is not capable of sustaining grazing use (VIII) from that which is capable of sustaining grazing use with severe limitations (VII), with moderate limitations (VI) and with slight or no limitations (V). Use experience is betrayed in the condition of the land itself both in degree of depletion of vegetation and in degree of erosion of soil.

The Institute has been concerned in the past that criteria for separation of classes and standards for conservation practices required for each class might vary excessively from district to district. The former active experience as soil conservators of nearly all of the professional staff of the Institute, coupled with their continuing work with Catchment Authorities and Water and Soil Division staff in tussock grassland and mountain land areas of both Islands has contributed in some degree to the greater practical harmony of land capability classification standards among districts that now exists.

(c) Land Use Capability Unit

The Land Use Capability Unit* has recently been developed as the basic component of the Land Use Capability system. Present members of the Institute staff have made substantial contributions to this development. In practice the Capability Unit is delineated on maps as an area of relatively homogeneous inherent characteristics. This is not often practicable for mountain lands on scales greater than 1:50,000.

The Institute welcomes the clear expression of the Capability Unit concept in the Land Use Capability Survey Handbook produced for the Soil Conservation and Rivers Control Council by the Water and Soil Division of Ministry of Works. The Capability unit concept will provide a much more precise basis for the planning of land use in the tussock grasslands and mountain lands.

(d) Standards of conservation management for different uses

Much of the current work of Institute staff in their own research and in collating the findings of other scientists is intended to establish standards of conservation management for pastoral use as well as for other uses of different capability units. It has become evident that one of the most important differences between different capability units lies in soil fertility. Conservation management standards are therefore needed for each in formulations of seed and fertiliser for oversowing. Likewise studies of native grasses allow the formulation of management standards appropriate for different capability units which are not likely to be topdressed and oversown in the near future. An account of progress in this work is given in a later section of this report (see Codes of Land Management Practice).

(e) Recognition of pattern of land units: the land system

Although the land inventory units recorded in the conservation survey of a particular property establish the boundaries of capability units readily enough, the full application of the capability unit concept has been hampered by the lack of detailed soil survey information and agronomic records in most

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*** A Land Use Capability Unit comprises those lands requiring the same kind of management and the same kind of intensity of conservation treatment, adapted to the same products and having similar potential yields.**

Sown pasture at intermediate level of culture on Braemar Station with front slopes of Ben Ohau Range in the background.

"To record the actual use experience and production performance for almost every paddock and block on each side of Lake Pukaki".

of the tussock grasslands and mountain lands. Hitherto soils in these regions have been mapped only as soil sets, containing within them a considerable range of actual soils of varying capability. It has been for the soil conservators engaged in inventory work to identify their own units within the soil set, sometimes without the benefit of skilled profile examination or soil correlation. The Institute has therefore been glad of the opportunity during the past year to co-operate with Waitaki Catchment Commission staff and a soil survey team of Soil Bureau, DSIR, in the promotion and utilisation of a more detailed soil survey of a portion of the Mackenzie Basin in the Upper Waitaki catchment.

One phase of the Institute work in this area has been to facilitate the field work of a graduate student at Lincoln College for the Diploma in Natural Resources whose project was to interpret the Land Systems of a sector of the Upper Waitaki catchment. The Land System represents the recurrent pattern with which tracts of land at the level of Capability Units exist in the landscape. There can be few better ways in which land information can be organised for the implementation of a conservation programme, for the relationship in the landscape of each kind of land to each other is readily seen.

(f) Land evaluation for pastoral use

Another phase of the Institute's work has been to record the actual use experience and production performance for almost every paddock and block on each side of Lake Pukaki, assess on the basis of experience and experiments the pasture production at each level of culture for every soil occurring in the area, and check the actual stock carrying performance of each paddock against the performance estimated from the aggregation of assessment for the areas of soils within each paddock. A close correlation has been found between actual livestock load and estimated capacity derived from pasture production assessments.

The results of these studies indicate that provided there is sufficiently detailed soil mapping and sufficient pasture production records either from experiment or by monitoring of farmers' field performance, the accurately defined capability unit can be used not only as a basis for land use planning but also for estimating livestock carrying capacity and economic value in pastoral use. Future work at the Institute is intended to test such techniques for cropping and tree growth, as well as to extend the experience with pastoral use.

It is anticipated that the greater precision provided by the Land Capability Unit based on good soil survey and supported by agronomic or other use records will be of considerable value for the alternative and multiple use situations which are now emerging in the tussock grasslands and mountain lands. Likewise it is expected that the practice of interpreting the Capability Units as recurrent features of Land Systems will provide a valuable framework for regional planning integrated with catchment planning.

4. The Need for Evolution of Land Use Capability Classification

The outline above of current activities of the Institute in the application of land use capability classification to tussock grasslands and mountain lands indicates two particular aspects of the Institute contribution to soil conservation. First it is dedicated to improving the validity of the actual basis for the classification system. Second it is concerned to increase its usefulness as well as its precision.

Pastoral land of the tussock grasslands and mountain lands generally, for economic and conservation reasons, cannot continue to be used in the identical fashion of earlier traditions. It will become imperative therefore to identify and define capability units on the basis of scientific soil and vegetation research and the use experience of land development rather than merely rely on the evidence of land condition as an outcome of past use in the undeveloped state. The necessity for detailed soil survey in tussock grassland areas is evident. Fortunately, the detailed pedologic studies which have been carried out in the Upper Clutha, the Mowbray, and the Mackenzie, indicate that soil characters are closely related to the occurrence of soils in landscape. Properly defined soils respond as units in land development. Agronomic experiment and current farming experience have to be related to such defined soils. Current research with which the Institute is familiar reveals that depth, slope and aspect variations in soil greatly affect the response to land development practices. The land use capability classification system must take account of such differential response to development or run the risk of becoming irrelevant to the technology on which practical soil conservation and economic prosperity of the pastoral industry alike depend.

The usefulness of the land use capability classification system in the past is not in dispute. It would be unfortunate if we were to become complacent because of the wide acceptance of capability classification and its application in soil conservation plans for a high proportion of pastoral runs. There should be no complacency when development of off-site grazing sufficient to allow effective retirement of Class VIII land may require several years. Complacency is intolerable when the levels of improvement achieved in pastoral practice are only a small fraction of the levels demonstrated in research results. Likewise there should be no complacency when a very substantial proportion of the Class IV, VI and VII land in pastoral runs is perforce allowed to remain unimproved and in only fair or poor condition while its grazing load may be little altered either in quantity or in season of incidence.

It is acknowledged that it takes time to convert extensive pastoral management to intensive hill country farming. It would, however, greatly increase the usefulness of the land use capability classification system and its contribution to soil conservation if it were made the vehicle for much more rapid intensive pastoral development.

PROVIDING FOR ALTERNATIVE USES

The usefulness of the land use capability classification system would also be increased if it were developed further to provide a framework for considering alternative land uses in a multiple use situation. This possibility has been acknowledged in the Land Use Capability Survey Handbook but little such development has yet been manifest. The principles and procedures by which such planning can be done have been outlined in a recent publication of the Institute*. Current work in the Institute is intended to develop these principles and procedures to a level where they can be used as a practical guide for those responsible for administering our mountain land resources for a range of objectives. Some of these objectives are discussed below.

1. Recreation

Some of the most strident claims for resource use in the mountains are made in the name of recreation. Of greatest importance is the fact that recreation is not all of one mould, nor of equal significance to soil erosion or soil conservation. This Institute explicitly affirms its view that some forms of recreation based on the continued presence of grazing animals on land which lacks the capability to support them must be considered as transient in character. Risking the loss of soil and vegetation stability or foregoing the chance of restoring such stability is sufficient reason for excluding recreational hunting from the list of safe sustained uses for some kinds of land. The publicity which the Institute has given to game meat recovery, hunting and deer farming signifies its concern with the presence of these animals in conditions where they are ecologically hazardous and its interest in having them confined to areas where uses associated with them would be in accord with the capability of the

* O'Connor, K. F. 1972: *Planning for Recreation Among Other Uses of Mountain Land and Water Resources.* Rev. Tussock Grasslds Mount. Lands Inst. 24: 26-41.

Endeavour . . .

The opportunity . . .

REVEGETATION OF ERODED MOUNTAIN LAND

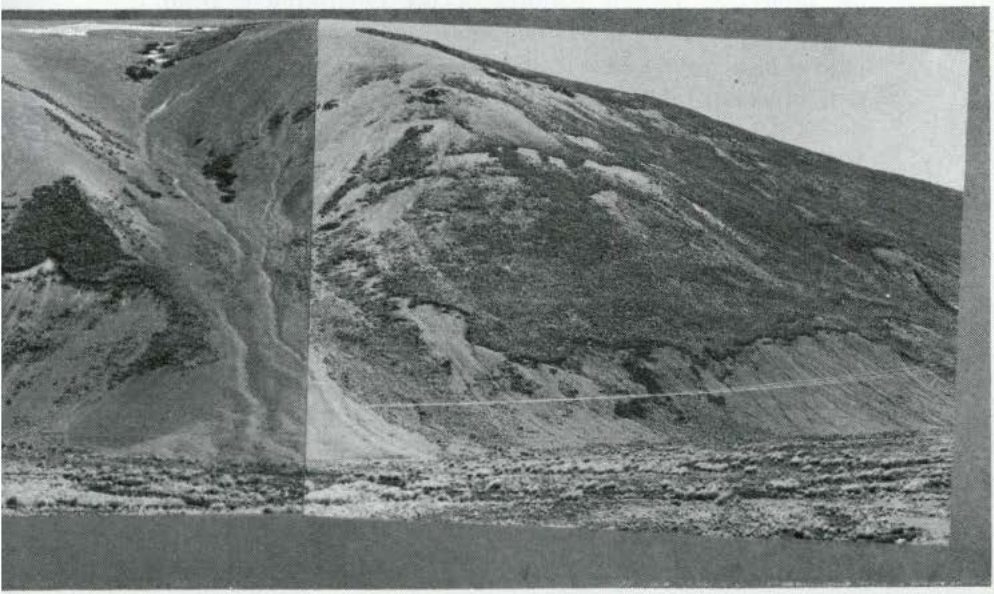
A new vegetative cover may be established, even on high-altitude sites with remnants of subsoil and raw parent material, if suitable seed and fertiliser are applied at the right time of year. This successful endeavour was at Island Pass, Molesworth.

. . . . On this denuded site at 1400 m above sea level Yorkshire fog, browntop, chewings fescue and white clover established well after October sowing with fertilisers supplying nitrogen, phosphorus, sulphur, magnesium and potassium.

(G. A. Dunbar)

. . . . These results provide positive leads to action being taken now on adjoining land by Lands and Survey Department, not merely to check further depletion of the vegetative cover and removal of soil but to begin the return to a more stable steepland condition. This opportunity for restoration is in the Upper Wairau catchment, Molesworth.

(E. R. Mangin)

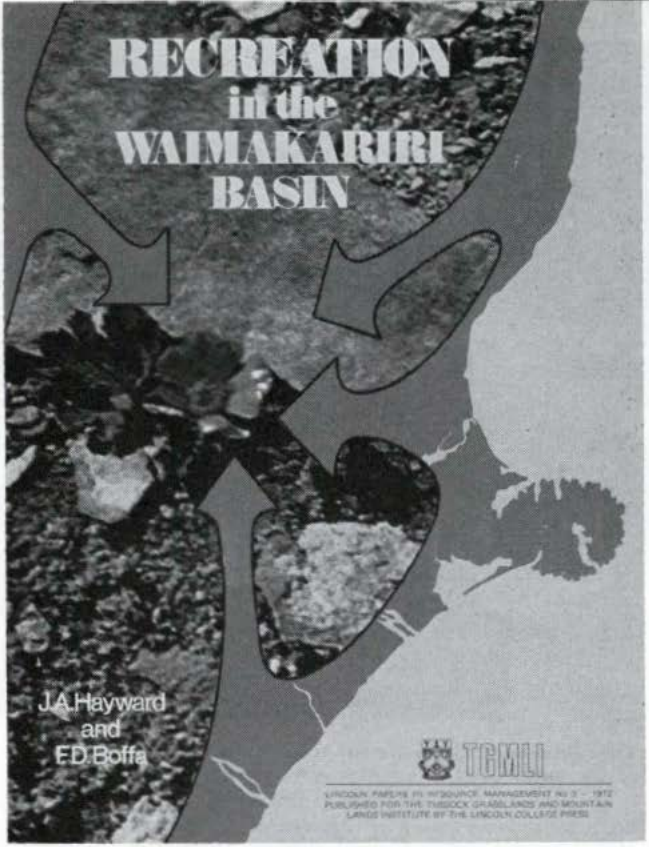


land. Recreational and commercial uses of wild animals must be subordinated to the need for control to a level determined by correct land use. What is correct land use can readily be defined in principle but it requires collaborative studies of animals, plants and soils to establish tolerable levels of grazing pressure in complex mountain situations. In pastoral land such grazing pressures cannot ignore domestic animals. The Institute is willing to co-operate in any appropriate way in the assessments that must be made in the interest of soil conservation. Considerable further research would be necessary before it could be established that open range grazing by deer, chamois or thar on a permanent basis for most sectors of the New Zealand tussock grasslands and mountain lands is within the capability of all the land units involved. The emphasis placed on the differentiation between various kinds of hunting and other forms of mountain recreation in the recent submissions by the High Country Committee of Federated Farmers concerning the future of lands retired from grazing is an indication of the need to consider the suitability of mountain land for different kinds of recreation. For this task the Institute is prepared to assist in any appropriate fashion, as has been indicated by the Waimakariri Recreation study published in 1972†.

2. Water Production

The Institute has been involved in recent months in assisting planning agencies by the provision of data and interpretations for protecting various features of the environment from disturbances detrimental to the public interest. When zoning of land is to be proposed for different land use objectives the question of compatability of uses becomes real and practical and the deficiencies of present knowledge become more obvious. Perhaps this situation is best illustrated in regard to the most important product of the tussock grasslands and mountain lands, water. Soil conservation does not require the justification of water production, for soils and vegetation are valuable in their own right even at high altitudes. Nevertheless, the significance of water production from the mountains has made it topical.

† Hayward, J. A., Boffa, F. D. 1972: *Recreation in the Waimakariri Basin.* Lincoln Papers in Resource Management No. 3. Lincoln College Press, 140 pp.



"As a practical guide for those responsible for administering our mountain land resources for a range of objectives".

Water is produced from tussock grasslands and mountain lands in varying and largely uncontrolled quality and quantity. Quality is most seriously affected by sediment but other factors such as enrichment of water with nutrients and organic matter are likely to be important as consequences of particular forms of land use in catchment areas. Whereas sediment is a most obvious pollutant in conditions of flood flows, it also adversely affects the possibility of water storage for use in low flow conditions. High and varying bed load sediments greatly affect the accessibility and utility of low flows. Dissolved nutrient loads are likely to be more significant to users in small streams than in large, in low flows than in high, in regions of low precipitation than those of high. Water quantity varies in its significance for different uses just as does water quality. For some uses summer flows are most significant. For other situations winter low flows are critical. For still others, total water yield is the dominant consideration.

The Torlesse Stream sediment trap. A vortex tube in the floor of the flume diverts bed load sediments to the weighing cage at the right of the picture.

". . . the current programme of research at Torlesse Stream into the relationship between stream discharge and quantities and sources of sediment".

In the catchment study dye dilution is used as a method of determining stream sources and volumes.

Information assembled at the Institute indicates that quality and quantity of water yield may be differently affected in different parts of the country by rock, soil and vegetation conditions and may also be differentially affected by the same land use practices in different conditions. It is noteworthy that land use management of some tall tussock highlands may conceivably affect water yield without notably affecting soil stability. In some of the major glacial-fed catchments on the other hand, land management may have negligible influence on the total annual water yield although it may locally affect seasonal water yield. While the Institute attempts to foster further research to clarify these features, it must also point out that water yield and water quality must be more critically defined as resource use objectives if they are to be used in multiple use planning in the future. Not only will it become necessary to define in some detail the suitability of different tracts of land for beef cattle production and production of different kinds of recreation value, including scenic value, but it will also be advisable to consider in more detail than at present the potentials of different tracts of land for the production of water at different times and for the negative production of sediment. The preliminary programme in hydrologic research at Paddle Hill Creek and the current programme of research at Torlesse Stream into the relationship between stream discharge and quantities and sources of sediment may have great value in assisting these problems of definition.

CODES OF LAND MANAGEMENT PRACTICE

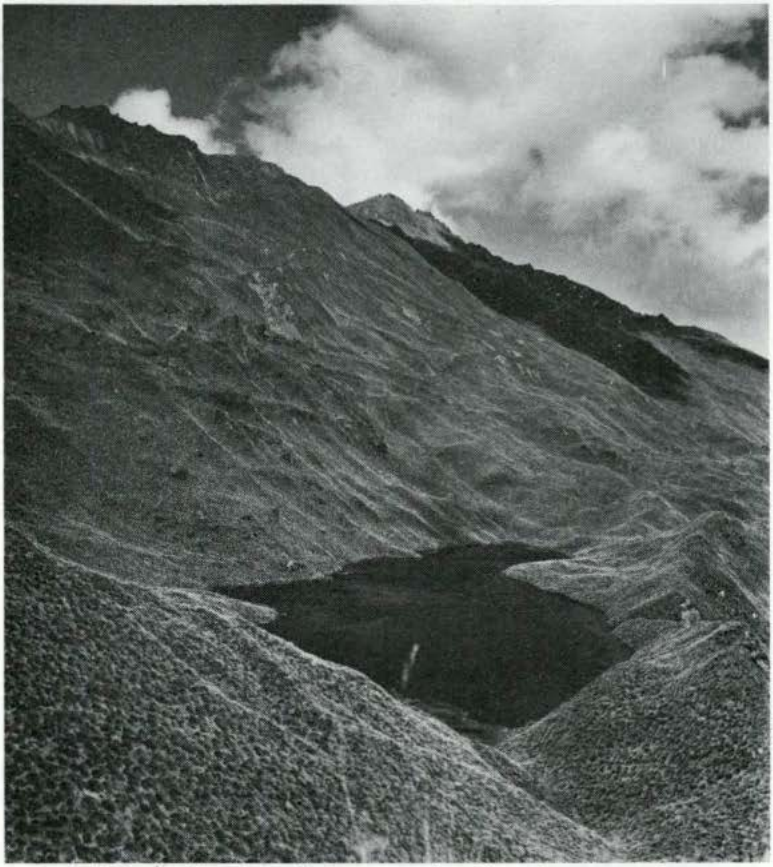
As has been noted several times earlier in this report, a large part of the Institute work is designed to collate information from research and experience that will provide objective codes of essential management practices appropriate to different capability units. An outline of progress in four sectors is given in the following sections.

1. Establishing Cultural Practices for Management of Land Retired from Grazing

The Institute has from its inception paid particular attention to acquiring and collating information on high altitute soil and vegetation management. A sustained set of studies evaluating plant and fertiliser materials for the revegetation of eroded and exposed high altitude mountain soils by the Institute agronomist has led to the discovery of widespread magnesium and potassium differences and interactions in addition to the nitrogen and phosphorus deficiencies discovered by Grasslands Division, DSIR, and N.Z. Forest Service. Results of this work have been progressively published and have been made available in advance to Lands and Survey Department and N.Z. Forest Service for implementation in aerial sowings. This sector of work contributes substantially to establishing standards for the restorative management of Class VIII land retired from grazing. A scientist member of a catchment board in an assessment of research on retired land at the November 1972 meeting offered the following comment on the Institute work in this sector:

> **"What this work really shows is that it is possible to establish plant cover on exposed subsoils of low fertility. It shows that this cover can persist. It shows that effects of frost can be diminished. It shows most importantly that the problem of establishing quick developing cover is a problem of plant nutrition and not primarily a problem in choosing species. The conclusions are that plants like Yorkshire fog, cocksfoot, chewings fescue, browntop and clovers are adequate for revegetation when nitrogen and phosphorus deficiencies are overcome and that magnesium and potassium will give an increased response. Plant introduction trials may reveal something new, but the starting materials are here and can be used with safety because much is known about them. Agronomic refinement, however, will be necessary. As a catchment board member I find that the primary research is done. The foundation is laid; modifications will be needed to suit some individual sites. Improvements will come from experience in doing the job".**

The work of Institute staff in latter years has given particular attention to the nutrient responses and persistence of sown native grasses in swards established by oversowing exotic grasses and legumes and has also recorded the increase of volunteer species both native and exotic in initially stabilised areas.



A high density of grasshoppers was found on these upper slopes of Mt Alta in the West Wanaka district.

(E. G. White)

"High density localities have been found at some high altitudes."

2. Assessing Needs for Insect Control for Maintenance and Improvement of Vegetation Cover

The Institute has for several years employed an Entomologist to assess the populations of some of the apparently more important insects and to assess the possible needs for insect control measures for the maintenance of vegetation. Three salient insect problems have been studied in varying detail: snow-tussock seed-feeding insects; cicadas in tall tussock-shrubland-herbfield associations; grasshoppers in tall tussock in different conditions. The most intensive study has been on grasshoppers.

Recently published work from this project gives a reliable estimate of their consumption under known density conditions. It can be inferred that their consumption pattern is not likely to deplete further the vegetation except perhaps in already very badly damaged open vegetation or perhaps in respect of susceptible revegetating plants, sown or volunteer. This inference depends, however, on the precision of estimates of annual primary productivity, herbage growth. Some good indices of this are urgently needed. They may emerge from the current Institute, Lincoln College and Otago University studies of tall tussock productivity.

During the past year a survey of opinion among scientists, field officers and others familiar with the high country has been made with the purpose of identifying localities in which high densities of grasshoppers have been experienced. Several of the areas so indicated have been sampled. If grasshoppers are indeed a problem seriously affecting vegetation cover then it seems the problem will be of very small extent. High density localities have, however, been found at some high altitudes where the expected ratio of annual consumption to annual production of herbage may be close enough to be serious.

3. Establishing Cultural Practices for the Management of Grazing Land

The soil conservation movement in the tussock grasslands and mountain lands is not going to achieve its objectives merely by the retirement of Class VIII land from grazing nor even by the successful revegetation of that land wherever revegetation is possible. Substantial areas of Class VI and Class VII land remain in grazing use and require management at improved levels of soil fertility or else at existing levels.

(a) Tussock grassland improvement

In some cases where soil fertility and climate are not grossly unfavourable, especially on Class VI land, vegetation conditions are not unsatisfactory for soil conservation objectives and there is no notable downward trend. These same situations are usually those where most gain in pasture production is achieved by introducing suitable grasses and legumes, top-dressing with appropriate fertiliser and intensifying grazing management. The Institute staff is engaged in collating published and unpublished information on these improvement practices for different soils and is actively involved in co-operative research programmes

with university and government department personnel in evaluating grazing management and topdressing practices, native and exotic grasses for use in such areas and in evaluating the soils themselves.

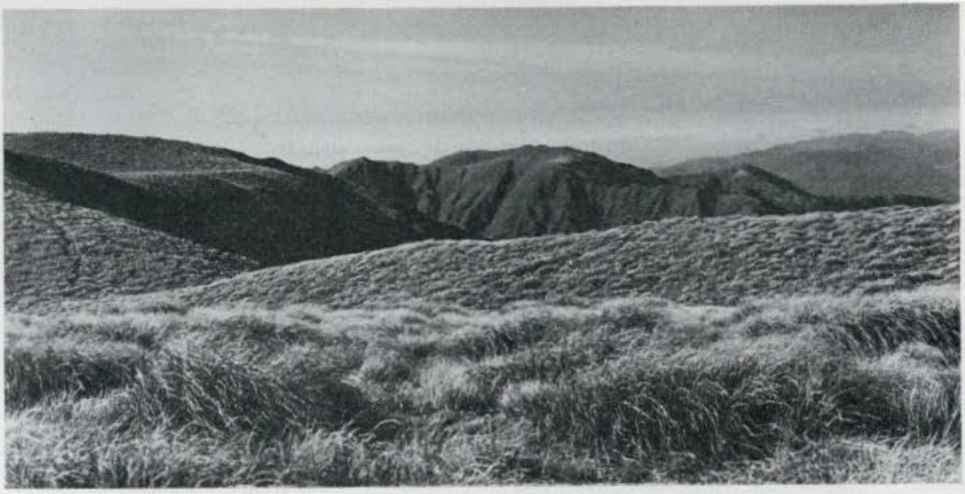
(b) Management of tussock grasslands at current fertility levels

Because of their responsiveness, Class V lands and the better Class VI lands are often given highest priority by a runholder in a development programme. Because of their capacity to provide alternative grazing to that previously provided by more vulnerable land of Class VII or Class VIII, such better Class VI lands are also often given high priority for development by soil conservators in the preparation with runholders of conservation run plans.

The implementation of a run plan therefore often leaves considerable areas of poorer Class VI and Class VII land for many years with no topdressing or legume introduction, indeed with no other conservation practice than a seasonal reduction in grazing load. Many of these areas are in tall tussock at various stages of depletion. The Institute has been actively involved with several university departments and divisions of Department of Scientific and Industrial Research and the Ministry of Agriculture and Fisheries in the active study of the ecology of several species of these tall tussocks (*Chionochloa*). The current emphasis of the Institute contribution is on the mineral ecology of the tall tussocks and of some associated grasses and legumes.

(c) Mineral ecology of grassland plants

Evidence accumulated from this work programme of the aptitude of different races and species of *Chionochloa* to different soils, especially differing in fertility factors, has been matched by evidence of such differences among introduced plants. Studies on sorrel and sweet vernal at the University of Canterbury by scientists of Grasslands Division, DSIR, have revealed similar features in those species. Similar information on introduced grasses and legumes has been derived principally from the work of present members of the Institute and the current studies of the Forest and Range Experiment Station on the revegetation of eroded high mountain soils. That plants differ in aptitude for different soils has great potential significance to the improvement



Tall tussock *Chionochloa* grassland at 1400 m on the Tararua Range above Otaki River (North Island). In a mosaic of *C. pallens* and *C. flavescens*, the taller *C. flavescens* occupies the hollows with more mature soil.
(P. A. Williams)

". . . *the aptitude of different races and species of* Chionochloa *to different soils, especially differing in fertility factors, . . .*"

Canterbury *Chionochloa flavescens* at 1000 m at Porters Pass. This form is ecologically distinct from the North Island form, being restricted to youthful soils such as the rubbly slope illustrated.
(P. A. Williams)

Lotus pedunculatus **intertwining on the supporting leaves of snow tussock. This introduced legume has been found to have greater aptitude to many of our high acidity, low phosphorus soils.**

Evidences of differences among introduced plants in aptitude to different soils.

of vegetative cover on the many areas of grazing land at present in unsatisfactory condition whose full rehabilitation by wholehearted topdressing and management would be likely delayed many years. The Institute especially welcomes the decision of the Director of Grasslands Division, DSIR, to allow the release of new varieties of *Lotus pedunculatus* and to develop further work on plant breeding and evaluation to suit a range of environmental conditions. The Institute itself is continuing its active collaboration with Grasslands Division, Soil Bureau, Ministry of Agriculture and Fisheries and the Soils Department of Lincoln College in this phase of work.

(d) Animal behaviour

The behaviour of grazing animals determines whether satisfactory vegetation conditions result from well-intentioned management decisions. Decisions to reduce grazing load on a block of tussock grassland do not necessarily reduce grazing pressure on a particular vulnerable species or sector of the block. Grazing animals have wills of their own. The studies of diet selection by the Management Officer of the Institute in the joint programme at Ribbonwood with Divisions of DSIR have indicated the significance of diet selection to the maintenance of satisfactory mineral balance in the stock and have also pointed to the likelihood of fertility transfers and uneven grazing pressures even within relatively homogeneous blocks. The current Institute studies on sheep behaviour in the Torlesse Stream catchment at Brooksdale suggest that there may be even more uneven animal presence and grossly different grazing pressure in a rather lightly

"To monitor the behaviour of silver tussock on a field scale under projected practical control measures."

THE PROBLEM:
Vigorous growth of silver tussock dominating an improved grassland. (C. B. Ward)

A REMEDY:
Reduced density of silver tussock following heavy stocking with sheep and cattle during winter.
(J. G. Hughes)

BUT THE PRICE:
Pugging of an adjacent swale of highly productive pasture, with some hydrologic significance.
(J. G. Hughes)

stocked but more heterogeneous block of land. Such studies are valuable for the development of standards of management that will be more satisfactory for soil conservation in such areas in the future.

(e) Assessments of vegetation and vegetation changes

Preliminary field assessments have been carried out in the Manorburn Experimental Basin in Central Otago for the analysis of vegetation, assessment of condition, and determination of changes in vegetation during the experiment. Strata within the catchments have been determined by the previous detailed soil survey of the basin carried out by Soil Bureau of DSIR. Stereographic cameras are being modified for the rapid recording of vegetation at fixed points within the strata. Assessments of other tussock grasslands can therefore be carried out in similar manner to that employed by N.Z. Forest Service at high altitudes.

Observations have also been made on changes in tussock grasslands at different localities where these have been subject to new management practices. The observed preference of sheep for certain sites, many of which are especially vulnerable to depletion and erosion has been noted in the past and has contributed to the arguments for the use of cattle grazing for the promotion of soil conservation. Extensive use of cattle, especially at moderate to high grazing pressures can generate its own set of problems. The depletion of tall tussock by cattle grazing has already been observed in many localities. Another problem with cattle dominance appears to be the increase of certain weeds. Molesworth has such experience in recent years and the Institute, at the request of Lands and Survey Department, has carried out a survey of weed incidence and apparent trend in certain sectors of that property to provide a basis for an improved strategy of weed control.

The oversowing and topdressing of some kinds of land can likewise lead to an increase of less palatable plants. Some attention in this respect has been given in the past by the Institute to matagouri. Its relatively slow growth suggests that it may not be as serious a problem as silver tussock has become in some of the tussock hill country, some of it recently depleted from tall tussock. The Institute has acceded to the request of Lands and Survey Department and catchment board officers to monitor the behaviour of silver tussock on a field scale under projected practical control measures.

4. Assessing Management Achievements on Grazing Lands

In any programme of amending land management the better to conform with land capability it is important to appraise management from the land user's viewpoint as well as from the viewpoint of resource condition and trend. Only by understanding the user's relationship with his resources are we likely to design acceptable amendments to management. The Management Officer of the Institute has maintained liaison with runholders and with catchment boards in this respect wherever it has been advisable in the preparation of run plans. He has also maintained liaison with the Economic Service of the Meat and Wool Boards and the Ministry of Agriculture and Fisheries in surveys of high country production and management. Institute staff have also carried out the first year's recording of the second complete enumeration survey of run utilisation and production in the high country sector. Results for the 1971/72 season have been summarised for publication. Results of the first two surveys 1965/67 and 1971/73 will be compared following the completion of the second year of recording in this second survey. In addition to the recording of all information on physical production, current recording is attempting to assess some of the changes in area of land utilised for grazing over the last few decades.

An important contribution to and measure of management achievement is the weighing of livestock. In recognition of this fact the Management Officer has promoted the evaluation of livestock weighing equipment by the N.Z. Agricultural Engineering Institute and with other staff of T.G.M.L.I. has co-operated with them in this task.

Conclusion

This review of problems and progress has considered the work programme of the Institute as a contribution to soil conservation in a wide sense, in keeping with the stated objectives of the Institute. The financial support of the Soil Conservation and Rivers Control Council and of the New Zealand Wool Board is gratefully acknowledged. The financial assistance of the Environment Council in meeting the expenses of the Waimakariri Recreation study report and of the Lands and Survey Department for the weed study report is also acknowledged. The co-operation of all manner of persons and organisations in the work programme of the Institute is warmly appreciated.

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

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A WEEDS CONTROL PHILOSOPHY

"There are several possible justifications for spending money to control weeds on pastoral land. Weeds can detract from the appearance of a property and reduce its market value. They may spread to the stage where the cost of control is beyond the value of the property. They may reduce the supply of available forage, the property thereby becoming less profitable and perhaps eventually uneconomic. Especially in the case of noxious weeds there is the further community responsibility of preventing their spread to neighbouring land."

" . . . budgeting for systematic weed control should continue to be an integral part of planning for future forage production . . ."

This philosophy on weed control is quoted from *Distribution of sweet brier, broom and ragwort on Molesworth Station* by E. J. Stevens and J. G. Hughes—Special Publication No. 9—1973, Tussock Grasslands and Mountain Lands Institute. Control methods are evaluated in this volume which should prove of interest to extension officers etc., and runholders troubled by these weeds. $2.00 per copy from the Institute. Copies for officers of the Lands and Survey Department will be distributed by their department.

SUCCESS IN OVERSOWING . . .

Farmers, as do research workers, measure the success of their oversowings on the basis of the number of plants surviving some years after seeding. Farmers tend to make some adjustments in the sowing rate of different species, but all too frequently the differences of seed size and the percentage germination are overlooked.

The following table has been prepared from average weights of samples each with 1,000 seeds. The germination percentage used for each species is in line with the quality of seed used by most farmers. The density of mature plants is derived from seed density and percentage survival. Unfortunately there is very little data available on percentage survival, but with the aid of this table the farmer will more readily observe the degree of success for each species he uses and can adjust future sowing mixtures.

Average Number of Viable Seeds Sown per Square Yard Seeded at a rate of One Pound per Acre

Legumes	
Turoa red clover (Mont)	43
Hamua red clover (Broad)	43
Pawera red clover	34
White clover	145
Alsike	102
Lotus	89
Lucerne	40
Grasses	
Ariki ryegrass	51
Ruanui ryegrass (perennial)	44
Manawa ryegrass (H_1)	45
Cocksfoot	95
Yorkshire Fog	210
Timothy	300

Note: 1 lb cocksfoot = 2 lb ryegrass = ½ lb Yorkshire Fog. 1 lb white clover = 3½ lb red clover and lucerne = 1½ lb Alsike.

—DSIR Grasslands Division.

Environmental Protection and Enhancement Procedures

Issued by the Commissioner
for the Environment
November, 1973

Introduction

1. Government has decided that in order to protect and enhance the environment a system of environmental impact assessment and, where appropriate, environmental impact reporting is to be introduced for all major Government works and actions likely to affect the environment.

Scope

2. The process of environmental impact assessment and, where appropriate, environmental impact reporting is to be applied to:

(a) the works and the management policies of all Government departments which may affect the environment;

(b) all proposed actions, by other than Government Departments, which may affect the environment, which are financed in whole or in part by money appropriated by Parliament and included in a departmental vote;

(c) the works and the management policies of all statutory boards, corporations, commissions, etc. which may affect the environment and which are subject to Cabinet Works Committee programming;

(d) the granting by the Crown of all licences, authorisations, permits and privileges which may have environmental implications and which are issued pursuant to:

(i) the Coal Mines Act, 1925
(ii) the Fisheries Act, 1908
(iii) the Forests Act, 1949
(iv) the Harbours Act, 1950
(v) the Health Act, 1956
(vi) the Iron and Steel Industry Act, 1959
(vii) the Land Act, 1948
(viii) the Maori Affairs Act, 1953
(ix) the Maori Reserved Land Act, 1955
(x) the Mining Act, 1971
(xi) the National Parks Act, 1952

(xii) the Noxious Animals Act, 1956
(xiii) the Petroleum Act, 1937
(xiv) the Reserves and Domains Act, 1953
(xv) the Urban Renewal and Housing Improvement Act, 1945
(xvi) the Wildlife Act, 1953

and such other Acts as may be determined from time to time by agreement between the Minister for the Environment and the Minister responsible for the legislation in question; the provisions included, or to be included, in proposed legislation affecting the environment, including Local Bills such as reclamation empowering Bills under the Harbours Act 1950.

Environmental Impact Assessment

3. Environmental impact assessment is a process whereby a conscious and systematic effort is made to assess the environmental consequences of choosing between various options which may be open to the decision-maker. At the most simple level the process need be no more than a mental check of the likely environmental consequences of a particular decision (for example a decision to grant a permit to enter a State forest). Decisions of greater complexity having the possibilities of greater environmental impact will justify a more rigorous examination backed by appropriate documentation.

Environmental assessment must begin at the inception of a proposal, when there is a real choice between various courses of action including the alternative of doing nothing. It must be an integral part of the decision-making process proceeding through all the development stages of a proposal through to actual implementation.

4. Environmental impact assessments are to:

(a) determine and evaluate the environmental impact of possible actions to enable a choice to be made between various options;

(b) determine whether or not the possible actions being considered would affect the environment significantly and would require the preparation of an environmental impact report;

(c) determine whether or not any measures should be taken to improve the environment, minimise or avoid damage to it in the course of developing or implementing a proposal irrespective of whether or not an environmental impact report has been or is to be prepared.

5. Provision for environmental needs is to be an integral part of the costs of a proposal and estimates or assessments of cost are to include appropriate provision for these needs. Some costs will be built into the overall design of a project and therefore are unlikely to be recognisable as direct environmental costs. Other costs (e.g. beautification or ancillary costs associated with the development of public amenities consequential to the principal activity) will be clearly identifiable.

6. The methods used to assess the environmental implications of a proposal can be varied to suit the nature of that proposal. A checklist to identify impacts may be useful and copies of such a checklist (Chart PW 27) may be obtained from the Ministry of Works.

The Environmental Impact Report

7. The process of environmental assessment may determine that an environmental impact report should be prepared. An environmental impact report is a written statement describing the ways of meeting a certain objective or objectives and the environmental consequences of so doing. The statement is not to be a justification for a proposed action, but is to be an objective evaluation setting out clearly and precisely, with appropriate documentation, the environmental consequences of a proposed action and of the alternatives to that action, and ways of avoiding or ameliorating any harmful environmental consequences.

Responsibility for Preparing Environmental Impact Reports

8. The organisation responsible for promoting a proposal or exercising a discretion with environmental consequences (in terms of paragraph 2 above) is also responsible for ensuring that the process of environmental assessment is carried out and where appropriate that an environmental impact report is prepared.

9. Where departments or other organisations responsible for the preparation of an impact report are themselves unable to assess environmental impact or to determine the provision for environmental needs, the Ministry of Works or such other department or organisation as the Commission for the Environment may suggest, may provide the necessary service including, if necessary, the preparation of the formal report.

10. Where the action concerned is proposed by a non-government agency but is subject to environmental assessment because Government approval or finance is involved, any impact report required should normally be prepared by the promoting organisation but with the agreement of the latter the relevant Government department may, if it so wishes, prepare the report.

11. Before an organisation prepares, or requires the preparation of, an impact report preparatory to the exercise of a statutory discretion, it should establish whether or not any other agency has a similar requirement in terms of these procedures. If necessary the Commission for the Environment will decide which organisation should prepare or commission the impact report.

When Reports are Prepared

12. Environmental impact reports are required for all actions or legislative proposals as defined in paragraph 2 above where those actions or legislative proposals are likely to have a significant effect on the human, physical or biological environment. It is for the Government organisation (including Statutory Board etc.) responsible for the action or legislative proposal to determine whether or not any specific proposal comes within this definition, but Government organisations are to be guided by consideration of the following questions:

(a) does the proposal transform a significant physical area?

(b) does the proposal affect existing communities or involve the establishment of new communities of a significant size?

(c) in respect of those living in the neighbourhood, is the proposal likely to have a long term effect on their living conditions or quality of life or their use and enjoyment of the environment?

(d) is the proposal likely to have a significant impact on ecosystems in the area?

(e) are any especially significant plant or animal species likely to be affected?

(f) are scenic, recreational, scientific or conservation values likely to be affected?

(g) is the proposal, although not significant environmentally on its own, likely to stimulate further developments which would have a significant environmental impact?

(h) does the proposal affect any areas or structures of historical or archaeological importance?

(i) is the proposal likely to be one of substantial public interest?

(j) does the proposal create a significant demand on a resource which is, or is likely to become, in short supply?

(k) does the proposal create significant pollution problems?

(l) has the proposal already been fully considered under the procedures of the Town and Country Planning Act 1953 or the Water and Soil Conservation Act 1967 and has this consideration involved a comprehensive examination of the impact of the proposal on the environment and provided an opportunity for public objection and appeal?

Minister may Direct Preparation of Report

13. Where a department does not propose to prepare an environmental impact report but in the view of the Commission for the Environment a report should be prepared in terms of the criteria referred to in paragraph 12 above, the matter shall be referred to the Minister for the Environment who may, after consultation with the Minister concerned, direct that a report shall be prepared.

Submissions to Cabinet Works Committee

14. All submissions to the Cabinet Works Committee dealing with projects likely to have an effect on the environment are to be accompanied by a report from the Commission for the Environment. It is the responsibility of the promoting organisation to ensure that the Commission receives a copy of the submission for comment. The Commission will be required to comment on whether, if an impact report has not been prepared, it believes such a report is necessary. Where there is doubt as to the need for an impact report, organisations are urged to consult the Commission for the Environment early in the consideration of a particular project. Failure to do this could lead to delays when the matter is referred to the Cabinet Works Committee.

Declaration of Intent to Prepare Impact Report

15. When a Government organisation (including a Statutory Board etc.), decides to prepare within the terms of these procedures an environmental impact report or to require in terms of para. 2(b) or 2(d) some other organisation to prepare such a report it is to notify the Commission for the Environment in writing giving a short description of the proposal concerned and its initial assessment of the environmental impact of the proposal and the date by which the impact report is likely to be completed. The initial assessment by the agency is to be in sufficient detail to enable the Commission to judge whether or not, in its view, an impact report is required.

16. On receipt of this information the Commissioner for the Environment may issue an appropriate public notification.

Content of Environmental Impact Report

17. The format for an environmental impact report is set out at Appendix A.

Relationship with Planning and Other Statutory Procedures

18. The procedures for environmental impact assessment and reporting are not alternatives to the statutory procedures required under the Town and Country Planning Act 1953. They have been introduced to make explicit provision for a study to be made of the environmental consequences of contemplated actions. Where there is a significant environmental impact it is likely that there will be implications for the local planning authority in respect of its District Scheme and objection and appeal provisions may be involved. The environmental impact report should therefore be prepared as early as possible to provide basic information for the local planning authority and other statutory authorities which may be involved in a consideration of the proposals. The impact report and the audit thereon will also be an important source of information for any persons who may have rights of objection and appeal under the provisions of the legislation. In the case of a Ministerial requirement in respect of a public work the impact report should, wherever possible, be prepared before that requirement is made.

19. The above considerations apply equally to proposals which involve other environmental legislation such as the Water and Soil Conservation Act 1967.

Proposals of Non-Government Agencies

20. Although the major impact of these procedures will fall on Government departments other organisations will also be affected by the provisions of paragraph 2. In some cases the environmental consequences of an action which is proposed and which comes within the terms of that paragraph may have been considered under the provisions of existing legislation (e.g. the Town and Country Planning Act 1953). This does not necessarily obviate the need for the preparation of an environmental impact report but it is to be a factor to be considered when determining whether or not a report should be prepared (see para. 12).

Timing of Environmental Impact Report

21. In addition to the considerations in paragraph 18 above, the environmental impact report should be prepared in sufficient time to ensure that all processes are completed including audit by the Commission for the Environment, by the time a decision is required from the relevant authority (e.g. Cabinet Works Committee or joint Ministers) which would commit resources to the proposal, or before legislation is introduced into the House of Representatives.

22. Departments are to bear in mind that for certain major projects with substantial environmental impacts more than one environmental impact report might be appropriate. The initial report could deal with various alternative solutions to the problem of meeting the objectives intended of the proposed development. A second report could deal with the environmental impacts of a specific proposal, when its form, location, scope and operation have been clarified as a consequence of consideration of the first report. In some cases a third report could be justified which would identify further environmental impacts, arising from detailed design work, additional specific information on the nature of the development (e.g. selection of operating equipment).

Consultation with Statutory, Local and Other Authorities

23. Particular environmental aspects of a proposal may by law or by Government decision be subject to approval or consideration by another Government agency, statutory or local authority. In general formal approval of such agencies should

be obtained following the preparation of the environmental impact report. Where timing is critical this may not be possible and in such cases the procedures for seeking such approval may be invoked before completion of the report. Informal consultation with interested authorities and organisations should be commenced as soon as possible and the results of such consultations referred to in the impact report.

Publication of Environmental Impact Reports

24. On completion the environmental impact report is to be forwarded:

(a) by a department to its Minister;

(b) by a statutory board, commission etc. to the Minister administratively responsible for that board, commission etc.;

(c) by organisations other than those covered in (a) and (b) above to the department responsible for exercising the discretion which has given rise to the requirement for a report, the department in question will in turn forward the report to its Minister.

25. On receipt of the report the Minister will decide whether the report should be:

(a) forwarded to the Commission for the Environment for public notification and auditing;
or

(b) referred back to the department for revision.

26. Twenty-five copies of the report which is to be audited are to be forwarded to the Commission for the Environment by the responsible department and, except as provided in paragraph 28 below, the Commissioner is to:

(a) insert appropriate notices in the New Zealand Gazette and in the Public Notices columns of the New Zealand press and in such other publications as he considers appropriate, the advertisements to state the nature of the report, where copies may be obtained and that any representation or comments on the environmental implications of the proposals should be forwarded to the Commission within 28 days of the notice;

(b) after consultation with the responsible department forward copies of the report to organisations, individuals and groups likely to be interested advising them as in (a) above.

27. The responsible department is to ensure that sufficient copies of the environmental impact report are made available to meet the likely public demand. A charge may be made for the report (where distribution is through the Government Printer this will be determined by him) and to keep costs down xerox or similar processes should be used where possible. All environmental impact reports released for publication are to contain or have appended a statement from the responsible department to the effect that the specific action covered by the impact report has not yet been decided upon by the Government. It should be explained that Government will consider the proposal in the light of all relevant factors including the environmental impact as identified in the impact report, any comments received from the public and interested organisations, and a report from the Commission for the Environment.

28. Should the Minister in charge of the responsible department consider, after consultation with the Minister for the Environment, that in the public interest an impact report should not be published, the matter will be referred to Cabinet for decision.

Audit of Environmental Impact Report

29. On the authorisation of the relevant Minister the completed environmental impact report is to be forwarded to the Commission for the Environment for auditing. The report is, as far as practicable, to include all relevant reports obtained from statutory, local and other authorities including the reports of experts covering particular aspects of the environmental impact of the proposal. Where it is not practicable to attach a report (e.g. size) a full reference should be made to the document.

30. In auditing the report the Commission is to have particular regard to establishing whether or not all environmental implications of the proposal have been identified and evaluated and that various alternative proposals have been adequately studied. The Commission is to ensure that advice has been obtained from appropriately qualified sources and that careful attention has been given to avoiding or mitigating harm to the environment and that wherever practicable environmental improvement

has been sought. In the process of auditing the report the Commission for the Environment may seek such further expert advice as it considers necessary. The Commission is to take into account any representations made by the public either by individuals or by organisations. The audit of the Commission for the Environment is to be in the form of a report to the head of the department or the statutory board etc., which prepared or commissioned the impact report, and is to be accompanied by any reports from experts or other agencies relevant to the substance of the environmental impact report and the audit thereon.

31. The Commission for the Environment is to report on its audit of an environmental impact report on or before 60 days of receipt of the impact report. This period may be extended by agreement between the department concerned and the Commission.

The Publication of Commission's Audit

32. The audit by the Commission for the Environment of any published environmental impact report shall also be published. The availability of the report is to be made known by an appropriate press notice or statement.

33. Subsequent to the issue of the above press notice a copy of the audit report is to be sent by the Commission to all individuals and organisations which:

(a) were responsible for the preparation of the environmental report;

(b) submitted to the Commission comments on the environmental impact report;

(c) have a *bona fide* interest and request a copy of the report.

Submission of Proposal for Approval

34. When a proposal which has been the subject of an environmental impact report is submitted for approval at the appropriate level it must be accompanied by the environmental impact report and the Commission for the Environment's audit report.

Action Following Audit and Approval

35. Where a proposal is approved without conditions the organisation responsible for implementing the proposal is accountable for ensuring that the environmental provisions included in the proposal, or promised for inclusion, are adhered to.

36. Where conditions are attached to the approval the means by which the conditions are to be observed are to be discussed by the responsible department with the Commission for the Environment before the work or action is commenced.

Effective Date

37. These procedures are to come into effect on 1 March, 1974.

Proposals Committed as at 1 March, 1974

38. Proposals already committed are defined as those for which preparatory planning, investigation and preliminary design have been substantially completed to a stage where a change will involve a repetition of much work. Such proposals which come within this category and which also would normally be subject to environmental impact reports are to be advised to the Commission for the Environment which may, if it considers such action warranted, ask for an environmental impact report to be prepared. In the event of the organisation concerned and the Commission failing to agree on this the matter is to be referred to the Cabinet Works Committee for decision.

FORMAT OF AN ENVIRONMENTAL IMPACT REPORT

Introduction

The aim of the following format is to achieve uniformity in the presentation of environmental impact statements. It is not intended to be rigid, but is open to modification of content and detail according to the type of statement being prepared, and to the nature and scope of the proposal being examined.

It will clearly not be possible or desirable in all proposals to go into the type of detail or be as thorough as the following guidelines imply is desirable. The scope of an impact statement will reflect the scale and scope of the environmental significance of the proposal.

In preparing a report, care is to be taken to ensure that appropriate expert advice is sought. Environmental impact reporting requires a multi-disciplinary approach. Great care is to be taken to ensure that those consulted for specific technical or scientific advice are appropriately qualified to give such advice. Organisations should not feel bound to seek advice from

departmental sources only but should seek the best advice possible from within and without the State Services. Where the advice is likely to be of critical importance in assessing the environmental impact of a proposal it may be desirable to consult more than one expert in the same field.

Written reports should conform to the following general layout, should be as concise and brief as possible, but should nevertheless embrace all relevant aspects of the environment.

ENVIRONMENTAL IMPACT REPORT

1. **Name of Proposal** (include name of relevant part of a larger proposal).

   Stage of Commitment State whether at the concept, planning or design stage. State whether it is in an approved programme of works (e.g. included in Power Planning report, Works Programme, forest planting or land development programme).

2. **Objective and Options**

   (a) the purpose of the action proposed and its justification in terms of public needs;

   (b) the options open to achieve the purpose defined and the advantages and disadvantages of each option in terms of the objective.

   Note: Certain options may be quickly discarded because of only marginal acceptability. Where there are two or more options which are sound the environmental impact of each option should be assessed so that the decision makers are given an opportunity to select from alternatives. The reasons for discarding options before assessing their environmental impact should be clearly stated. The "do nothing" option should always be considered.

3. **Description of Proposal**

   (a) description of proposed action, including necessary technical data, photographs, maps and other information relevant to an assessment of the environmental impact of the proposal;

(b) reasons (environmental, social, economic etc.) for following the action proposed including explanations for site selection and choice of locality, where relevant.

4. **Description of Existing Environment**

(a) general description of the characteristics and condition, in qualitative and quantitative terms, of the existing environment prior to implementing the proposed action, including a definition of the boundaries of the environmental sphere of influence for the purposes of the report;

(b) any special features such as the presence of critical plant or animal species and the stability of the current ecosystem. Where significant comment on geology, soils, flora and fauna, water quality, climate, hydrology and other relevant physical characteristics;

(c) relevant aspects of the existing human environment including land use, community patterns, man-made facilities and activities etc.

5. **Impact on the Environment**

(a) the Ministry of Works uses an information matrix for assessing environmental impact. Copies of this check list (PW 27) may be obtained from the Ministry. The chart may be modified in size, form or headings to make it relevant to the proposed project and departments may wish to develop their own check list to suit particular recurring classes of action;

(b) it is emphasised that the use of a chart is optional. For some impact reports its use may be helpful—for others it would clearly be of little value. The chart should be considered as a reference tool only and specific to the officer preparing the impact report. It should not be associated with the completed impact report;

(c) in considering each of the possible interactions, the following should be used as a guide:

(i) adverse and/or beneficial effects

(ii) primary and secondary effects

(iii) unavoidable effects

(iv) immediate short-term effects

(v) long-term effects

(vi) the probability of an effect occurring, whether or not any changes are irreversible, or will alter or consume an irreplaceable resource.

In each case the magnitude, intensity and significance of the effects is to be assessed and areas of uncertainty (where there is insufficient information for an evaluation) identified;

(e) the new amenities, if any, created by the proposal should be identified.

6. **Safeguards**

(a) identify the safeguards incorporated in the proposal to avoid or minimise adverse environmental effects;

(b) the environmental effects of the safeguards should themselves be evaluated;

(c) the possibility of remedial measures being taken later in the life of a project should be examined;

(d) the additional safeguards which could be adopted but which are not recommended and the reasons for this.

7. **Conclusion**

Summarise the environmental impact of the proposal, the steps that would be taken to minimise adverse environmental effects, and the recommendation which the department would place before the decision making authority.

8. **Consultation**

Individuals and agencies consulted for their expert views and advice or opinion should be listed and wherever possible their written views and/or recommendations attached to the report.

9. **References**

Any reference works or scientific/technical papers used in the environmental study should be listed.

10. **Responsibility for Report**

The report, which should be dated, should be signed by the permanent head of the department, or by a senior officer authorised by him, who is to take full responsibility for the contents.

The Top Fell Off Our Peruvian Mountain

Peter T. Gough

In May, 1970, a severe earthquake devastated the Ancash province of Peru, killing some 30,000 people. Its force was no more than 6.8 on the Richter scale. This was less than that of the 1968 earthquake in Inangahua in which only three people were killed.

To understand why the earthquake in Peru caused so much destruction and loss of life it is necessary to look at the physical and social geography of the area.

Peter Gough was a member of the New Zealand Andes Expedition which spent six months in South America during 1970. Much of his climbing was done in the Southern Alps of New Zealand and he is currently studying for a Ph.D. in electrical engineering at Canterbury University.

The Ancash province of Peru may be divided into three distinct zones. There is the coastal desert, the mountain ranges and included valleys, and the Amazon jungle.

The coastal strip seldom sees the sun, being covered by a cloud layer for nearly nine months of the year. This mist is caused by the interaction of the cold seas and the hot land, since the cold Humbolt current runs close to the coast at this point, and Peru itself is nearly on the equator. Incidentally, the Humbolt current provides Peru with one of its greatest industries, by carrying the nutrients for the many fish found there.

The coastal region stops abruptly at the foothills of the Andes, the Cordillera Negra, or the Black range. These mountains rise to 12,000 ft. (the height of Mt. Cook), and have no permanent snow. There are several major road passes across the range, affording access to the Santa valley. This valley runs almost directly north-south, and is situated between the Cordillera Negra and the Cordillera Blanca, or White range. The complete contrast between the two ranges explains their names, as on one side of the Santa valley one sees the bare rolling hills of the Cordillera Negra practically devoid of trees, whilst from the other side, rise the magnificent snow covered spires of the Cordillera Blanca.

On the eastern side of the Cordillera Blanca lies the Amazon jungle, the headwaters of the Amazon river.

The Blanca is the largest range of mountains in Peru, rising to 22,000 ft. The area has offered great challenges to New Zealand mountaineers for many years, but is in many ways very different to our New Zealand mountains. Since the mountains are virtually in the tropics they show very rapidly any variation in temperature. Thus the glaciers advance or retreat very markedly. In advancing they bulldoze a wall of rubble before them, and on retreating they leave an enclosed area which is filled by melt water from the glacier to quickly form a lake. At frequent intervals the terminal face from the glacier breaks away and falls into the lake, thus forming gigantic icebergs.

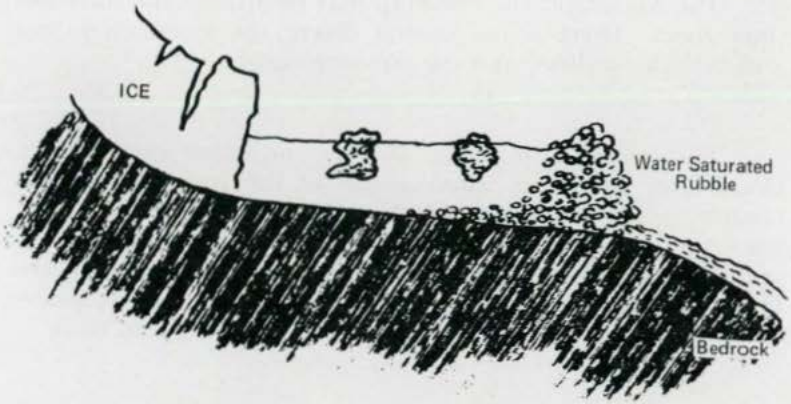


FIG. 1 THE MORAINE LAKES

The towns and villages of the mountain regions are as picturesque as the mountains themselves. They are filled with two and sometimes even three storey adobe mansions and houses topped by steep tiled roofs, the bright red tiles setting off whitewashed walls. The adobe-blocks of which the walls are made, are a mud straw mixture, making the houses cool in summer and providing good insulation to keep in the warmth of the fires in the winter.

These villages or *pueblos* are hardly the setting for a horror story.

In April 1970, I left New Zealand with a group of New Zealand mountaineers to climb in the Cordillera Blanca of the Peruvian Andes. A number of groups of New Zealanders have travelled to South America to climb in the Andes, which reach a maximum height of 23,000 ft. at the peak of Aconcagua on the border of Argentina and Chile.

The expedition travelled by boat to Panama and there we split up with half of the expedition flying to Lima, the capital of Peru, to organise local travel arrangements. The remainder with the food and equipment travelled on a cargo boat to Callao, the port of Lima.

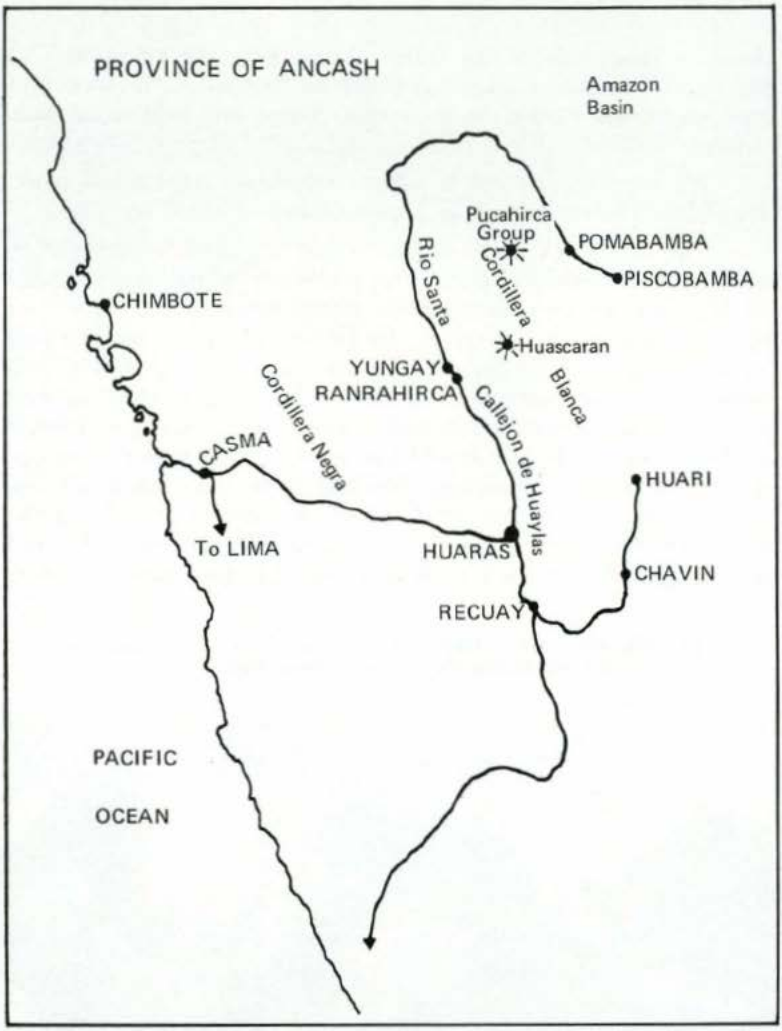


FIG. 2 SKETCH MAP OF REGION

After a few days in beautiful Lima City with its many reminders of Spanish origins we left the coastal desert and began the journey to Base Camp. A day's travel, in a country where this means twenty-four hours of continuous travelling, took us through the foothills of the Andes, the Cordillera Negra, and into the Santa valley to the town of Huaras, the capital of the province of Ancash. We then spent two days on the back of a truck travelling along the length of the Cordillera Blanca to the northern end, across a 14,000 ft. pass and into the

Amazon Basin side of the range. From here the remainder of the journey to Base Camp was made on foot while the food and equipment was loaded on to burros, urged into action by their driver.

We were to attempt to climb a hitherto unclimbed peak, Pucahirca Oueste, which is approximately 19,000 feet high.

The first week in Base Camp was to have been spent in acclimatising to the altitude. During this period we had intended to carry out most of the scientific programmes which were part of the expedition's objectives. In fact most of us acclimatised very quickly after the journey up through the high towns and villages and were very keen to begin climbing. Within the first week we had already negotiated a route up through the ice fall at the bottom of the climb and had established a depot of equipment well up the mountain. On the 30th May we made the most serious reconnaissance in which we almost completed the ascent of Pucahirca, but turned back in doubtful weather, and so managed to get back to Base Camp by the following afternoon.

The Pucahirca tops, from left, Pucahirca Norte, Pucahirca Central, and Pucahirca Oueste (the main objective).
—P. Gough

About three o'clock in the afternoon, therefore, five of us were lying in the sun at Base Camp, when the earthquake began.

We had all experienced earthquakes in New Zealand, but this was different. The ground started moving beneath us to the extent that it became impossible to stand.

Another member of the party, who had been visiting a dam further down the valley, was returning to Base Camp when the earthquake began, and found himself crossing a bog in which the tussock mounds were moving independently.

Although the earthquake lasted only about a minute, everything appeared to occur very slowly. The whole top fell off 'our' mountain, most of it fortunately falling into the valley behind. Some of it did fall into the lake beside our Base Camp, sending a wall of water surging over the moraine dam, and down the valley. Rocks and boulders toppled all around us, and a cloud of dust obscured the mountains.

The next day some news trickled into us from passing hydro engineers who were seeking a route out to Huaras on the other side of the mountains. All communications were cut and the road around the end of the Cordillera by which we had entered the Amazon Basin had been destroyed. Therefore they were trying to make their way through the high passes to the Rio Santa valley, in order to obtain news of friends and relatives. We offered to accompany them to see if we could be of any assistance, but they considered that our lack of fluency in Spanish, and complete lack of knowledge of native *Qhechua* would make us simply more mouths to feed under difficult circumstances. So we remained in Base Camp, and having helped some of the locals over a nearby 17,000 ft. pass, resumed our climbing programme.

It took us some time to get back to our previous position because of the large number of aftershocks which continued for a couple of weeks. Thus we did not learn the full extent of the disaster until some weeks later, on our return to the village from which we intended to leave the area.

The damage caused by the earthquake can be attributed to two separate causes. There was the damage caused by the *aluvion* or avalanche and that which resulted from poor building construction.

Pucahirca Oueste during the earthquake.

—J. Glasgow

The destruction wrought by the *aluvion* was the most costly in lives, the most violent. In a terrible instance a whole town of 20,000 people was swept away—leaving only the cemetery on a slight rise. The town of Yungay was the Hermitage of Peru, situated beneath the massive summit of Huascaran. During the earthquake a huge ice cliff high on Huascaran fell away, and falling into a glacier lake below, burst the moraine dam. Thus thousands of tons of ice, water, snow and debris surged down the main valley off the mountain, gathering rocks, mud and vegetation as it went.

During the earthquake clouds of dust swirled around this mountain hut. Elevation 14,700 ft.; below Pucahirca Oueste.

—P. Cough

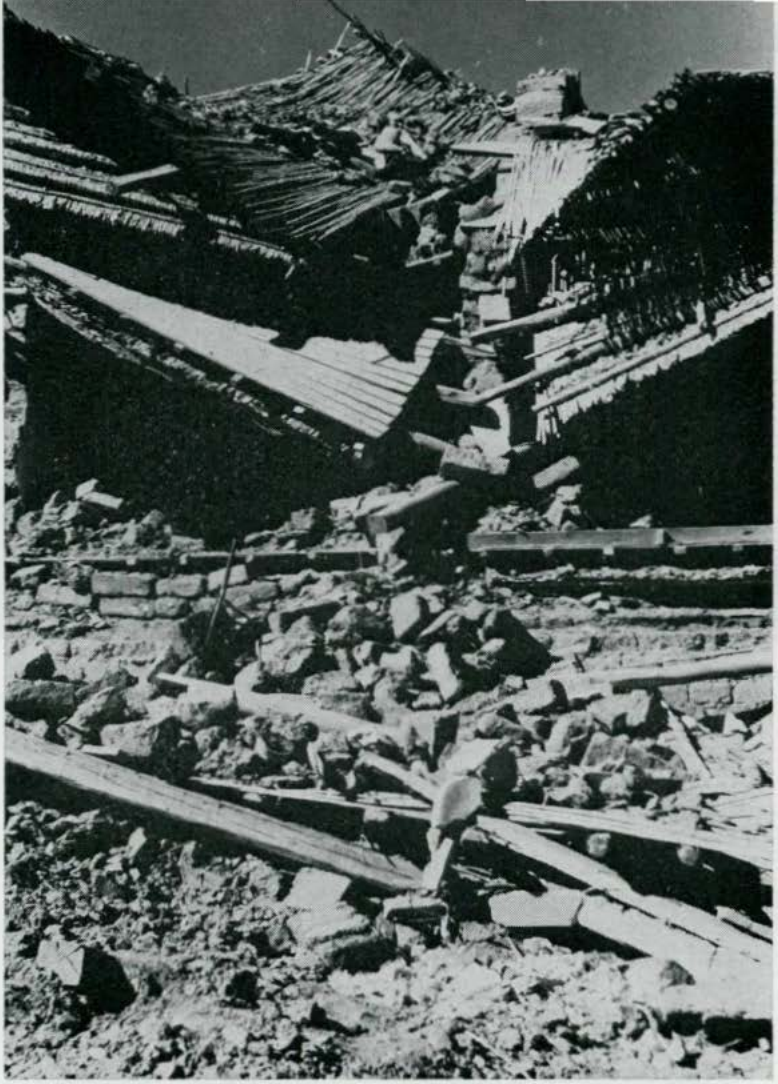
Pucahirca Oueste during the earthquake.

—J. Glasgow

It took ten minutes to reach the town of Yungay that had always considered itself safe from such occurrences, which are not unusual in the province of Ancash, because it was not sited in the main valley off the mountain. However a side chute of the avalanche leapt a five hundred foot hill, as a river overflows its banks, and swept onto the town below. A handful of people close to the cemetery hill were saved, stranded on the hill for several days, eating cactus, until the swampy surface had dried sufficiently for them to be able to cross it and make their story known.

This small village which lies between Yungay and Huaras shows direct damage caused by earth tremor.

—J. Gough



The remains of the hotel in Huaras in which the expedition members stayed on their way. One member was in the hotel but escaped uninjured.

—P. Gough

The other main cause of death was all the more tragic, because it could have been avoided to some extent. During the earthquake most of the *adobe* buildings completely collapsed because of inadequate reinforcing. Whilst the adobe blocks themselves are bound with straw the houses are built without any sort of tying at the corners. Neither are the roofs tied to the walls.

Pumabamba, a small town directly across the Cordillera Blanca from Yungay, at an elevation of 11,000 ft. It was little damaged by the earthquake apart from cracking of the adobe walls, which are untied at the corners.

—J. Gough

When the earthquake began the people ran out into the streets only to be crushed as the walls of the houses fell outwards and completely filled the narrow streets. Even those who remained inside were killed as the heavy rooves fell. Unsecured tiles added to the destruction.

The sole survivors of Yungay huddled on the nearest high ground which was the cemetery.

—J. Gough

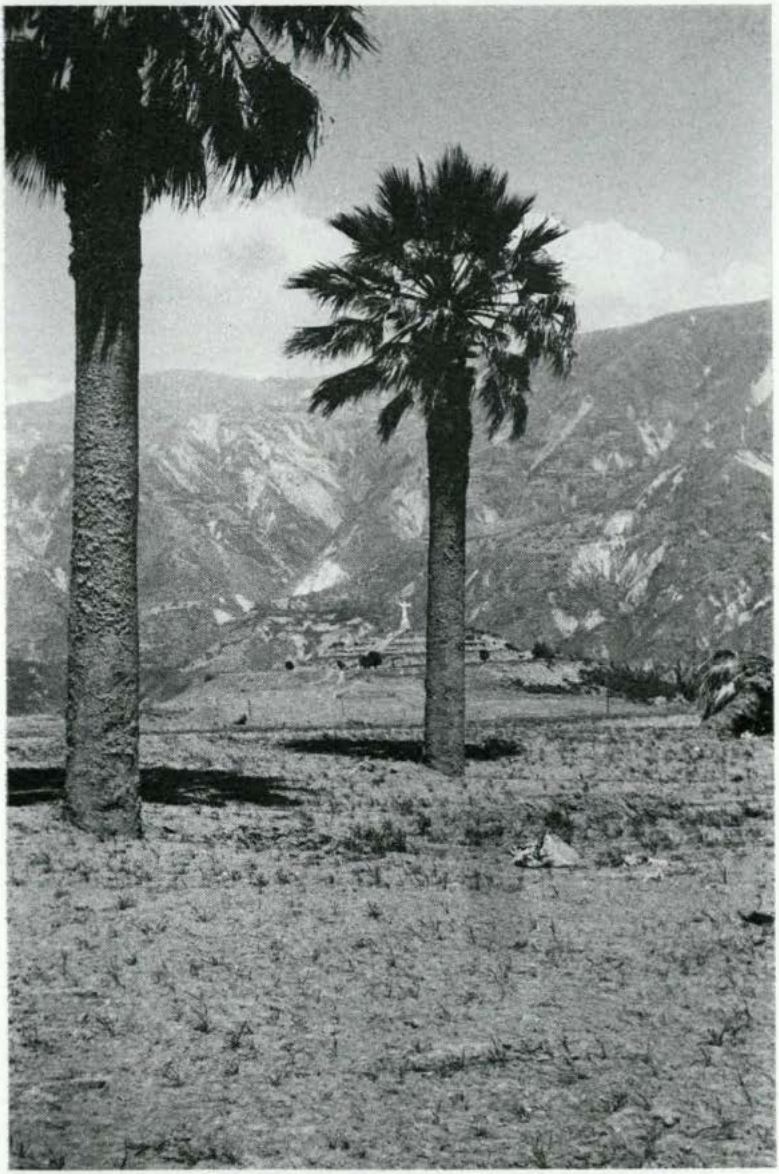
On this small plain a town once stood and the pride of Yungay was Mt. Huascaran in the background. The 500 ft. hill over which the debris swept is seen on the right of the picture. Crosses were placed all over the site by relatives of the dead.

—P. Gough

Those in the small high villages were on the whole much luckier for most of them were working in the fields. Those that were injured had mainly been hit by falling rocks.

Huaras, capital of Ancash, was the city most greatly affected, and here, even modern buildings did not escape.

A number of buildings still standing were considered structurally unsound because of large cracks, or because the people were just too terrified to live under the same walls. However, memories are short, and as we were leaving the area finally, some two months after the earthquake, the buildings were gradually being repaired, still in the same old manner with no reinforcement. When we asked what the consequences of a second earthquake would be, they replied 'it is as God wills it,' which seemed remarkably typical of their way of life.



Remaining features of Yungay which a few weeks before this picture was taken had 20,000 inhabitants. The scene is toward the cemetery and Mt. Huascaran is behind the photographer.

—J. Gough

Hidden in high cloud is Huascaran. Four palm trees survived the avalanche and mark the site of the cathedral which was the most solidly constructed building in Yungay. (See the opposite photo.) The mound on the right is the remains of an up-ended bus.

—P. Gough

A typical Peruvian village where all is well.

—J. Gough


Yungay y el Huascarán.

Earthquakes are a way of life in Peru. All over the country evidence can be found of this. It seems strange that the people are not more prepared for such contingencies. Huaras, half of which was destroyed in 1970, suffered a similar fate about twenty years previously when an *aluvion* swept through the central part of the city. Ranrahirca, a small village close to Yungay, has been completely destroyed three times now and it seems likely it will be rebuilt on the same site.

Retreat to Lima

Coming out from Base Camp, members spent some time in a small village on the western side of the Cordillera Blanca, attempting to get transport out for our equipment. Roads were cut, horses and mules unobtainable. Eventually the road was partly restored, and a bus set out from Pomabamba with Peruvians seeking news of relatives. Most of the members got aboard. After three days and three changes of vehicle, as impassable slips and rivers were met, we reached Huaras. At one point all persons and equipment had to be ferried across a large river on a rickety flying fox anchored in a sand bank, with half a 44 gallon drum suspended from the wire. At another point all equipment, and we had about 120 pounds per person, had to be carried for several hours down a steep hillside to avoid a landslide across the road.

The road to Huaras crossed the area which had once been Yungay, and which now was a dust covered flat with four large palm trees where the plaza had once been, and a small hill on which stood a twenty foot plaster statue of Christ, arms aloft, facing the mountain which had destroyed the town.

In Huaras life was by now returning to its normal pattern. Although the main part of the town had been destroyed, the administrative centre had simply moved itself to the undamaged end. The market had returned, situated half in its original building, and half in the street outside. Though it was now nearly two months after the earthquake, a number of relief workers were still in the area. The main problem facing them was to re-build for the homeless, before the rain-season.

Have your say or ask a question

In an earlier issue of Review, readers were invited to comment on any pastoral subject they felt strongly about. A few comments have been published. We think this healthy as it enables us all to appreciate some of the advantages or disadvantages enjoyed or suffered by the individual or the community. In most instances of advantage these are heeded readily enough if the idea is openly sponsored by someone in the know. That's you. In some instances of disadvantage these are heeded too if they who heed are disadvantaged by doing nothing about it. We could cite examples of this journal having already affected your lives materially (apart from what it costs you) but should not do so as we've only begun and hope to carry on, with your help. Customarily the pastoral community are readers and speakers before they are writers, but we have found that when a member does write he does so well . . . . see the Letters Column in *The Press* which are quite the best in the world, most of them written by the 'complete man' with the necessary time for writing. But our aim is not to discover the complete man, rather to create a better journal to serve our pastoral community.

Also we invited readers to submit their managerial problems to us. Some ticklish ones there were too, that the answers given might not have withstood publication critique. This is not to say the answers lacked quality but that most of these were extraordinary enquiries for which there are few answers. However we appreciate having these for if we cannot answer them we can refer the enquirer to an appropriate authority, or use the problem as a guide for future research or article selection. Where there was some doubt as to the validity of our answer we have asked, guardedly, for the recipient to conduct a limited trial, as with ram synchronisation and using ram harness at tupping, or criteria for the selection of beef breeds and so on.

You Asked

The following reply was sent to a North Island enquirer of some aspects of feedlot cattle farming:

Recently I have been endeavouring to rank common feedstuffs according to metabolizable energy produced within a given time. My present ranking is maize, choumoellier, lucerne hay, barley and straw, swedes, hay and pasturage, wheat and straw, oats and straw, fodder beet, turnips, average pasture.

The straw component of the cereal crop roughly equals the grain component for energy but in feedlotting 50 percent of the straw is not utilisable unless complemented with about an equivalent weight of grain or concentrate brought in; or mixed with a succulent crop.

There are several other crops which should be evaluated locally, such as peas, sorghum and pumpkins. In the maize-growing districts I would expect a combination crop of maize and cattle pumpkins (intersown) to return the highest yield of metabolizable energy within six months. The addition of choumoellier may improve this although cause a utilisation and harvesting problem. Cereal-vetch combinations such as barley and vetch make good cereal hay and yield well.

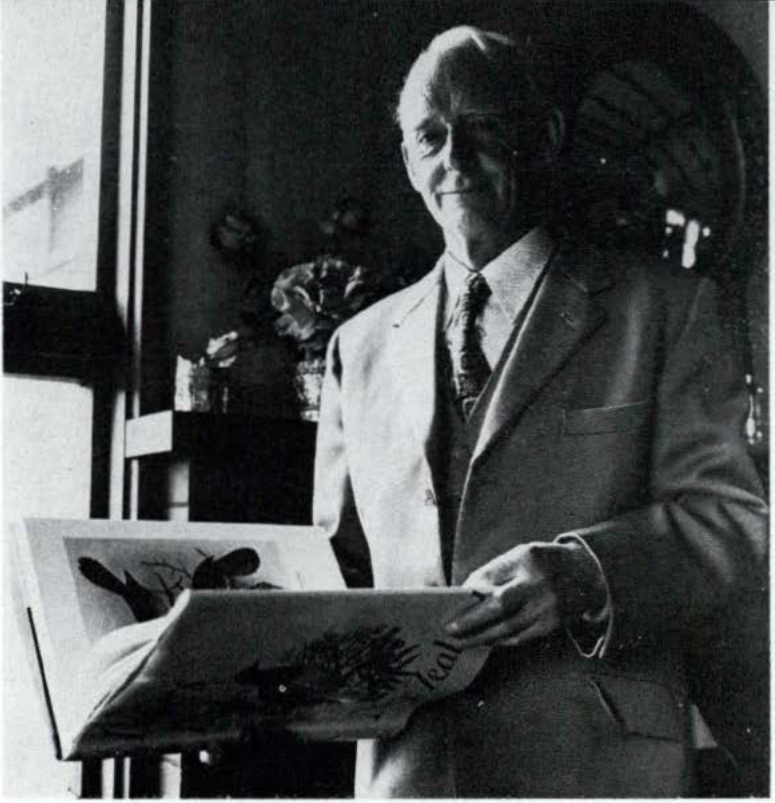
The possibilities with crop combinations are almost limitless.

Undoubtedly the crushed grains are more efficiently utilised by feedlot cattle but according to an article in Review 27 the crushing of grain is only marginally economic and for this reason has lost favour in North America. I think the quality, age and hardness of the grain are deciding factors. Fresh grains are less likely to need crushing than are grains which have been stored for some time. For instance, maize grain older than a season would need crushing. The matter is less critical with the other grains (depending on the rate of dehydration).

I have an opinion that where a farm-feedlot unit can support its own cropping programme the direct feeding of forage crops will prove more economic than full grain feeding since it involves fewer middlemen profiteers. However, grain feeding has its place to provide out-of-season feed.

I should add that one way around the high cost of marketted feeds is for a large proportion of these to be grown locally by co-operatives, or in joint contract-letting systems for cropping and harvesting, as in the pea seed industry, but where the farmer can retain a proportion of his crop, or buy part of it back. The other question is how to harvest a combination crop. Stemmed crops are forage-harvested but it is also possible to take out the pumpkins in a pumpkin-maize crop, by rolling aside the pumpkins from one swarth width of crop before harvesting it. This would be a worthwhile practice on an intensively-farmed area and has the added advantage of holding the pumpkins to fill the gaps in the feed supply.

—Ed.



Mr J. T. Holloway is to be conferred an honorary doctorate by the University of Otago for his conservation work with the Forest Service. He was formerly Director of the Forest and Range Experiment Station at Rangiora and a member of the Management Committee of the Institute. His successor in both positions is Mr J. Y. Morris who was appointed earlier this year. In the photo he receives from members of the Institute a volume of *Bullers Birds of New Zealand* which replaces an original edition that he lost in a hotel fire in London during the last war.

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