IMPROVEMENT OF TUSSOCK GRASSLANDS OF SOUTHLAND

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The tussock grasslands of Southland play an important role in the agriculture of the province, both directly and indirectly. This paper aims therefore to focus some light on the improvement of the tussock grasslands in relation to run management and soil and water conservation. The area under discussion is in the northern Southland district and comprises the Eyre, Takitimo, Garvie, Thomson, and Livingston Mountains- The head water catchments of the main river systems of Southland originate in this higher altitude tussock country, with the Aparima commencing in the Takitimos, the Oreti and Mataura in the Eyre, the Waikaia in the Garvies, and the Mararoa in the Thomson and Livingston Ranges.

The tussock grasslands of Southland represent approximately one-third of the total occupied land, being 1% million acres in extent. Of this, about one third of a million acres are estimated to bc severely depleted and suffering from moderate to severe erosion, 100,000 acres of which are classified as severe and advanced erosion. Much of the lower tussock country has and can be improved by cultivation. This paper, however, refers generally to that country outside the scope of improvement by cultivation and will deal with the unploughable tussock country included in and about the pastoral runs.

Geology

Geology is fundamentally important when considering the present condition and proposed treatment of our higher altitude tussock grasslands, the parent rock influencing both fertility and stability. Most of this country is derived from the greywacke-argilite complexes, which become less stable as altitude increases due to severe weathering. The lower altitude tussock areas, though grcywacke, are more stable due to a less severe climate. Most of the higher tussock regions are derived from greywacke, except for the Takitimos, where strong igneous intrusions occur, and the Garvies, which comprise the more stable schists.

Soils

The tussock grasslands in the main are yellow brown earths, yellow grey earths, and some related soils (see p. 18).

Climate

The climate ranges from moderate to severe throughout most of the tussock grasslands. Rainfall varies from 30 to 45 in. at lower levels to 75 in. at higher altitudes. Normally the winter snow-line is between 3,000 and 4,000 ft, with the permanent snow-line at 6,000 ft. Winters are hard at lower levels with severe frosts and occasional heavy snowfalls. At the higher altitudes snow, severe freezing, and cold winds add to a hostile environment. These conditions are likely to persist until well into the spring, with most favourable conditions for growth from mid-October onwards. Summers are usually dry and windy, tending towards drought. The autumn is warm, and at lower altitudes favourable growing conditions prevail, usually carrying on well into May.

Vegetation

It is convenient to divide the tussock grasslands into three main groups:

(A) Fescue Tussock (*Festuca novae-zelandiae*) Dominant Association.

(B) Snowgrass (*Danthonia* spp.) Dominant Association.

(C) Alpine Association.

(A) *Fescue Tussock* (Festuca novae-zelandiae) *Dominant Association*

There are approximately 200,000 acres of the fescue tussock dominant association below 3,500 ft, the country being mostly flat to gently sloping. Extensive areas have been subjected to poor management in the past and have reached a very depleted and unproductive state, but this class is more readily rehabilitated than the others. Due to ease of access and location this country suffered to the extent that it became almost derelict waste. The depletion of the country immediately above also contributed to this condition of the lower country.

The dominant plants of this association were originally hard tussock, silver tussock (*Poa caespitosa*), blue tussock (*Poa colensoi*), blue wheat grass (*Agropyron scabrum*), plume grass (*Dichelachne*), and the danthonias, etc., which formed a dense ground cover. Generally tussocks are unpalatable, but they provide a protective shelter for the more palatable plants. After approximately 100 years of occupation the original native vegetation has adapted itself to the semi-desert state of these depleted lands, with flatweeds, scabweed (*Ruouli* spp.), sorrel (*Rumex acetosella*),

thistles sweet vernal ***(Anrhoxanthum odoratum),*** hemlock ***(Conium maculatum),*** and bidi bidi ***(Acaena*** spp.) forming a sparse cover. The introduced species such as browntop (*Agrostis tenuis*), sweet vernal, English hair grass (*Vulpia bromoides*), chcwings fescue (*Festuca* ***rubra*** var. *fallax*) have now practically replaced the native grasses. Gorse (*Ulex* ***euroyaeus),*** sweet brier (*Rosa eglanteria*), cassina, and matagouri ***(Discaria*** *toumatou*), have also invaded the associations in places. Numerous modifications in the original plant community have generally resulted in an increase in the less palatable species.

In the mid-altitude zone of similar fescue tussock country between 1,500 to 3,000 ft the greatest improvement can be expected. Country with a northerly aspect is now generally in a depleted and critical condition. Vegetative cover is sparse, leaving much bare ground exposed to the elements. In many cases tussock remnants and associated plants have had difficulty in surviving under the indifferent management of the past and have thus given way to less desirable and unpalatable species. On less eroded shady country hard tussock has become dominant and such native plants as dwarf heath ***(Leucoyogon fraseri),*** which was once unimportant, has now become numerous. Before settlement the tussock grasslands developed in complete absence of browsing animals; therefore the impact of grazing alone has had a bearing on the behaviour of the tussock vegetation. In its present condition much of this sunny country has little grazing value. The southerly aspect or shady country is, however, more stable and is generally clothed with a dense plant cover of tussock and related plants.

(B) *Snowgrass* (Danthonia spp.) ***Dominant Association***

Snowgrass dominant association is distinguished by a strong dominance of snowgrass in the plant community, which consists of such shrubs as mountain flax ***(Phormium colensoi),*** Spaniard ***(Aciphylla colensoi)*** , snowberry (*Gaultheria*) cotton plant (*Celmesia* spp.), dracophyllum, hebes, etc.

This zone has little or no grazing value except in the north-east Garvies where some snowgrass areas are extensively used for sheep grazing. It is, however, a very important area with regard to water conservation. When snowgrass areas become denuded of plant cover erosion becomes severe, resulting in rapid run-off under high rainfall intensities and quick snow thaws. This causes damage to the lower tussock and flash flooding in the rivers.

Changes in the snowgrass association have been toward a decrease in the number and size of tussocks and an increase in the sub-alpine herbaceous plants. More palatable plants have no doubt been reduced by the presence of the grazing animals, However, much of this country is in a critical condition.

(C) Alpine Association

This has no grazing value and should be **treated as** a watershed protection area only. It is in this zone that geological erosion is most active. Preservation of protective forests and montane scrub communities is, therefore, important, as it serves to retard rapid runoff.

Problems and Pests

The most serious problem confronting the pastoral tussock country today is that of depletion and erosion. This has been brought about by a number of factors with the cycle of depletion commencing in the 1850s. The early settlers were then required to depasture a minimum of sheep before a pastoral licence was granted, but from then on sheep numbers increased rapidly. Records show that large areas of mid-altitude fescue tussock land were supporting one sheep to 2 to 3 acres (today it is nearer one sheep to 7 to 20 acres). After this quick build up in stock numbers, firing of the rank growth and roughage soon became much too frequent. Settlers claimed that stock did better on the resulting new growth and that more stock could be carried. It was reported that it was necessary to burn rank growth to destroy, of all things, rats and myriads of fleas with which it was infested. Difficulty of access also led to the USC of fire to clear the way (this still applies).

Reports as far back as 1856 showed that excessive burning was causing devastation and that steep slopes and hillsides were being denuded of original dense tussock cover. The practice of unwise and excessive burning has thus continued for over 100 years.

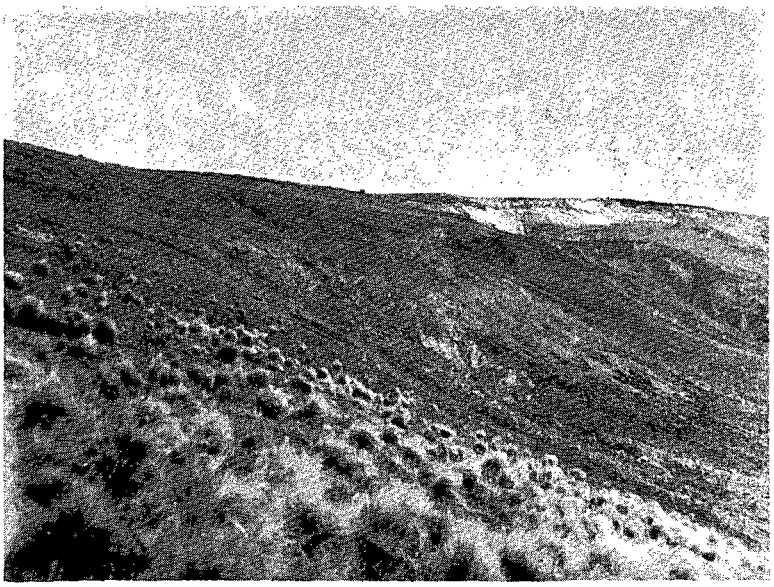
With the introduction of the rabbit in the 1860s many runholders liberated them on their runs for sport and later on the commercial value of the skins tended to protect this pest.

As frequent burning reduced the native vegetation, the increase in rabbit population plus over grazing with domestic animals brought about total destruction of the native species. The introduction of deer in the early 1900s also added to the grazing pressure on this critical country. Lack of subdivision and unwise subdivision have led to over-grazing and unbalanced utilisation of sunny and shady country. The influence of various **classes of** stock is also an important factor in the management of tussock grasslands; for example, cattle are less severe than sheep in their grazing habits and Merino sheep graze to higher levels than crossbreds.

Determination of the original run boundaries was based largely on settlers' claims for land, but this did not always achieve a

Above: Deplcted state of a hard tussock minor catchment in 1948 one year after area was acquired.

Below: The same area in 1960 after spelling and oversowing, and topdressing



boundary which lent itself to the most efficient utilisation of that land.

Rehabilitation and Improvement

So extensive and serious was the problem of depletion of the tussock country that in 1947 the Soil Conservation and Rivers Control Council decided that something had to be done. A block of 1,050 acres ranging from 1,000 to 4,826 ft was acquired for investigations into rehabilitation methods. The area, now known as Mid Dome, was a portion of the winter block of the Fiery Creek Run and at the time of taking over was considered one of the worst depleted and eroded areas of tussock land in Southland. At this stage the carrying capacity of this 1,000 odd acres was 50 to 60 sheep. Depletion of the vegetative cover and the soil erosion cycle had reached such an advanced stage on this steep country up to 3,000 ft that it presented a very real problem. A wide band of bare, denuded scree that was being sheet and wind eroded enveloped the bulk of the mountain side, which was vertically slashed from top to bottom with eroding gullies and streams that spewed out great, bulging fans of rock scree over the lower slopes and flats below. Above, a sparse cap of pedestalled snowgrass-tussock was succumbing to the ravages of frost lift, wind, and sheet erosion; while below, closely cropped fescue tussock survived in patches on the gentle slopes not already engulfed by shingle fans. In less than a century the combined effects of burning and overgrazing by sheep and rabbits had almost ruined the land for pastoral purposes.

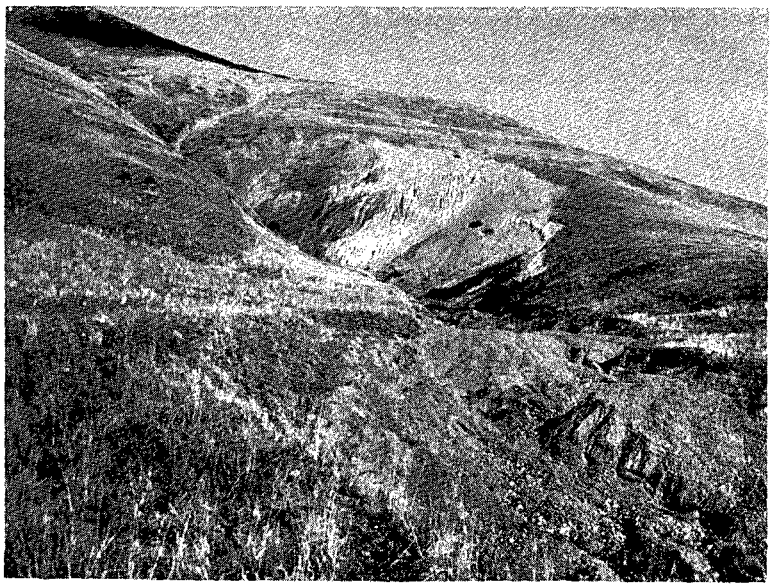
Experimental Investigations

The first essential was to remove stock from the area. To achieve this, wing fences were extended up the hillside in an endeavour to exclude neighbours' sheep. The next move was to reduce the rabbit population. Extensive rabbit destruction operations were begun with the best known methods at that time, which included trapping, dogging, and hand poisoning.

In 1949 the first attempt was made to introduce improved grasses and clovers on the lower slopes. Rabbit fenced observational plots were sown out with various grasses and clovers including cocksfoot (*Dactylis glomerata*), ryegrass (*Lolium perenne*), fescue (*Festuca ovina*), browntop (*Agrostis tenuia*), Yorkshire fog (*Holcus lanatus*), tall oat grass, crested wheat grass (*Agropyron cristatum*), and *Danthonia pilosa*. Clovers included white (*Trifolium repens*), Subterranean (*Trifolium sub terraneum*), Montgomery red (*Trifolium pratense*), and sweet clover (*Medicago* spp.), The most striking feature of this experiment was the

Above: Active erosion at 2,000 feet in one of the major catchments on the reserve taken in 1948.

Below: The same area in 1960 after spelling, oversowing, and topdressing.



effect of rabbit fencing on the growth of grasses and clovers when protected from constant browsing. The incorporated fertiliser treatment indicated the necessity for superphosphate.

Trial seedings with and without fertiliser were continued in rabbit-proof enclosures on the middle slopes. The response of red clover to superphosphate was outstanding, and as the clovers became more vigorous, grasses began to improve. When fenced from the rabbit the surviving native grasses also recovered, but failed to colonise on the bare ground. Results showed that cocksfoot, tall oat grass, Montgomery red and white clover would colonise and establish readily when topdressed with superphosphatc provided they were protected from overgrazing by sheep and rabbits.

The first field scale oversowing of grasses and clovers using the aeroplane was carried out on a 90-acre block in 1950. Strike was good but plants did not survive the constant rabbit browsing. In 1952 a steep, unstable slope was aerially oversown with cocksfoot and inoculated red and white clover plus some tall oat grass, browntop, and ryegrass and topdressed with 1½ cwt of reverted superphosphate. The area established readily, but rabbits were still a problem and it was not until 1955-56 that the local Rabbit Board achieved a worthwhile control with a blanket coverage programme using the acroplane and 1080 poison. An excellent establishment of cocksfoot, browntop, red and white clover was obtained on the lower country in 1955. The block has now developed into a vigorous cocksfoot, browntop, clover association. This area has received 4½ cwt of superphosphate per acre to date.

In 1957 the mid-altitude area, which was at that time bare, denuded moving scree, was oversown from the air with cocksfoot and tall oat grass. Tall oat grass has an extensive fibrous root system and is an aggressive coloniser on unstable screes; in early development it is less palatable than cocksfoot and therefore has an important place in erosion control. Cocksfoot establishment has been outstanding on the more stable areas, which are consolidating naturally after the removal of the rabbit. Inoculated clovers plus 1½ cwt of phosphate were applied in the early spring of 1959-60 after the cocksfoot and tall oat grass had provided a protective cover. Excellent results have been achieved with vigorous establishment of both grasses and clovers. With the regeneration of native grasses and introduction of exotic species, control and utilisation of the surplus growth became an important aspect of the rehabilitation programme.

In 1957 the lower area of 400 acres was fenced off in an endeavour to control and improve cover by grazing, and in 1958 the first grazing was carried out without damage to the sown

Above: Depleted nature of hard tussock area on lower slopes in 1948.

Below: The same area in 1960 after spelling, oversowing, and topdressing. Developed

species. Experience **and** observation have proved that moderate cattle grazing provides the best convalescent treatment after grasses and clover-s have established. It is estimated that the lower 400-acre block is capable of carrying 250 sheep and 2.5 cattle, but further grazing studies are still under consideration.

Recent fertiliser investigations have indicated marked clover responses to 1 cwt of 400 lb sulphurised supcrphosphate on sunny country up to 2,500 ft, but equal results have been obtained from the application of 2 cwt of superphosphate. Application of $2\frac{1}{2}$ oz of molybdenum has resulted in vigorous clover growth on the steeper slopes.

Trial plantings of hardy exotic trees were made at various locations to determine the capacity of trees to revegetate the severely eroded areas. Early plants were lost to the rabbit, but subsequent plantings proved the *Pinus contorta* would establish and grow well at 4,400 ft while *Pinus luricio* established and made good growth at lower levels.

Another important aspect is the stabilising of actively eroding gullies on steep slopes to reduce the discharge of debris on to the improved land below. Experimental work has shown that the establishment of light willow structures and poplar poles in gullies and seepage areas will assist in arresting scree movement.

The results of investigations on Mid Dome are being applied on a run scale on a depleted area in the Eyre Creek Catchment. Some 1,350 acres have been ovcrsown and topdressed with cocks-foot and clover and molybdic super. It is intended to develop this area under cattle grazing.

Conclusion

lnvestigation shows that rehabilitation of scvcrcly depleted tussock country is possible provided certain **basic** principles and practices are observed, including:-

(a) Eradication of noxious animals.
(b) Removal of all domestic stock and complete spelling for 3 to 5 years depending **on** rate of recovery.
(c) Rigid control of burning.
(d) Oversowing of the less unstable areas with cocksfoot, followed by applications of clover and fertiliscrs after the cocksfoot has provided some protection.
(c) Less stable areas to be sown with tall oat grass to arrest erosion.
(f) All clover seed should be inoculated.
(g) The use of sulphurised molybdic super at 1 cwt every 3 or **4** years.
(h) Subdivision of sunny and shady country for more efficient

grazing control, and fencing off of critical snowgrass areas and alpine regions.

(i) Increased use of cattlc and the introduction of crossbred sheep in critical areas.

(j) Spell for occasional whole growing seasons to allow natural seeding.

(k) Greater use of the aeroplane for topdressing, seeding, supply dropping, and fire control.

(I) Establish willow structures and poplar cuttings in active gullies and seepages.

(m) Planting of exotic trees in areas where deep-seated erosion is a problem at higher levels.

(n) Revision of present Pastoral Run boundaries to Catchment boundaries where possible. This suggestion, although placed last, is not by any means the least important.

DISCUSSION

Q. (D. A. Campbell) : Could you give an estimate of the potential carrying capacity of the 1⅓ milion acres of Southland's tussock grassland when restored and developed, based on experiments already completed?

A. This is a difficult question. The increase from 50 to 60 sheep to 250 sheep plus cattle at Mid Dome Reserve gives a guide.

Q. (J. Tripp): What percentage of grass is expected to germinate and what time is best to sow these?

A. Grass germination is not as good as that of clover, but we have not done any grass or clover counts yet. Survival is more important than germination. Frost lift is severe. Two times of sowing were tried. Cocksfoot was sown first. in January, then later clovers for stabilisation. Now both are aerially sown together for economic reasons.

Q. (P. D. Sears): Could you give a figure on germination?

A. My estimate is about 2.5 per cent for grasses and higher for clovers.

Q. (A. C. Wigley): Have you sown any imported clover varieties?

A: No.

Q. (A. C. Wigley): Is there any compensation for' retiring country or plans made to meet retirement?

A. There is some provision for compensation in recent legislation.

Comment (D. A. Campbell): Compensation for retirement was avoided in the past legislation as it encouraged bad husbandry, i.e., burning off and overgrazing. The new Act provides for compensation under prescribed conditions and encourages good husbandry. There is provision for I to I subsidy on severely eroded areas, 1 to 2 on moderate areas and 1 to 4 on fair country for initial oversowing and topdressing. Conservation fencing and tree planting are also subsidised and permanent retirement of steep high eroding class land encouraged.

Q. (E. Cutler): What are your views on Kaikoura soils and how can these soils be improved?

A. Each case is treated on its merits. Improvements are introduced where possible such as control of burning and pests, spelling to promote

natural regeneration, and oversowing and topdressing where there is a response to such treatment.

Q. (P. D. Sears): Who cleans up the rabbits on retired areas?

A. If it is Crown Land a grant is made to the local Rabbit Board, and leased or freehold lands pay rates to Board.

Q. (T. Burnside): What is the cost per mile for fencing in the area after subsidy and rail cost adjustments? How do you fare in snow areas where there are active slips'!

A. Approximately £300 to £400 per mile, but much cheaper electric fencing has some merit. We intend to use it this year at 5,000 feet. Agreed, fencing is very costly but if lower country can be improved, stock would naturally not tend to use high altitudes as much.

Q. (Elliott, Gore): Has any work been done on selection of fog, sweet vernal, and other grasses without topdressing'?

A. No.

Q. (J. Earl, North Canterbury): Has any work been done in oversowing in winter when frost lift is working, or at work at the time of sowing?

A. Use is made of frost action by spring sowing early enough to take advantage of this action.