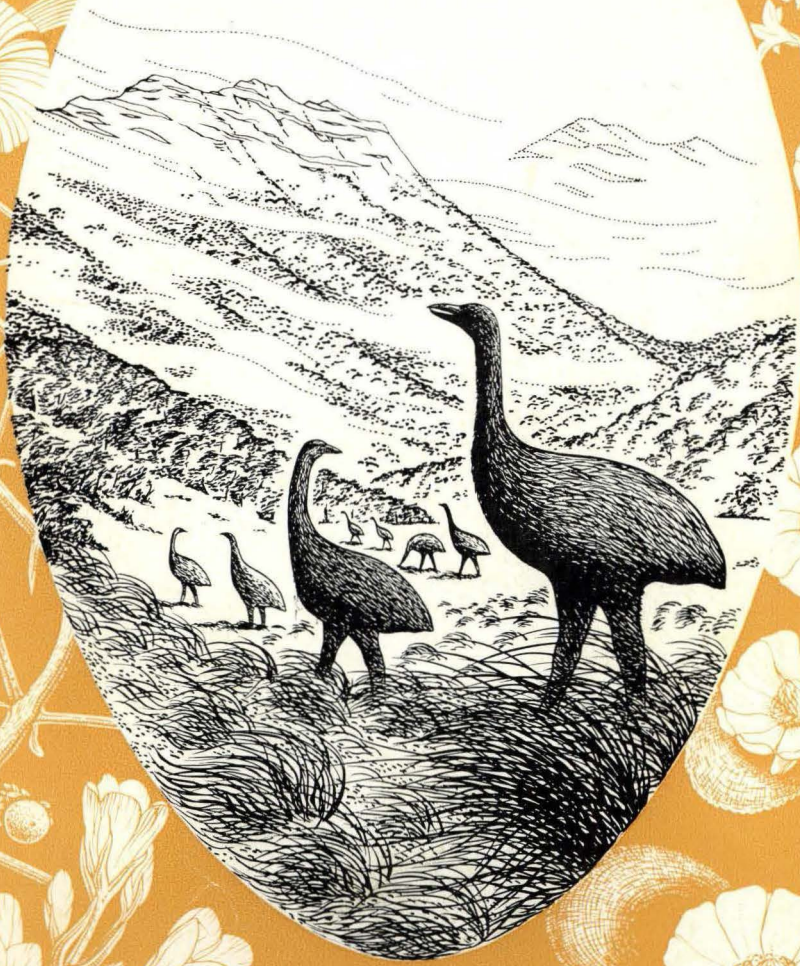
TUSSOCK GRASSLANDS AND MOUNTAIN LANDS INSTITUTE

REVIEW



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No. 2 February, 1962

RESEARCH CONFERENCE

In September 1961 the Institute organised a two-day conference of 20 representatives of organisations and Government departments concerned with research work in the fescue tussock grasslands and the low-altitude snowgrass areas. Those attending represented the Soil Conservation and Rivers Control Council; the Soil Bureau, Botany Division and Entomology Division of the Department of Scientific and Industrial Research; the Department of Agriculture; the New Zealand Forest Service; the Department of Lands; the N.Z. Catchment Boards' Association; Lincoln College; and the Institute.

The Conference was designed as a forum in which existing research projects could be explained, an assessment made of gaps in our knowledge, and advice be given to the Institute as to the nature and scope of desirable future research projects.

General agreement was reached by members of the conference on the following points of general interest:

1. That studies of condition and trend in vegetation are of great importance for work in the high-altitude grasslands.
2. That work on plant introduction, especially with legumes, should be looked at afresh in the light of our present knowledge of fertiliser deficiences and of the fact that such trials can now be carried out in the absence of rabbits.
3. That the major need, as far as plant introduction is concerned, is investigation of all possible strains of promising species, especially cocksfoot, with subsequent field trials on a comprehensive scale.
4. That there is a great need for further work on methods of introducing and establishing improved grasses into tussock grassland.
5. That there is an urgent need for more work to be done on the maintenance requirements of fertilisers to ensure that improvements resulting from oversowing and topdressing are maintained at the highest state of productivity.

6. That land capability surveys must be recognised as the only satisfactory basis for land use adjustments, farm plans and catchment control schemes.
7. That the plant-animal relationship was the most vital factor on which we required more knowledge.
8. That the main need on the lower country was the application of existing knowledge. The lack of application appeared fundamentally to be an economic problem. There was an urgent need for research into the reasons why progress was so slow.
9. That there was need for better demonstrations, on a run scale, of the results of research.
10. That more work was required in the whole field of hydrology especially in that area between precipitation and flow in the smaller streams.
11. That there was need for a detailed study of matagouri.

In 1962 the Institute plans to call a similar conference of workers concerned with research into the high-altitude grasslands.

RESEARCH GRANTS

In the light of its research policy outlined in the first issue of this Review, the Committee of Management has made the following grants to assist research projects of definite interest to the Institute:

1. To Mr C. J. Burrows of the Botany Department of the University of Canterbury, to study the inter-relationship between grasslands in which the tussock species *Danthonia australis, D. crassiuscula* and *D. oreophila* are important. These grasslands are extensive in the mountains of the South Island between 4,500 and 6,500 feet. Special climatic stations have been set up to study the environment in which these grasses occur and laboratory studies will be made of such factors as seedling growth and the degree of infestation by parasites.
2. To the Soil Science Department of Lincoln College to enable Professor T. W. Walker and his staff to carry out further work on sulphur in the soils of the tussock grasslands. The main aims of the proposed programme will be to examine some of the more basic problems such as the reasons for the widespread deficiencies of sulphur, the availability of sulphur in soils, and the fate of sulphur applied to soils.
3. To the Plant Science Department of Lincoln College to enable Professor R. H. M. Langer and Mr C. E. Iversen

to test crosses of creeping types of lucerne for their creeping ability, to test plants of this material under high-country conditions and to produce sufficient seed for large-scale trials to be carried out.

4. To the Agricultural Zoology Department of Lincoln College to enable Dr. R. A. Harrison and a student, Mr G. White, to begin a survey of the insect fauna in the tussock grassland, both leaf-eating forms and soil-inhabiting insects. Either or both of these groups may be of major importance in the maintenance of plant cover. A census of species will be made and the importance of selected insects will be investigated. This project has the interest and support of the Entomology Division of the Department of Scientific and Industrial Research.

CONSERVATION RUN PLANS

Subsidies Are Available for Land Improvement

As one of its aims is increasing the cover and thus the stability of the high-altitude grasslands, and as decreased use by domestic animals of those areas is dependent on higher-carrying-capacity of the lower-altitude grasslands, the Institute has decided that it will aim at encouraging the maximum possible improvement of areas of fescue tussock and low altitude snow-grass as soon as possible.

The Soil Conservation and Rivers Control Council under the 1941 Act and working through Catchment Boards, provides subsidies to assist farmers and runholders to undertake land improvements which will result in better cover and thus help to check run-off and soil loss. While subsidies are available for single practices, the tendency is to make them available on the basis of a farm or run conservation plan. Such a run plan is produced by the soil conservation staff of a Catchment Board in conjunction with the land occupier. The first step towards securing such a run plan is an approach to the Catchment Board or the District Soil Conservator of the Department of Agriculture.

Land Inventory

The first step in the production of a run conservation plan is the preparation of an inventory of those physical facts about the area in question which can influence the use of the land.

On suitable maps or aerial photographs, accompanied by detailed notes, the Soil Conservation Officer records particulars about the soil. Depth, texture, permeability to

water, supply of plant nutrients and erodibility are described for each soil type. The angle of slope is measured and recorded and an estimate is made of the amount of soil erosion that has occurred. The existing vegetation is described and mapped and the present method of using the land recorded. Also noted will be what information is available about the local climate such as the amount and intensity of the rainfall, the temperature and the wind pattern.

Land Capability Classes

Using the information collected in the land inventory it is possible to sort out units of land and place them in various land capability classes which are based on the capacity or potential of the land to produce while still maintaining an adequate cover of vegetation. The land class indicates the most intensive use to which units of land can be subjected without unduly increasing run-off or causing loss of soil by erosion. Such a classification is worked out by making full use of the recorded field observations, the results of research and field trials, and, wherever possible, the local experience and knowledge of the farmer himself.

The land capability classes used in New Zealand are as follows.

Land Suited for Cultivation

Class I. This is very good land from all points of view. It is level or nearly level. The soil is deep, fertile and well-drained and is not subject to erosion.

Class II. This is still good land but has certain physical conditions, such as slope, wetness or perhaps a tendency to drying out, which require careful management and the use of simple conservation practices.

Class III. This is moderately good land but, because of slope, poor drainage or dryness, the best of farming methods and conservation practices are necessary if it is cropped.

Class IV. This land is good enough for occasional cultivation under careful management but is not suited for regular production of cultivated crops.

Land Not Suited for Cultivation

Class V. This is land which is nearly level and not subject to erosion but because of its stony nature, outcrops of rock, or wetness it is not suited to cultivation. It is usually good grazing land and requires only normal standards of good management to maintain or improve its fertility.

Class VI. This is land so steep or with soils so shallow that it is not suitable for any but surface cultivation and needs considerable care to grow and maintain good pasture—typical stable N.Z. hill country.

Class VII. Because it is very steep, rough, or too dry, this land must be managed very carefully to retain a cover of grass or trees and thus control erosion—unstable or eroded hill country. This needs special conservation practices or treatment.

Class VIII. This is so steep, rough, unstable, eroded or swampy that it is unsuitable for grazing either by domestic or noxious animals. Any vegetation should be used solely for soil and water conservation.

Conservation Run Plans

On suitable maps or aerial photographs the land capability classes are marked. The occupier and the Soil Conservation Officer now discuss alterations in management to the end that use of the land may approximate as nearly as possible that of its capability class. Where Crown leases are concerned, the Pastoral Lands Officer should take part in the discussion. Appropriate conservation treatments are planned in the light of the economics of the property and of the subsidies payable. The implementing of such a plan is spread over a number of years depending on the resources available.

The final plan, if subsidies are to be claimed, is submitted to the Catchment Board for approval.

AN ACTUAL EXAMPLE

Let us take as an example a large run of nearly 60,000 acres which, because of a long history of rabbit infestation, has a large area of depleted and eroded ground. Thanks to the Rabbit Board, the pest is now under control and the owner has some certainty of a payable return for money he is prepared to spend on improvement.

He approached the Catchment Board with the intimation that he was prepared to spend money and effort which would result in the conservation of soil and water but that he could do more effective work if he were assisted by subsidy. The Soil Conservation Officer, using every available piece of information and assistance, made a land inventory and produced a map of land capability showing that the run consists of the following classes:

Classes II, III, IV	4 per cent
Class V	7 " "
Class VI	18 " "
Class VII	63 " "
Class VIII	8 " "

The maximum carrying capacity under present conditions is approximately one sheep to six acres.

The Soil Conservation Officer, in consultation with the owner, produced a conservation run plan which, while providing for the carrying of the existing stock on land capable of rapid improvement and able to stand intensive grazing, will exclude the Class VIII land from grazing and will enable the Class VII land to be lightly grazed and at times completely spelled.

Obviously conservation fencing must have a high priority in the plan. Other measures which will be included are:

1. Production of extra winter feed on the lower areas capable of cultivation.
2. After the winter feed is fed-off each year, sowing high-quality pastures such as lucerne-cocksfoot mixtures.
3. Development of the irrigable area where water is available.
4. Preparation of an area of "botom-land" for the production of seed crops of grasses and clovers. (The seed thus produced will provide materials for oversowing the Class VII land during the second five-year period).
5. Oversowing suitable areas of Class V and Class VI land.
6. Use of fertiliser according to indicated deficiencies.
7. Contour furrowing for water conservation and the sowing of grass and clover seed on the contoured areas by means of the chisel seeder, disc drill or sunprong harrow.
8. Controlling gullies by bulldozing and seeding.
9. Construction of farm ponds to enable cattle to be carried on dry tussock blocks during the summer.
10. Re-organisation of the stock management, including increased use of cattle to enable maximum utilisation of the feed grown on the lower areas and spelling to enable re-seeding on the depleted Class VII land.

Detailed costs of carrying out these practices over a five-year period were worked out and a programme prepared providing for an approximately equal amount to be spent each year. Most of the practices mentioned will qualify for a pound-for-pound subsidy so that the farmer will have to find only half of the total cost of £10,000. The programme will be reviewed annually in the light of progress already made and of changing economic conditions.

This is a run with a high proportion of land in Class VII, much of it depleted. The practices being followed in

the first five-year period are designed largely to enable the second five-year period to be devoted to the rehabilitation of the Class VII land by oversowing and topdressing and the use of sub-divisional fencing to enable better management.

The owner of this property is one of nearly 300 satisfied farmers for whom farm plans have been prepared by soil conservators since 1956.

The members of the Committee of Management of the Institute wholeheartedly support the conservation farm plan system. They believe that this system represents a sincere effort to conserve national resources and to assist runholders in maintaining sound properties.

SUBSIDIES AVAILABLE FROM THE SOIL CONSERVATION AND RIVERS CONTROL COUNCIL

Soil conservation subsidies and the conditions on which they are based cannot be made absolutely rigid nor be designed for all situations. Variations and exceptional cases will be met from time to time and the Soil Conservation and Rivers Control Council will consider each of these cases on its merits. All applications for subsidies should be made to the local Catchment Board or, where there is no Board, to the District Soil Conservator, Department of Agriculture.

Tree Planting

The subsidy £1 for £1) is restricted to areas eroding or likely to erode. The work eligible shall consist of the establishment and protection from damage by stock or other animals of trees or other protective vegetative cover on such areas. Works eligible include:

(i) Open planting of trees on areas which can be safely grazed.

(ii) Close planting of areas to be permanently retired from grazing.

(iii) Planting of areas where the removal of noxious weeds (in terms of the Noxious Weeds Act) would lead to further erosion.

(iv) Protection fencing of unstable areas which carry bush or other protective vegetation to be retired from grazing.

(v) Windbreaks. Where there is a wind erosion hazard, such as the funnelling effect in the mouths of gorges, subsidy for windbreaks is restricted to the protection of cultivated land or land intended to be cultivated.

The cost of fencing required to exclude stock shall be eligible for subsidy as will other forms of protection of trees from stock.

Conservation Fencing

Cases will be eligible solely on the basis that the fence proposed will control erosion of grazing land. Each case

will be considered on its merits e.g. the separation of winter from summer country, dark from sunny faces, and eroded from non-eroded land may be eligible.

The basis of subsidy is £1 for £1 on the cost of materials only (posts and wire) at the nearest railhead. In exceptional cases, where cost of transporting materials to the site is excessive, the Council may consider a higher rate of subsidy on the cost of materials.

Where cattle grazing is required to obviate burning or where it is recommended as a conservation practice, the bringing of fencing up to cattle-proof standards will be eligible for subsidy on the cost of materials. Subsidy of £2 for £1 on materials only will be considered for fencing off depleted and eroded country at higher altitudes where grazing restrictions are imposed, such as total retirement from grazing, seasonal retirement for seeding purposes, retirement from sheep grazing and limitation of types and numbers of stock.

Permanent Retirement from Grazing

The Soil Conservation and Rivers Control Council has approved in principle the meeting of the cost of fencing for permanent closure of land where it is the most practical method of controlling erosion and promoting conservation by natural regeneration, provided that:

(i) The land is Crown land.

(ii) The farmer undertakes normal maintenance of the fence.

(iii) Satisfactory arrangements are made to patrol the area closed and to control noxious animals and fire.

(iv) The assistance is restricted meanwhile to areas under conservation farm plans or catchment control schemes.

(v) An agreement is included in the lease to safeguard maintenance of the fencing and patrol of the area closed, by the lessee.

(vi) Where necessary, the cost of rabbiting is borne by a grant in lieu of rates from the Department of Lands and Survey as is done on unoccupied Crown land.

Gully Control

An overall subsidy of £2 for £1 is available for controlling active and potential gully erosion. This includes corrective and preventive work in the gully catchment such as fencing, tree planting, contouring, and diversion of water, and corrective and training work in the gully itself.

Farm Ponds and Small Flood Detention Dams

Where it can be shown that these can play a useful role in rehabilitating or conserving eroding or potentially erodible land the cost of construction may be subsidised as follows:

(i) Where the dams are entirely for flood and silt-detention, the subsidy will be £3 for £1.

(ii) Where dams are also used for other purposes such as stock or domestic water, fire fighting or irrigation, the subsidy will be £1 for £1.

Contouring

Subsidies of £1 for £1 may be paid for the following practices: pasture furrows, graded banks, diversion terraces, broad-based terraces and grassed waterways, and subsoiling on the contour to a depth of at least 12 inches by chisel ploughing or ripping.

Subsidies for Run Conservation Plans

Where a runholder has a plan prepared on the basis of a land capability survey and he is prepared to enter into an agreement with the Catchment Board to comply with any modified management and maintenance conditions imposed, he may receive subsidies as already mentioned, together with the following:

(i) Restoration of pasture cover. The Council in special circumstances will consider subsidizing the cost of materials for initial seeding and top-dressing of severely depleted lands subject to firm conditions of spelling, grazing, and further top-dressing, if necessary, at the runholder's expense.

(ii) Construction of fire-breaks in special cases, either by mechanical means, oversowing and topdressing, or by planting deciduous trees in breaks.

(iii) Provision of extra storage of water for fire-fighting and supplemental irrigation.

The subsidies for the conservation practices mentioned in (i), (ii) and (iii) above will be awarded, according to the severity of the erosion hazard, on the cost of approved conservation measures as follows:

Slight erosion and run-off	£1 for £4
Moderate ,, ,, ,,	£1 for £2
Severe ,, ,, ,,	£1 for £1

In special cases of severe erosion the Council will consider a higher rate of subsidy.

EXPENSES ALLOWABLE AS A DEDUCTION FOR INCOME TAX

(Some of these may apply in the case of an improvement plan for a run.)

Trees planted by farmers for shelter or to prevent erosion. Section 120 of the Land and Income Tax Act, 1954, provides that the Commissioner may allow a farmer a deduction of expenditure incurred in planting or maintaining trees planted for shelter belts, erosion prevention, or for other agricultural or pastoral purposes or in erecting or maintaining fences to protect these trees. If any doubt arises as to whether the trees were planted for these purposes a certificate of an officer of the Department of Agriculture of the N.Z. Forest Service is to be accepted as conclusive evidence.

Expenditure on development work, etc. Section 119 of the Land and Income Tax Act, 1954, authorises the deduction for taxation purposes of expenditure incurred by a taxpayer engaged in any farming or agricultural business, for the following purposes:

(i) The eradication or extermination of animal or vegetable pests on the land.

(ii) The felling, clearing, destruction and removal of timber, stumps, scrub or undergrowth on the land.

(iii) The destruction of weeds or plants detrimental to the land.

(iv) The preparation of the land for farming or agriculture, including the cultivation or grassing thereof, but not including expenditure falling within the scope of items (v) to (xi).
(Note: There is no limit to the amount of the deduction which may be claimed under the above four headings, but in respect of the following seven items the maximum deduction which may be allowed is £400 in the agregate for the income year).

(v) The drainage of swamp or low lying lands.

(vi) The construction of access roads or tracks to or on the land.

(vii) The construction of dams, stop banks, irrigation or stream diversion channels, or other improvements for the purpose of conserving or conveying water for use on the land or for preventing or combating soil erosion.

(viii) The repair of flood or erosion damage.

(ix) The sinking of bores or wells but not the cost of pumps, windmills, etc.

(x) The construction of aeroplane landing strips to facilitate aerial topdressing of the land.

(xi) The construction on the land of fences, including the purchase of wire or wire netting for the purpose of making new or existing fences rabbit proof.

Any expenditure incurred under heading (v) to (xi) above in excess of £400 in the aggregate is not deductible in the year in which incurred, and cannot be claimed in a subsequent year. Moreover, the limit of £400 applies in respect of each farming business, so that, if the farming business is carried on by two or more persons in partnership or otherwise jointly or in common only one £400 may be claimed under the above headings.

OVERSEAS VISIT BY DIRECTOR

During July and August the Director, Mr L. W. McCaskill, was overseas. Two weeks were spent on private leave in Britain and the remaining time in the United States of America. He represented the Institute at the Pacific Science Congress held in Hawaii where he read a paper, "The Revegetation of Severely Eroded Areas in New Zealand" and represented New Zealand in a symposium of all Pacific countries, "Soil Conservation : Who is Responsible?"

While on the mainland of the United States he confined his investigations to four of the western rangeland states, California, Oregon, Utah and Colorado, where he travelled under an arrangement made jointly by the Forest Service and the Soil Conservation Service, both agencies of the United States Department of Agriculture. Most of his time was spent in the field studying range management and research into its improvement. Some extracts follow from his report to the Committee of Management of the Institute.

DIFFERENCES BETWEEN AMERICA AND NEW ZEALAND

I must stress some of the main differences between conditions in the western states and New Zealand. These have been ably outlined by Mr J. T. Holloway of the Forest and Range Experiment Station of the New Zealand Forest Service, Rangiora, in a paper to the New Zealand Science Congress and I summarise them as follows:

"Accelerated erosion as we know it in our mountain country is almost unknown in the American West. Their mountains are not as young and rarely as steep or composed of such rotten rock as our main-divide greywacke ranges."

"Annual precipitation in our lowest-rainfall mountain country falls little short of total precipitation on their wettest mountains."

"Most of the water that falls on their mountains falls as snow in winter, most of ours falls as rain."

"The heavy winter snow pack protects soil from frost lift and rock from frost shatter."

"Much of their high-mountain soil is deep and fertile."

"Wind is a factor of much greater significance in New Zealand."

"Their mountain streams have smaller average and peak flows, flood more rarely and carry less rock waste than ours."

"The vegetation zones are largely reversed between the two countries."

"Wild animals are largely controlled by climate in America in a way which does not operate in New Zealand."

"If they are concerned about soil compaction by trampling we should be deeply worried."

Although conditions in the two countries are so different I believe we have much to learn from a study of their problems and how they tackle solutions.

RANGE RESEARCH

Research into the management and improvement of range is carried out by the Agricultural Research Service, the Forest Service and the Soil Conservation Service, all agencies of the U.S. Department of Agriculture, and by the Universities, especially the Land Grant Colleges. My contacts on this visit were with the Government agencies, especially with the Forest and Range Experiment Stations at Berkeley California; Portland, Oregon; Ogden, Utah; and Fort Collins, Colorado, and most of my field observations were made on range under control of the Forest Service.

Until these areas were created as National Forests in 1907, practically all the land suitable for livestock grazing was grazed by cattle and sheep owned by pioneer ranchers, speculators and transient stockmen. Grazing was unregulated resulting in conflict, range "'wars", destructive use and serious erosion.

Over the past 25 years a programme of rehabilitation, based largely on long-term research projects, has resulted in striking improvement in vegetative cover over vast areas with resulting benefit to grazing capacity and the water

regime. But so severe was the deterioration in many places, and so difficult has rehabilitation proved, that there are areas de-stocked in 1935 which are still not open for grazing.

In recent years changes in emphasis on the use of rangeland have brought new problems. Water is now the most urgent need in Western America. Requirements of water doubled in the past 20 years and it is estimated they will double again in the next 18 years. In addition to controlling soil erosion and sedimentation and attempting to build up stock-carrying capacity, range management aims at conserving water and making it available for irrigation, for industry and for domestic use in ever-increasing quantities. The demands of recreation, especially hunting, also affect planning and action. Under the "Multiple Use" policy of the Forest Service, grazing may be restricted or even prohibited for the benefit of wild life. In some areas grazing is adjusted seasonally to prevent conflict with recreational use. And yet this same population of game in some areas may be preventing successful regeneration of important timber species. The position is complicated by the fact that all game, even on Federal land, is under the control of State Governments.

The attitude to rangeland in the National Forests today is to regard it as being part of some watershed and to include its management as part of the management of the watershed complex—soil, water, vegetation, livestock, wild life, recreation.

Research on the range is ultimately co-ordinated by the Agricultural Research Service through its Central Project Office in Washington. It has been based on Forest and Range Experiment Stations each of which serviced several states in which there are local field stations and experimental areas. A reorganisation now in process will withdraw scientists from the field stations and base them on new Forest Service laboratories being erected on the grounds of Land Grant Colleges. The aim is to provide a better scientific basis for the field research projects and to enable staff to have closer contact with university staffs. At each laboratory will be stationed, in addition to other research workers, a watershed-management research team charged with the study of management of vegetation in the interests of soil conservation, water yield and live-stock production. A team will consist of specialists in pedology, climatology, hydrology, ecology and physiology together with a range conservationist. The amount of effort being put into range research is out of proportion to its agricultural return. National needs and returns as regards water,

flooding, sedimentation and recreation are the deciding factors.

RANGE MANAGEMENT

The extent to which the Forest Service is prepared to go in restoring the range is shown by the fact that it plans within the next few years to erect 18,000 miles of fences and construct 9,500 ponds of flood control structures to enable full implementation of a programme of intensive management based on the results of continuing research.

(a) Forage Management

Simplification of criteria for determining range condition and trend has made it possible for managers and users of the range to detect signs of improvement or deterioration in the vegetation. Standards have been established for readiness when grazing can begin without injury to plants or to the soil. Increase in the use of supplementary feeds such as hay or concentrates makes it possible to avoid grazing the range before it is ready and still maintain livestock in good condition. Each species has been studied to ascertain the season of use when herbage can be grazed with minimum damage. On bunch-grass range, somewhat similar in character to our tussock grassland, rotation-deferred grazing has proved economical in production and in some cases completely checked runoff and soil erosion. On a typical area in Oregon, after five years of this system, range forage increased by 40 per cent. and the same amount of beef was produced from half the number of breeding cows. A unit is divided into sections of approximately equal grazing capacity which are grazed in rotation, but not at the same time, in successive years. The method has proved successful where bunch-grass range must be grazed during the entire growing season or during the entire grazing season. Plants vary as to the best season for grazing and this system over the years gives all plants a chance to produce seed, and rhizomatous species the opportunity to extend their range. The system of course involves the grazing of mature forage which is not so valuable nutritionally and also increases the fire damage.

The system of rest—rotation grazing was developed by the Forest Service and tried experimentally over a period of nine years at Harvey Valley (rainfall 18 inches). The trial is planned to run for a further eleven years. It is a system, based on the growth requirements and characteristics of the primary forage plant species, which provides the regular rest from grazing necessary for the recovery of vigour, production of seed and the establishment of new plants. The area usable by cattle is 24,000 acres.

Five-Year Grazing Schedule

(Number of animals for 4 months)

		I	II	III	IV	V
1960	1st half	200	300	Rest	Rest	Rest
	2nd half	Rest	100	Rest	400	Rest
1961	1st half	300	Rest	200	Rest	Rest
	2nd half	100	Rest	Rest	Rest	400
1962	1st half	Rest	Rest	300	200	Rest
	2nd half	Rest	400	100	200	Rest
1963	1st half	Rest	Rest	Rest	300	200
	2nd half	400	Rest	Rest	100	Rest
1964	1st half	Rest	200	Rest	Rest	300
	2nd half	Rest	Rest	400	Rest	100

A complete cycle for any unit is:

e.g. V. 1st year—Complete rest to restore vigour.

2nd year—Rest till seed ripens. Graze fully for livestock production. Seed is distributed and trampled in. (Reseeding can be done at this time.)

3rd year—Rest entire season to ensure establishment of seedlings.

4th year—Graze during first half or until seed ripens for livestock production. Rest for seed distribution.

5th year—Graze fully.

Results to date show improved range condition, increased grazing capacity and sustained high livestock production, all in a period of successive drought years.

It must be stressed that cattle only are used, an increasing tendency in the west where sheep appear to be on the way out. It is much easier to use cattle in rehabilitation work.

Another management method is the "degree of utilisation." Many studies of light, moderate and heavy use show that moderate use results in maintaining the range in good condition and allows the optimum production of animal products.

An example from Manitou Experimental Forest in Colorado will illustrate this point.

Five Months Grazing 1 June—31 October

Stocking rates.

Heavy (57% herbage removed)	Depletes stand Poor cattle gains	Return of $1874 per section
Moderate (33% herbage removed)	Improves stand Good cattle gains	Return of $2162 per section
Light (14% herbage removed)	Improves stand High cattle gains	Return of $1612 per section

Incidentally I saw at Manitou an excellent idea for exclosure plots. Instead of fencing a single area from stock and comparing it with the grazed land over the years, each year a further plot adjoining is enclosed and so on As a result progressive changes under absence of grazing over 12 years can be observed. An adjoining climatic station provides the records so necessary in interpretation.

(b) **Fencing**, as elsewhere, is an expensive method of controlling grazing but is being extended at an increasing rate. Various types of snow fences are in use. Herding is now being more used by cattle men to assist better utilisation of the forage and to protect weak areas against over use. Practically all sheep, on the summer range at least are herded; if carried out efficiently this process can be beneficial to the range. Herders are increasingly difficult to obtain and at present are being imported from Spain.

(c) **Salting** is widely used to encourage stock to graze areas deemed ready for grazing and areas, such as shady faces, which they will otherwise tend to avoid. Placed at the lower levels in the early part of the season, salt is also used to deter cattle from going up to higher altitudes before the grass there is ready for grazing.

(d) **Weeds** are controlled by chemical means, by fire, and by mechanical means similar to those used by the Lands Department in New Zealand in their programme of land development.

(e) **Fertilisers,** where rainfall is sufficient, are used on selected sites to produce extra feed to enable spelling of other areas.

(f) **Reseeding** is still a problem in spite of over 20 years of research. Low rainfalls are a major difficulty and few suitable legumes are yet available for the arid areas. Main results from research to date are:

(i) That little advantage comes from seeding a small area within a large unit to species quite different from the native forages in quality or season of use.

(ii) That every effort must be made to provide a good seed bed prior to sowing from the aeroplane or with implements. A great variety of special machines has been tried.

(iii) That from trials of hundreds of species some plants are available for most range sites. Among these are native species which, while not necessarily high-producing, give good performance under unfavourable conditions such as long periods of drought.

Except where a good seed bed has been prepared by "farming" methods, the areoplane is little used for range seeding. It is used on steep hill country after an accidental or intentional burn or just prior to leaf fall on deciduous shrub land.

PLANTS FOR RESEEDING

The production of these plants is the job of the Soil Conservation Service through its Plant Materials Centres of which I visited the one at Pleasanton, California. The system of evaluating and testing begins with selections made by trained observers who have in mind, as well as animal production, the soil conservation functions these plants can perform on the land. Selected plants are successively tested in rows, in plots, alone and in mixtures, and in field sowings, much on the lines practised by our Grasslands Division.

Since 1939 this centre has tested over 14,000 species or strains of grasses, legumes and forbs for conservation use and developed various practices now used in improving range land. It has also pioneered the development of a grass-seed industry through Soil Conservation Districts in California based on the production of foundation seed stocks by the centre and the production of certified seed by farmers.

Examples of new strains released are: cocksfoot, Phalaris, four types of wheat grass, a brome and a vetch, with twelve others in the final testing stage. One of the characteristics studied in the evaluation of new strains is root production aimed at suitability for soil conservation work.

Studies on native species have shown that in western America they do not lose nutrients as much as the exotic species when used as standing hay and though their production may be low it fluctuates less under the influence of adverse conditions. Work on selection of native species is continuing and the scientists there consider New Zealand should do the same. It is quite impossible to suggest from trials in America what species might do well here but it is worth noting that of 400 species or strains tested in Utah for range improvement, only 40 were considered of any practical use and only 14 are recommended. These are five species of wheat grass, tall fescue, smooth brome, tall oatgrass, cocksfoot, timothy, mountain brome, lucerne, sweet clover and Russian wild rye. All except the last three have been used in the trials by Miss Moore at Molesworth reported in the latest Journal of Agricultural Science.

REPELLENTS AND SYSTEMIC POISONS

At Beltsville and Denver, the Fish and Wildlife Service have tried out more than 7000 chemicals in efforts to develop suitable repellents for livestock and wild animals, and still test several hundred new ones each year. Three for use externally with young trees are available commercially:

TNB—A, ZAC, and TMTD. These give some protection against hares, deer, cattle and goats. Because they last only a short time and cannot protect new growth, a search is being made for systemic repellents, particularly for deer and hares which are a major problem in forest restoration. In America the deer is a sacred animal and systemic poisons cannot be used but that does not apply to the hare.

Of systemic poisons, only one has exhibited stability for longer than one year. This is tetramine (Tetra—methylene disulpho tetramine) first tested in 1951. It has shown no adverse affects on seeds or plants, and has extreme, almost frightening mammalian toxicity. It can be combined with a fertiliser in a pellet and placed in the planting hole when a tree is planted. For use with hares without affecting deer it is proposed to fence against deer a small proportion of poisoned planted trees and attract hares to the poisoned trees by free use of fertiliser on the site.

Tetramin had such a limited market that it was not attractive to manufacturers and the patent holder has withdrawn licences. However the Wildlife Research Centre is continuing research with it and will keep the Institute informed regarding this chemical and other developments. As an answer to our noxious animals, tetramin has tremendous potential provided we can use it in the absence of sheep and cattle.

Investigations are also continuing into the use of sterility—producing chemicals as a possible means of control of noxious animals.

THE SMALL WATERSHED PROGRAMME

In general, experience in America is that flood-source areas cannot be satisfactorily restored by grazing exclusion alone. On vast areas, soil erosion has reduced the fertility and capacity of the soil mantle for moisture storage to the point that, even with permanent exclusion of grazing, plant cover adequate to prevent excessive run-off and erosion cannot develop by natural means. Additional control measures are usually needed and all methods practised in New Zealand are in use with the addition of contour trenching practised on steep slopes to control run-off from high-intensity summer rains threatening valuable land and built-up areas below.

The small watershed schemes, provided for by Public Law 566 in 1954, have proved a highly successful method of complete catchment control. They are limited to catchments of 250,000 acres and the sponsor is usually a Soil Conservation District. For each state there is under the

Soil Conservation Service a planning unit which does the planning as a service to the District. A unit normally consists of a conservation engineer, an assistant engineer who is a specialist in construction, a pedologist with training in sedimentation, a hydrologist (usually an engineer who has made himself a hydrologist) and survey technicians. The members of the unit work with the local soil conservationist, who is an officer of the Soil Conservation Service, for local agricultural knowledge and planning and call on the Forest Service for advice on tree planting and forest management.

The main requirements for a scheme are that the local people must assume responsibility for maintenance, the provision of land for easements, and the local costs, and that benefits must exceed costs. No construction works can start unless soil conservation measures based on farm plans are in action on at least 50 per cent of the area above the structures. The Federal Government pays for all structures such as flood detention dams which must not include any single structure of more than 5000 acre feet of floodwater detention capacity. If the Federal contribution is more than 250,000 dollars then Congressional approval is necessary. Federal loans are available to finance the local share and generous subsidies are available for measures on farms up to 2500 dollars per farm per annum.

I studied in detail five of these watersheds which had been completed, Walnut Creek in the foothills of California, Pleasant Creek and Provo Canyon in the Wasatch Mountains, Trout Creek in the mountains of Colorado and Kiowa in the foothills near Denver. In each case it is extremely doubtful whether the schemes could have been completed without the generous Federal assistance. In spite of the high cost of structures, each has proved economically justifiable. These and other pilot watersheds have proved so successful that 1320 applications for other such schemes have been made for planning and 270 have already been approved for Federal assistance.

The small watershed programme has done much to bring farm and city people together in a common aim. In the United States the non-farm beneficiaries of soil-and-water conservation and watershed protection now outnumber farm people by about nine to one and this proportion is widening each year. This has resulted in a switch of publicity in this field towards urban people rather than the farm and this change may have something to do with the apparent willingness of the taxpayer to find the Federal share without obvious questioning.

MATAGOURI

(Continued)

In response to the request in the previous "Review" for views and experiences on matagouri the following comments have been received.

A North Canterbury run-holder, with a life-time experience of matagouri, says: "It is a great pity to call this plant a weed. It has only two faults—it hinders movement of stock and is untidy in appearance. The first can be overcome to some extent by mechanical means and by spot burning at chosen times.

The virtues of the plant are many. It stabilises many a back-country river bed and stops bank erosion with the exception of that caused by really bad floods which carry all before them.

The tree matagouri, growing on well-drained flats with some river silt is an excellent preserver of winter and spring feed. It shelters palatable plants from the winds and keeps off much frost. The plant appears to improve the soil around its roots and thus stimulates grass growth underneath its open branches.

The creeping kind allows grass to grow within its structure and so gives some feed in bad winters. Also by allowing grass freedom to seed it is constantly replenishing surrounding land with fresh plants when stocking allows this to happen.

Its eradication is in most cases unnecessary. On a river flat where there was no danger to surrounding land we have used a hot summer fire during a drought to kill dense creeping matagouri. On the other hand, spring fires can make a passage for stock for a couple of years but afterwards the plant may be even more vigorous and exasperating.

Overstocking with cattle will thin out the tree variety in a bad winter as they go under for feed and shelter and barge around breaking many branches.

We have tried commercial sprays with the aim of opening up creek crossings and gateways to assist stock movement but have had no success even with using a "Special Mixture".

We have so many real weeds to keep back country-men employed in their rare spare time that I think we can forget matagouri's small faults and appreciate its many virtues."

Another North Canterbury runholder says:

"There is a lot of matagouri on this place and in my opinion it is more an asset than a liability. In the severe winter of 1961 it acted as a cover for cocksfoot. When the snow came the stock obtained the only picking available

from the lee side of the matagouri where the branches kept the snow off the ground.

I think if you topdress matagouri country several times, the plants grow beyond that stunted stage which is such a nuisance to sheep and dogs when mustering. Someone could well do a little research on the effect of topdressing on stunted matagouri".

A retired engineer who spends much of his time in the back country says:

"Although not a farmer or occupier of tussock grassland, I am interested in matagouri and should like to offer a few comments about this small tree.

A hill-country farmer pointed out to me that matagouri holds up snow well so that even when open country is all under snow, sheep can still find a bit to eat. The grass under the trees in the photograph on page 10 of the first issue of the "Review" seemed to be growing well but closely eaten by sheep. Grass grows close up to the stem or trunk of the tree so that there is hardly any land wasted by bushes or trees that are large enough to let sheep feed under them.

The largest ones I have seen were all growing where there was underground water near enough to the surface to assist growth in dry seasons. In places where pigs had been rooting amongst medium-sized matagouri, the pigs had never worked close to the stem and in such cases the plant helped to save grass and check erosion.

Considered as timber, matagouri has a pleasing grain and is suitable for wood turning. It is inclined to warp while seasoning and to develop some shrinkage cracks.

I hope that satisfactory means may be found of getting rid of excess seedlings of matagouri while still retaining others in places where they would be of use in snow and for resisting erosion. Nature seems to show great wisdom in providing native plants to suit the country and matagouri has at least some good points."

Several run-holders have commented that "creeping" matagouri must be burned periodically to enable them to maintain their stock-carrying capacities. Most of them would welcome a method of control which did not involve burning.

TUTU

The family to which tutu belongs, Coriariaceae, has only one genus, Coriaria, named from the Latin corium, leather, because some species in other countries have been used for tanning leather. Altogether there are some 36 species growing in Europe, Asia, Central and South Amer-

ica, and New Zealand. The forms to be found in New Zealand are so diverse that botanists have long disagreed about their classification. However, in the new Flora of New Zealand by Allan, eight separate species have been described. Runholders will continue to use the common names such as tree tutu *(Coriaria arborea)*, ground tutu *(C. sarmentosa)* and alpine tutu *(C. angustissima and C. plumosa)*.

All the species except the tree tutu have much-branched underground stems. While making these plants useful for holding stream banks and slips, this characteristic also makes them exceedingly difficult to destroy. On its roots tree tutu, at least, carries large nodules in which it fixes substantial amounts of atmospheric nitrogen possibly making it self-sufficient for that element.

Ground tutu, the commonest one met in the tussock country, will be used as our example for detailed description. It is a shrubby or semi-herbaceous plant with square stems and shiny, opposite leaves. The branchlets and leaves die and are shed in the late autumn or early winter. The flowers examined individually are small, green and generally unattractive but what they lack in size they make up for in abundance. Long, drooping stems hang down from a flower stalk, each stem bearing one hundred or so flowers which produce large quantities of pollen. As with so many other plants which are prodigal of pollen, tutu is wind-pollinated.

In most other plants the petals shrivel and fall after pollination. In the case of tutu, they enlarge as a result of becoming filled with purplish juice. These enlarged, coloured, juicy petals then act as a protective covering for the seeds as well as providing anattractive diet for berry-eating birds. The seeds, but not the swollen petals, contain a deadly poison first isolated in 1900 by Mr B. C. Aston, then chief chemist to the Department of Agriculture who was working with Professor Easterfield. They called it tutin.

The ancient Maoris knew of the poison. From the juice of the berries they prepared a beverage by crushing the ripe berries and pouring them into a conical bag made of cabbage tree leaves and packed full of the seed heads of toe toe to act as a strainer. The juice could be diluted for drinking or, if left concentrated, would set as a jelly and be eaten in that form. So prized was this jelly that groves of tree tutu would be protected by a "rahui" (the equivalent of "Trespassers will be Prosecuted"). Maori children frequently ate the berries and swallowed the seeds regardless of warnings. The cure for any resultant poisoning was said to be to build a smoky fire of leafy twigs and suspend the children head down in the smoke, shaking them during the process. The earliest recorded poisoning of pakehas

occurred in 1835 at the Bay of Islands when four French sailors met a horrible death after sampling the fruit. Other deaths have since been caused in this way. Signs of poisoning are convulsions, vomiting, frothing at the mouth, staggering and a tendency to fall forward.

The early settlers made wine from several native berries, tutu among them. Warned by the Maoris they strained the seeds but the wine was not always above suspicion. Canon Stack records that when he and Bishop Harper were travelling in the back country in the South Island they drank this wine on the occasion but fortunately did little more than taste it. Soon they lost all feeling in their extremities and felt they must fall forward. A mist appeared to come over the room but soon their feet began to tingle and the sensation passed.

On his first voyage, Captain Cook landed sheep and goats which died soon after eating tutu. Right from the days of the earliest settlers we find records of stock losses. For instance the late Sir John Hall, who did much sheep droving in Canterbury in the 'fifties, mentions in his reminiscences: "Among newly-landed sheep and cattle, heavy losses were sometimes incurred through eating tutu. In the neighbourhood of what is now called Weedons, near Christchurch, there were two very troublesome stretches of this noxious plant which most imported sheep had to cross. If they were allowed to feed or rest there soon after landing, probably half of them would be "tuted" and lost. The practice, therefore, was to give them a good rest before reaching this locality, and then to rush them through the tutu so hurriedly that they could not feed."

Von Haast in an early volume of the Transactions of the New Zealand Institute described the death of an elephant travelling with a circus in Otago. It fed on grass and other herbage containing tutu for four hours and after drinking from a creek, fell to the ground and died soon after. Aston, when isolating the poison which he found in the young shoots as well as in the seeds, records that the percentage of tutin is higher in the spring and presumably the plant is more dangerous at that time. His experiments showed that the poison was fatal to cats, rabbits, guinea-pigs, pigeons, lizards, frogs and house and blowflies.

Sheep today seem to be little affected by tutu unless, when hungry or thirsty, they are given access to considerable quantities of tutu, particularly when the plants carry many young shoots.

Cattle have always been the chief victims of tutu poisoning and they are particularly susceptible when hungry. The best treatment, if they will remain still, seems to be to leave them alone. Animals recover from large

doses if they will remain quiet. Unfortunately they may develop a tendency to run about and often to charge any person approaching. Cures of staggering animals or others with convulsions have been effected by bleeding from the ears, neck or tail. Many stock owners or drovers have their own "absolute cures" which we would like to hear about.

Tutu can be a problem where tussock grassland containing it has been broken up and put into turnips, the stock sometimes eating the tutu for a change. Also on some properties where tussock-grassland improvement has necessitated the use of cattle, and the fertiliser used seems to have stimulated the plant, tutu has recently caused concern, to the extent that considerable effort and expense have been put into attempts at control by weed killers. According to the Department of Agriculture, "Tutu is susceptible to emulsifiable esters of 2, 4, 5 — T at two to three pounds, but repeat applications are necessary. The first application should be made when the plants are flowering or in early fruit. Regrowths should be treated about a year later when at the maximum leaf stage."

We would welcome any comments on tutu for publication in the "Review".

STAFF APPOINTMENT

The Institute has appointed Mr J. G. Hughes as its Management Officer. Mr Hughes was born on a sheep run and spent his school and university vacations working on runs, mainly in the Mackenzie Country. He graduated Bachelor of Agricultural Science at Lincoln College in 1953 and from 1954 to 1957 undertook contract fencing on sheep stations in Otago and Southland. He returned to Lincoln College in 1958 and obtained the Lincoln Diploma in Agricultural Engineering and the British National Diploma of Agricultural Engineering, in both cases with honours. In December 1958 he was appointed a soil conservator with the Department of Agriculture at Kurow where he has been working with the Waitaki Catchment Commission. He has assisted with land capability surveys, the preparation of run conservation plans and the general soil conservation activities of the Commission. He was particularly concerned with the planning and designing of structures for water conservation.

Mr Hughes took up his new position with the Institute on 15th January 1962. As mentioned in the first issue of this review he will be concerned with all phases of management of the tussock grasslands.

OUR COVER

Although New Zealand knew no grazing or browsing mammals until they were introduced by the white man, our native grasslands were grazed from very early times by birds. The re-discovery of the takahe or Notornis in 1948 enabled those privileged to enter the special protection area in Fiordland to study this bird and its methods of grazing snowgrass and other tussocks. The takahe cuts the stems at ground level and eats only the leaf bases. Where the birds have been feeding actively, the discarded leaves lie in rows just as if they had been cut with a scythe. Both flower-heads and seeds of the tussocks are also eaten by the takahe; they are obtained by sweeping the partly-open bill along the flower stalk.

Study of the habits of the takahe enables one to credit the belief of scientists who have analysed the gizzard contents of giant moas preserved in swamps such as that of Pyramid Valley in North Canterbury, that these birds were, at least in part, grazing and browsing animals. Undigested last meals have contained leaves of tussock grasses, stems of native broom and leaves and berries of ngaio and matai.

Our artist shows the large moas in grassland adjoining bush, a combination of vegetation types much more common in primeval times.

Anyone who has stood beside a reconstruction of one of these birds in a museum would probably not query the suggestion that a large moa would require as much grass or similar food as a bullock.

It is perhaps significant that the greatest collections of moa bones were found in places adjacent to large areas of natural grassland—Glenmark, Pyramid Valley and Waimate in Canterbury, and Enfield, Waikouaiti and Hamilton in Otago.

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