THE CHANGING TUSSOCK GRASSLANDS

By R. D. DICK, Soil Conservation Officer, North Canterbury Catchment Board.

A century ago the tussock grasslands covered over 50 per cent. of the South Island. Today over 30 per cent of this island is referred to as tussock grasslands. On the hills, downs, and plains, land where the plough could go, the natural grasslands have been changed into areas growing crops and introduced pastures. Beyond the reach of the plough in the mountainous region where, the soils are poor and the climate severe the tussock grasslands continue the struggle to perpetuate-their kind: As part of the great grassland formation which. has been estimated to cover about 1/5 of the land surface of the globe, the tussock grasslands form a tiny but quite unique segment. On the mountain ranges eastwards of the Main Divide of the Southern Alps there has developed a type of grassland with several characteristics peculiar unto itself.

It has, however, in common with all living things birth, growth, death, and replacement. It is also gregarious in that the tussock grasslands comprise a large number of different species of plants which grow in a community and all are . necessary to assist. mutually in the birth, growth, death, and replacement. of the component members of the community. All these species individually and collectively are dependent for their livelihood, among other things,. on the climate. The tussock grasslands developed under a. certain climate and their continued existence is dependent upon the continuation of such a climate.

CLIMATIC CHANGE

There is evidence that the- climate—the rainfall,, temperature, wind, and the other related physical forces-fluctuates and alters through the centuries.

In this mountain region one observes the reces-. sion of the glaciers and the retreat of, the forest to the higher rainfall belt near the Main Divide. The

dwindling patches of mountain beech forest in the present lower rainfall zone are surrounded by tussock grassland or shingle slope and the upper limits of the tussock grasslands and alpine plants are creeping down the mountainside. Mark P. Stoddart, one of the earliest Europeans to venture into 'the Rakaia River catchment, writes of totara tree trunks lying among the tussock grassland and rata trees growing beside Lake Coleridge. Lady Barker and G. A. E. Ross confirm such observations in the same district. Old totara tree trunks have been found elsewhere among the tussock grasslands, indicating that totara trees grew some centuries ago where tussock grassland grows today. Several scientists have submitted evidence that indicates the fluctuations in the climate of the recent past., e.g., botanist Cockayne, geologist Speight, pedologist Raeside, forest ecologist Holloway, and others. In an analysis of the rainfall records in New Zealand between 18631 and 1947 C. J. Seelye indicates that there is good evidence of a decline at the rate of at least 4 per cent. per century in the North Island and 2 per cent.'in the South Island.

So, as we approach the tussock grasslands today to gain an understanding of them and the changes that have occurred in 'the past century, let us carry with us the concept that before European occupation the tussock grasslands 'as observed in the 'fifties had populated the mountain slopes only for several centuries, they had succeeded forests over a great portion of the area because of climatic changes, and about 1850 the tussock grasslands themselves were not an aggressive plant community, but were finding difficulty in populating and surviving on the higher northerly and westerly facing mountain slopes.

THE PAST CENTURY

In the past century, the first one of European occupation, when forces other than natural ones have influenced the tussock grasslands, the change has been spectacular. Unfortunately, they have been to the detriment of these native pastures. Broadly similar harmful effects may be witnessed in other natural grasslands subsequent to European usage in Australia, South America, U.S.A., and in those countries occupied by Europeans in the past few centuries where extensive sheep grazing has been practised. It seems that damage to the tussock grasslands in the South Island has been particularly severe because of the

steep mountainous nature of this country, the practice of "burning off" vegetation and the continuous sheep grazing with few or no cattle, the concentration of the runholder on the breeding of stock to the exclusion of the feeding of stock, and the introduction and amazing spread of herbivorous vermin.

When the runholders first entered this region they used fire-the simplest and only tool at their disposal-td allow the flocks of sheep to be driven into the new pastures and spread over the ranges. Mark I'. Stoddart, who was in the first party in 1851 to enter the Rakaia high country, gives the following word picture : "Crossing a rapid brook, the Acheron, we came to a broken ridge of hills, for the most part bristling with wild Spaniard, a plant whose leaves resemble the blade of a dagger. We named these the Horse-hell Ranges. Fire had not apparently for ages touched this ground, the dead vegetation formed a deep rotten mat in which the horses' feet sank at each step and conjoined with the torture from the prickly plants drove them nearly frantic . . ."

The epidemic of fires which infested the tussock grasslands for 60 or 70 years affected this plant community just as all virulent epidemics affect living communities. The toll of plant life was heavy and the whole structure of the plant community was altered. Those perennial plant species that stored' a reserve of food in plant organs beneath the soil surface and the shorter lived species that quickly produced seed, some of which could remain viable in the soil for several years, were most suited to withstand the attack of frequent fires. The mortality in the tall snow-grass—***Danthonia*** *flavescens*—was high and a few members only remain today ; whereas some of the smaller Danthonias ***such*** as ***D.*** *pilosa,* ***D.*** *semiannularis,* and some of their varieties were able to tolerate fire and have helped to populate some of the bare ground left by the deaths of their fellow members. Likewise even the hard or fescue tussock, ***Festuca novae-xelandiae,*** has been able to tolerate fire better than snowgrass, and in the first few decades when the soil capital of fertility was comparatively high the replacement of snowgrass by hard tussock must have been remarkable. With the decreasing soil fertility the unequal struggle of the tussock grasslands continues and fire, though greatly reduced in more recent years, remains the greatest enemy to the tussock grasslands in its efforts to replace its kind.

Following fire came sheep and animal pests, such as rabbits, hares, deer, chamois, the goat, and others, all of which at first selected and later, because of the pressure of the animal population devoured what ever food was available. The tussock grasslands were unable to feed this population. After fire, plants straightway draw on reserve food supplies to produce leaves and every effort is made to produce immediate rapid growth. That is seen in the rapid leaf growth of the silver and fescue tussock after fire. The new green grass growth is more palatable and sought after by grazing animals. Severe defoliation occurred. Leaves, however, as well as roots are necessary to supply the food for "grasses."

The changes brought about by these new elements in the tussock grassland environment were many. Some harmful changes commonly referred to as tussock grassland depletion or deterioration were commented on from the 'sixties" onwards. Observant naturalists, and botanists virdting Central Otago in earlier days felt impelled to write about the changes, but the works of biological scientists are often revered only after the death of the scientist.

RABBITS

The control of the amazing spread of the rabbit in the late seventies and eighties was in reality left to the individual runholder. The ravages of the rabbit were so overwhelming that Government Acts, and Amendments followed in quick succession and even continue to this day, but the havoc of the rabbit continued. To indicate the alarming number of rabbits, let me quote some export figures of rabbit skins—1872, 15,551; 1882 9,198,887; and in 1924, 20,444 390. May the present system of rabbit boards be an effective measure in controlling this pest. The prtswt indications from the work of rabbit boards *are* that rabbits can be satisfactorily controlled provided that the land occupiers will support the plan wholeheartedly with their wisdom and co-operation and the people of New Zealand supply the finance necessary. The control of the rabbit is essential to enable changes for the betterment of the tussock grasslands.

The tussock grasslands are of great interest to the botanist snd plant lover, but of much more importance is the part they play in the whole economy of the country. From this region comes fine wool, store

sheep, and cast-for-age breeding ewes. The present, system of farm management of some farmers on the plains is dependent on this supply of store sheep from the high country.

SHEEP NUMBERS

A study of the numbers 'of sheep grazing on the tussock grasslands over the years belatedly indicates, among other things, that the production. from these grasslands is declining. In the high 'country of the Waimakariri River catchment in Canterbury, comprising 6 sheep runs and about 260,000 acres, the sheep numbers built up to 68,000 by 1879 had increased to 92,529 in 1895. They then decreased erratically till by 1917. they had fallen to 45,422, just under half the maximum number of sheep previously carried. In the early thirties the numbers climbed to 56,639, but again fell in the forties to as low as 40,685 and in 1952 41,405 sheep are recorded. Rabbits have always been few in this area so that sheep numbers give a rough guide to the reduced pasture production from 'this portion of the tussock grasslands. In a great deal of the high country the pastures have deteriorated as much or more so than in the Waimakaxiri grasslands.

OTHER USES OF VEGETATIVE COVER

The tussock grasslands are of increasing importance to the South Island, for the vegetative cover in the river catchment influences greatly' the degree of flooding in rivers and indirectly the supply of hydro-electricity.. The taxpayer, as well as the ratepayer, is aware of the costly damage. to property and production on, the lowlands due to flooding as well as the expensive engineering works to try to confine temporarily the rivers to their courses. About three-quarters of a million pounds are spent annually on engineering methods of river control in New Zealand,.only with the prospect of increased expenditure, The most economic dam 'or stopbank to control water is the blade of grass growing on the mountain slopes of the river catchment.

INVESTIGATIONAL WORK

The North Canterbury Catchment Board has started an investigation-into the changes in vegetative cover in the Waimakariri River catchment; On the

mountain slopes, -between Porters Pass and the Bealey hotel, on the road to Arthurs 'Pass, twelve line transects were pegged. The length of the transects varies from 10 to 15 chains on mountain slopes of different aspects and slope, at an altitude between 2500ft. and 4500ft. The work commenced in January 1947, and every subsequent year at a similar calendar date an observer records at 2in. intervals for a total distance 'of a few chains short of 2 miles' whether living or dead plant life or bare ground is present. Over -50,000 records are taken annually. The results of this work over 6 years show that all these mountain slopes have one thing in common. The vegetation is getting less and there is an increase in bare ground. The increase varies from an infinitesimal amount up to about -14 per cent, but in no case has there been a total decrease over the period, although in one year there may be a small decrease over the previous year. On the upper Slopes of Mt. **Lyndon** the following results have been recorded :—

Year	1947	1948	1949	1950	1951	1952
% of bare ground	51.7	54.9	58.6	61.1	64.5	64.8

The total increase in bare ground is 13.1 per cent.

Purple Hill

% of bare ground	56.0	57.4	62.5	65.5	68.8	64.7

The total increase in bare ground is 8.7 per cent.

Blackball (Nort-h)

% of bare ground	25.6	25.1	28.4	31.7	29.7	26.5

'*The* total increase in ***bare*** ground is 0.9 -per cent.

The above information is presented briefly to indicate that above 2500ft. on slopes of 25 degrees and steeper under the current methods of management the tussock grasslands are still thinning out on these particular areas observed, and I think similar results would be obtained on many of the mountain slopes in the South Island.

'At the end of the first century of man's attempt to use the native tussock grasslands for extensive sheep grazing, the outstanding grassland change has been that at least 50 per. 'cent of the soil that was growing native. "grasses" is now naked soil or shingle slope and probably about 25 per cent of the region that was. grazed in the nineties is today not used for pasturing sheep.

THE COMING CENTURY

During the next century the tussock grasslands offer the greatest grassland task in this country. The achievements of the land occupier, the research worker and the taxpayer will determine whether much of this region can be used for continued grazing, or will become barren waste land, or whether it possesses possibilities of other methods of use. It is a problem of land and also people.

Already the runholders have changed their practices with the changing conditions. They are aware of further necessary changes in their methods of management, but these are not carried out for divers reasons. Few fences have been erected since the original boundary fences were put up 60 to 80 years ago. The erection of subdivisional fences within blocks is the first essential to assist in the improvement of the tussock grasslands. Where this has been carried out and periodic instead of continuous grazing is practised, the tussock grasslands show signs of recovery.

In enclosed square chain plots in the Waimakariri River catchment that have not been grazed for between 3 and 4 years the increase in vegetative cover has been from slightly over 3 per cent to over 16 per cent. Plots on fans of poor soil show slower improvement. They all have one thing in common, however, and that is where the vegetation is ungrazed the plants proceed to cover the bare soil. As an example, consider Cloudy Knoll enclosed plot and the vegetative cover just outside the plot at about 2700ft.

Cloudy Knoll

Year	1949	1950	1951	1952
% of bare ground-enclosed plot	17.80	13.01	13.92	11.05
% of bare ground-not enclosed and normally grazed	18.87	21.50	27.87	23.23

The bare ground has been covered more by the growth of existing plants rather than by the establishment of new seedling plants. Seedling plants have difficulty in establishing on the bare ground where the natural humic mulch is absent. They are killed by the parching nor'-westers in the first summer or by frost lift, in the first winter.

SURFACE SOWING

Some success has been achieved by surface sowing. Where silver tussock is found among the fescue tussock on the more fertile of these soils, suckling and white clover, alsike, cocksfoot, browntop, chewings fescue, Yorkshire fog, sweet vernal, ***Danthonia pilosa,*** and ***Poa pratensis*** can be established by surface sowing, provided the seedling plants are not killed by grazing.

Where hard or fescue tussock occurs even limited success has been rare. It seems that preparation of the seed-bed is necessary by spelling the block to allow growth of existing plants to provide shelter and a mulch on the soil surface for nursery plants. Suckling and white clover sown with at least 1½cwt. of superphosphate to the acre and not grazed for 2 years can 'give spectacular results. The grassland principle of the ***use*** of a clover and superphosphate to maintain and increase the soil fertility and stimulate grass growth seems equally applicable to the high country as to the plains. Means of doing this only has to be found, for the way is clear. Recently sowing by the use of the aeroplane gives hope of a bright new chapter in the management of the mountain and hill country in New Zealand. The aeroplane has become a farm implement. Many of the seeds of the grasses for use in the tussock grasslands are coated with hairs which make them difficult to sow from the air. A special seed-clipping machine has been devised in Christchurch that can remove the hairy coat and awns and allows them to be sown satisfactorily. In addition. to fencing, the sowing of seeds to replenish the supply of seed to revegetate the bare soils and periodic grazing with cattle as well as sheep will require to supersede continuous or even seasonal grazing on much of the fescue tussock grasslands. Above all, fires must cease. Instead of a system whereby the runholders are required to get a permit to burn off vegetation, it. would be beneficial if the land occupiers urged their fellow-countrymen to assist in financing ways of preventing fires by educational methods and also by establishing firebreaks to restrict the area of fires should they be foolishly started.

For a final thought, I suggest that a survey be made of the tussock grassland region in the light of the knowledge of today and each parcel of land be ascribed to the category whereby it will be of the most permanent use to the people of New Zealand. Such

a survey would indicate? among, other things, where cattle could be included in the economy of the region, where pastures could most readily be improved, where fencing was most necessary, where firebreaks were required, where vegetation could be most productively used in assisting hydro-electric production and the control of flood waters to protect more productive land on the plains, and where territory was most suited for inclusion in national parks. The results of such work, I submit, would assist in increasing the production of material wealth in New Zealand.'

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