A SUMMARY OF THE NORTHBURN REGRASSING EXPERIMENTS CONDUCTED BY THE LATE DR. L. COCKAYNE.

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In 1918 the late Cr. L. Cockayne was appointed by the Department of Agriculture to undertake an economic investigation of our Montane tussock grassland, and members of this conference will in the main be familiar with the extensive series of investigations which he conducted with a view to collecting all the available knowledge of the tussock areas of the South Island, and,investigating the problem of preventing the comparatively rapid deterioration which, through various causes, was yearly rendering these areas less productive,

This article in no way attempts a review of the , voluminous work undertaken by Dr. L. Cockayne in the course of his investigations, but may be regarded as a summary of the regrassing experiments which'he conducted upon the Northburn Run in Central Otago, these being the climax to his general investigations over the tussock areas as a whole, in that they were designed to put to proof the theories he had formed as to the causes of depletion and the manner by which the degeneration which had taken place could be best overcome.,

The great tussock grassland area of the South Island, extending from the River Wairau in Marlborough to the forest areas of Southland, embracing 6 million acres constitutes the chief grazing area for the mountain flocks of the Couth Island. This tussock area ranges in height from lowland tussock plains to the mountain tops, but Dr. Cockayne's investigations were in the main confined to what he termed the "Montane" belt, ranging from 1,000 ft. to 3,000 ft., and this belt is to be regarded as distinct from the sub-alpine and alpine belts. Although certain tussock grasses may ascend to the actual summits and be common enough at all altitudes, the main tussock community is that of the Montane belt, and owing to its ease of access, Particularly on account of the absence of trees, it naturally was early settled and converted into sheep runs during the beginning of the "sixties" of the last Century. These areas, therefore, have in the main been continuously grazed for over seventy years, and during that time little has been done to improve their condition, Instead of improvement, gradual deterioration has taken place, the carrying capacity being slowly decreased until in Central Otago the original tussock country has been denuded to such an extent that it is today practically barren. In dealing with this aspect Dr. Cockayne points out that:
"An area of Montane tussock-grassland, where the tussccks stand thickly side by side, might, at fi-rst glance, well be considered pasture of a fairly high quality. Yet the fact stands out that were such an area capable of grazing one sheep to three acres it would far exceed in its carrying-capacity most parts of the tussock-grassland. Much at the present time will not carry even one sheep to five acres, and some parts are virtually barren. Nor do the above statements of necessity apply to those areas where the plant-covering has been greatly damaged and modified by the presence of rabbits in their thousands, Without going intc special details, it stands out clearly that the agric-

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ultural position of the Montane tussock-grassland is far from satisfactory, but it seems hopeful that methods can be devised for raising its carrying-capacity - or, indeed, such, methods, may be in practice on certain runs. New methods for improvement must be based on an accurate knowledge of the present plant-covering of the area, of the natural changes taking place, of the climate and soil conditions to which the species are exposed, of the effect of the operations of man and his grazing-animals, of the life-histories and physiological requirements of the species, of the germinating-capacity of their seeds, of the histories of the plant-associations, and of other matters connected with the relation of the plants to their extremely complex surroundings."

The chief causes of deterioration of our tussock areas can briefly be attributed to: (a) burning at the wrong time, (b) over-stocking with sheep, and (c) damage by rabbits, In regard to tussock burning and over-stocking, the evidence presented before the "Southern Pastor-al Land Commission of 1920" showed conclusively that these were among the primary causes of deterioration for:

> "With the exploitation of the tussock-grassland for sheep-grazing, the grazing-animal - a factor unknown in primitive New Zealand - cane into play. Unaided the sheep would probably not have made much difference in the composition of the pasture except by eating out the few specially palatable species, and so allowing those particularly aggressive -- perhaps the tussocks themselves - to occupy the small amount of ground, provided. But the sheep-farmer early found out that none of the tuseocks except the blue-grass (Agropyron scabrum) were palatable, but that if burned they, in their young leaves, would provide abundance of palatable feed. Consequently, throughout the grass-lands year by year the tussocks were set ablaze, and year by year they were exposed to an increasing multitude of sheep. Nor was the burning confined to that season of the year when the tussocks could best recover, but even during hot, dry weather was the tussock burned. Needless to say this indiscriminate burning and, in many cases, extreme stocking led to great changes in the grassland, OS these changes the most mornentnus were the following: (1) The increase of unpalatable plants on the ground laid bare by burning: (2) the exposure of actual bare ground subject to erosion. On the credit side was the incoming of foreign grasses and herbs of higher palatability than any members of the original pastures, Had it not been for this invasion of exotics the pastures would have been in a far worse condition at the present time."

In regard to rabbits, there can be no question that in their hordes they have been responsible for 'terrific defoliation and actual killing out of large numbers of the more palatable species. on the tussock areas, In the warm, dry climate of Central Otago the rabbit, since its introduction, throve and multiplied rapidly. A vivid description of the ravages made by this pest is contained in "The Naturalisation of Animals and Plants in New Zealand," by G. M. Thompson; wherein Mr James Begg, of Dunedin, describes the results of the influx of the rabbits in the following terms:-

"About the year 1874 they began to make their presence felt in an unpleasant manner. By 1878 they had reached Lake Wakatipu, leaving a devastated country behind them. At the same time they had reached as far east as the Clutha River, and in a f'ew'years later had over-run the greater part of Otago as well as the whole of Southland, Those were evil days for farmers, especially for the squatters who occupied large areas of grazing country. The fine natural grasses on which sheep and cattle 'grazed were almost totally destroyed. Sheep perished from starvation by hundreds of thousands, and it is no exaggeration to say that the majority of the squatters were ruined. In the old Burwood Station the number of sheep fell in one year from 110,000 to about 30,000, This 'was partly due to heavy snow, but the 'rabbits prevented any recovery. It is doubtful if the same country to-day carries more than 40,000 sheep. From the year 1878 onwards immense areas of grazing land were abandoned, as the owners gave up the unequal struggle with the rabbits. At first no efforts seemed to have the slightest effect in stemming the invasion, or in reducing the numbers of the rabbits... The'wet country in the South suffered equally with the dry lands of the interior, but the former is now showing a power of recovery from the, damage done, while in much of the latter the damage appears to be almost irreparable."

In Central Otago depletion from the above causes reached'its climax, accentuated also by the fact that the rainfall there is in'the vicinity of 15 inches per annum, the summer temperature being high and excessive frosts being experienced during the winter., all contributing factors to the inability of the plants to recover and for reseeding to take place,

Dr. Cockayne chose a portion of this territory,. known as the Northburn Run, located upon the Dunstan Range, for his experimental work in regrassing, and. the problem he set himself was indeed a difficult one, the country being virtually barren of vegetation. He explained that:

> "The experiments are not designed to regrass any particular piece of land, but to find out the principles, methods, and suitable plants upon which regrassing depends-, or to show that regrassing is , impossible as a payable proposition, They are "experiments" 'in the true sense, of -that word, and no't "demonstrations," though should plants of pasture value become established in reasonable time and in sufficient numbers, then they could be used for the latter purpose."'

In attacking the question as to the best manner of dealing with the regrassing of the denuded areas, it was obvious from a preliminary examination of the pastures of. Central Otago that no really sound knowledge regarding their improvement could be gained- except by experimental methods,. Certain areas throughout the territory which had been enclosed showed every stage of regeneration from the original almost bare ground to a dense covering of vegetation, but these areas were located either in the valleys or -at the base of the mountains, so that no information was available regarding the upper and greater part of the depleted area, nor were precise particulars available concerning the actual plant contents of the enclosed areas at

the time of their enclosure. It was, further, not known whether the vegetation in these areas had arisen from seed, or from plants already in the ground, and as this point was fundamental to the effect caused by spelling, which many claimed would alone result in regeneration, it was obvious that the enclosed areas were of little value.

A point which stood out very clearly to Dr. Cockayne was that even if spelling alone would suffice to bring back the native grasses it did not seem, in view of the capabilities of the rich mica-schist soil, that a mere return to the original pasture of low feeding value ought to be the destiny of the depleted lands. He felt that if regrassing were feasible, it should be possible to clothe the now barren slopes with plants of high rather than low pasture value.

The chief objects of the Northburn experiments which he eventually laid down can briefly be summarised as follows:-

1. To find out the effects of spelling alone and the length of time which must elapse before results of moment come about;

2. The effect of sowing seeds of various kinds;

3. The best time for sowing seeds:

4. To ascertain the different methods of sowing seeds;

5. The intensity of grazing which different species will tolerate when established;

6. Whether trees can be established by planting or sowing.

The actual sites chosen for the experiments were located on the Northburn Run, twelve plots of approximately ½-acre in extent being selected on the mountain slopes, their altitude ranging from 1,000 ft. to approximately 3,000 ft. These plots varied from the most stoney exposed and highly depleted ground to deep soil on dark faces where Californian thistle (Cnicus arvensis) was abundant. In one case two slopes of different aspect (Plot 10) and facing each other were selected. By the end of January, 1920, the plots were fenced with rabbit-proof netting and from then onwards Dr. Cockayne took most minute notes of the vegetation within the enclosures. Each plot was then divided into three parts, one for autumn, one for spring sowing of grasses, clovers and herbs, and the third portion was planted out with various species of plants, this latter being with the object of ascertaining if such plants would grow if planted with care, and to find out if seed from such would germinate under the conditions supplied by the environment, the seedlings being readily observed on the bare ground.

Seed was sown in the late autumn and early spring of 1920 and the early autumn of 1921, a wide range of species being used (Appendix A). Portions of the areas were sown broadcast; other portions had the seed raked in, with a view to emulating the effect of harrowing, since even on the mountain slopes thousands of acres are available where harrowing could be carried out.

Apart from the afore-mentioned twelve plots, another enclosure was made on the lower country of the Northburn Run to test the effect of sheep tramping as a means of increasing the germination of so-an seed, and other areas in close proximity were surface sown and harrpwed.

The writer had the good fortune to be in close touch with Dr. Cockayne during the period of his investigations on Northburn Run, and subsequent to his withdrawal on account of ill-health had occasion to make periodical inspections of the pilots with a view to recording the results obtained from the various sowings, results which unquestionably justified the infinite pains Dr. Cockayne exercised in recording the minutest detail, and the hard physical exercise entailed in laying down the plots and frequently reporting upon them. Time and again the steep face of the mountain was climbed and during the whole period of the experiment most careful notes were taken, Eventually in September, 1322, he published in the N, Z. Journal of Agriculture an account of the results of his work up to that time:

It is not proposed to outline the results of the experiments given in the abovementioned publication by Dr. Cockayne, but those interested are referred to the article in question. It has, however, to be remembered that the results given were merely of an interim nature, the plots only having been laid down for a period at that time of 2 years 3 months, cr. Cockayne himself pointed out that it would be unwise to form deduction at such an early stage of the experiments. He continued to make observations on the plots for a few more years, and finally, on account of ill-health, had to refrain from the strenuous work entailed in visiting them. The writer at frequent intervals visited the experiments, and during May, 1930, a detailed examination of the various species growing was made, and as a result it is felt justifiable to place on record a summary of the observations made during that year.

Summary of Observations on Northburn Regrassing Plots, May, 1930.

The inspection of plots, carried out as it was practically in mid-winter, was rendered difficult in respect of those situated at high elevations, owing to the amount of snow lying on the ground, Scarcely any rain had taken place since the previous January, and as a result of the autumn drought conditions the growth on the plots was at a considerable discount to what might have been expected had an average autumn been experienced. An examination was made commencing wi-th the highest plot, No. 12, and working from that to the lowest, Observations are therefore given in a descending order, each plot as described being situated at a lower level than its predecessor.

Plot 12 (2,600 ft.): Located on the margin of the sub-alpine belt, this plot in the series stands in a class by-itself, in that it receives more rain and snow than any other plot, When fenced originally there were many almost-dead tussocks, P. intermedia and Agropyrum scabrum, in appearance like small hummocks with here and there a few damaged leaves on their margins.

Wonderful regeneration has now taken place, over 70%of the ground being covered. Scab-weed (Raoulia) has practically disappeared, the dead plants having formed an excellent seed bed for the establishment of the tall blue tussock(P, intermedia) and fescue tussock (F. novae-zelandiae), these growing from 1 ft. to 2 ft. in height. Blue grass (Agropyron scabrum) is thriving vigorously and in places the plant covering is nearly 100%. Cocksfoot (Dactylis glomerata) is abundant, 3ft. high and in seed. Yarrow (Achillea millefolium) giving good cover in places. Triticum repens growing strongly in places, Sheeps burnett (Proterium sanguisorba) and chicory (Cichorium intybus) growing in isolated places. Free seeding of all plants seems to have occurred, but the plot is now dominantly composed of fescue tussock, tall blue grass, and blue grass. Growth is strongest and must vigorous around the fences, where accumulationsof wind-blown dust have taken place. This plot has two aspects, sunny and dark:, and more growth has taken place, so far as the native grasses are concerned, on the dark face. Quite a number of cocksfoot plants were still making growth and affording green feed at the base. Isolated clumps of tall oat grass (A. elatius)existed, these also seeding, and a fair quantity of Chewings fescue (F. rubra var..) was in evidence. Agrostis tenuis.growing in isolated patches, but growing well, Clumps of lucerne (Medicago sativa) were in flower and seed, and even at so late a period in the year succulent green growth was taking place.. Altogether the plot gave a remarkable exposition of the effect of closing that class of country to stock and surface sowing seed. The recovery of tussock grasses is unbelievable, and the plot shows up most distinctly in contrast to the denuded country surrounding it.

Plot 11 (2,450 ft.): This plot, the aspect of which is' on a dark slope, has also the advantage of receiving 'rain and snow on account of its high level, and, if anything; the growth is superior to that on No. 12, almost 100% of cover having taken, place, the average height of grasses and plants being 2'6". Poa pratensis and all native tussock grasses have thriven splendidly. Cocksfoot is in abundance and seeding freely. All the plants enumerated in Plot 12 are growing in this plot, but the fescue tussock is much denser in growth. Lucerne also has done exceptionally well and is seeding freely,. A dense sole of grass has formed, and it is difficult to conceive a better sole than exists, when the plants used are borne in mind., In the centre-of the plot yarrow has taken possession and is spreading vigorously. Tall oat grass is also in abundance and stands out conspicuously. Sheep's burnet and brown top are dispersed throughout.. A remarkable feature is the amount of red clover growing on one side of the plot and even at this time of the year it is making green growth. Two Pinus insignis trees have grown 8 ft. high, and one eucalyptus tree is 20 ft. in height.. Chicory plants are scattered about and have grown to a height of 4 ft. Outside the plot Chewings fescue, which was broadcast, has established in numerous isolated patches, which have been so eaten down as to give them the appearance of small cushion plants..

Plot 10 (2,300 ft.): This plot has two aspects, sunny and dark. In comparison with the two previously described it is disappointing and showed evidence of rabbits. On the sunny face there is practic-

ally no vegetation but scab-weed and a few isolated plants of cocksfoot and lucerne. On the lower, edge of the dark end of the plot there is a fairly well-eaten growth of the various plants and grasses mentioned in Plot 11. Mr. Middle ton, the run-holder, informs me that he purposely allowed rabbits into this plot to note the effect of grazing, and also to watch what recovery took place when grazing was discontinued. He states that heavy growth existed on the 'bottom. end of the plot on the dark face , and it can be well imagined that this was the case, Two gum trees have grown -15 ft. in height , and three pines are 6 ft. in height and growing well ,

Plot g (2,000 ft): Situated on a dark face, the establishment of sown seed and regeneration 'is poor on the top end of the-plot, getting gradually better as it approaches the bottom end where medium establishment on over 50% of the ground has taken place . Strangely enough, lucerne appears to predominate in this plot, and a fair quantity of catsesr (Hypochaeris radicata) is to be seen. Rabbits have been allowed into the plot and apparently have done much damage. A few cocksfoot plants are growing well, but regeneration of native grasses is very poor. Tall oat grass in isolated clumps is growing well, also sweet vernal (Anthoxanthum odoratum) and Chewings fescue,

Plot 8 (2,000 ft): s was located on an extremely steep, sunny face, the soil being stoney but good in places. Of all the sunny plots it showed the best growth. The establishment of most sown grasses and plants is quite fair, particularly towards the lower end of plot. All the grasses and plants enumerated in Plots 12 and 11 are growing here, but the density of growth and covering is not nearly so good. The plot shows signs of rabbit grazing, and this is instanced in the case of splendid lucerne plants growing vigorously as a result of grazing. There is excellent establishment of Sheep's burnet on one portion of the plot, approximately $\frac{1}{2}$ chain square in size, A pine and gum tree are growing well. Considering the Pact that this plot is situated on a bare sunny' face the growth is exceptionally good, 'but one feels disappointed that a greater regeneration of native grasses has not taken place, Tall fescue, cocksfoot and Chewings fescue are thriving very well and. are worthy of special comment , these being the result of the original May sowings.

Plot 7 (1,650 ft.): Situated on a dark face,, this is a remarkable plot , about 100% of the ground being covered, A great general growth, particularly of introduced grasses 'such as tall oat, tall fescue and cocksfoot has taken place., Poa Maniototo is thriving remarkably well . throwing an. abundance of feed, as also is the case with fescue tussock and Danthonia pilosa. This plot looks like a well-established grass paddock, and the cover is so good that a hawk's nest was found in the centre. Lucerne is thriving well and numerous young seedling plants abound. Yarrow also thriving, although not thickly. Very few Californian thistles now exist, although previously. there in abundance, Two years ago this plot was eaten down very closely, but the recovery has been excellent. Brown top was noticed to be doing well, and altogether it has been wonderfully successful.

Plot 6 (1,700 ft.) : Dark face. An excellent plot. The growth of luce me and c0cksfoot was so dense that it was difficult to locate dogs running in the plot. All native species of grasses have grown splendidly and this is one of the best plots in the series. The bulk of the lucerne which has grown remarkably appears to be confined to the eastern side, Yarrow is growing strongly but there are no clover plants showing up, This plot can be classified as an unqualified success.

5. (1,500 ft.): Situated on an open and exposed windy face. Probably 5% of the ground is covered with native tussock and introduced plants. Among the plants noticed are the following: Catsear, Chewings fescue, cocksfoot, red clove? in small patches, scab-weed, yarrow, sheep 's burnet. The plot is poor, and very little establishment of sown grasses occurred. The chief' vegetation is composed of isolated native grasses which are growing slowly. This plot is not in the same category as those previously dealt with, bu-t viewing its low elevation and exposed condition the results must be favourably looked upon, A gum tree has attained the height of 12 ft., whilst a pine is 6 ft, in height.

Plot 4 (1400 ft.): Situated on a sunny face. In regard to this plot, there is a poor establishment of sown grasses and other plants. The same remarks as applied to Plot 5 refer to this plot, with the exception that small patches of subterranean clover were noted and appeared to be seeding freely. Apart from scab-weed, 5% of' cover has taken place. Sheep 's burnet and tall fescue doing fairly well, but plot nowhere so good as those at higher elevations, Isolated plants of: catsear, brown top, in patches, young cocksfoot plants, good patches red clover, clumps of plume grass and sweet vernal are intermixed amongst fescue tussock grass. One gum 20 ft. in height and one 6 ft. were noted.

Plot 3 (1,300 ft.): On an extremely steep sunny face, this plot at the time of enclosure contained many plants 0f Danthonia Buchanani, greatly eaten but full of life, Remarkable number of cocksfoot plants growing but only about 1 5% of the ground. has been. covered. Bartsia and wild mignonette abundant Native grasses, apart from D Buchanani,, have not regenerated well. Sheep's burnet and native broom (Carmichallia Petriei) and other plants sparsely distributed throughout the plot. On lower end lucerne is growing very well,, having grown into strong, coarse plants.

Notes taken on the pure sowing made are as follow:-

1.	Chewings fescue :	Isolated weak plants.
2.	Sainf0in:	Nil.
3.	Cocksfoot·	Good.
4.	Chicory:	1 plant.
5.	Tall oat.	1 good plant.
6.	Sheep 's burnet ;	1 00% good,.
7.	Danthonia pilosa :	Nil.
8.	Plantago:	Nil
9.	Tall fescue ;	Good.

One gum has attained 40 ft. :in height and two pines 8 ft. in height,

Plot 2 (1,150 ft.): On dark face. This plot is very good considering that it is situated on such a low elevation, There is an excellent growth of lucerne and all native grasses, particularly fescue tussock, are growing well, Poa intermedia is abundant and cocksfoot has grown well.. Young socksfoot plants are everywhere in evidence and tall oat grass is growing splendidly, The lucerne plants are reseeding and young plants abound, Very little yarrow exists, but there is a fair amount, of sheep's burnet; probably 60% of the ground is covered with the above plants, and the 'plot can be looked upon as a most successful one. Poa Maniototo and Poa Lindsayi also have grown well and have spread over the plot.

Plot 1 (1,100 ft.): Situated on an open exposed face, this plot can be looked upon as nothing short of marvellous (originally it was a hard, salty flat covered with scab.-weed) The growth is now except--ionally good, lucerne in particular growing most strongly. Yarrow has established well, hair--grass is abundant and Poa Maniototo appears all over. The main growth, however, is mainly confined to introduced plants and grasses. Over 50% of the ground is covered, Several pines are growing, and these range from 3 P-t. to 14 ft. in height.

A short report on Plots 13A, B, and C will be of interest in that these, located at 1,000 ft. elevation on a hard open face, were laid down with a view to ascertaining the effect of sowing seed through the tramping of sheep, and also the effect of harrowing in seed, Plot 13A. was sown originally by scattering seed evenly on the ground, a mob of sheep then being placed. in the enclosure for two days. Plot 13B. had also seed sown broadcast, and the same mob of sheep was driven twice round the plot, Plot 13C. was harrowed, the seed sown broadcast, and again harrowed, The following records the effect of the above three treatments as reported upon by 'he writer some eight years after the plots were sown: -

Plot 13A: At time of inspection 30% o-f the ground was covered with sown plants and grasses, although there was very little growth of native grasses, an odd plant 'or two appearing here and there. There' was, however, an outstanding growth. of lucerne, which had. done remarkably well. Isolated plants of sheep's burnet, ynrrow and cocksfoo-t were also recorded. Chewings fescue; tall oat grass and Lotus angustissimus were in fair evidence. The plot as a whole was dominantly a lucerne one, and the effect of sheep tramping for the establishment of this plant had been most successful.

Plot 13B: The same remarks as made in the case of Plot 13A. apply in this plot, with the exception that only 25% of the ground had been covered.

13C: The' establishment had not been so successful as in the two neighbouring plots although very satisfactory, the same range of plants being noted,,

Summary of Experiments:

In viewing the experiments as a whole, the results must be looked upon as being very successful. There is sufficient evidence to show conclusively that on the, dark faces closing up the land, sowing seed, and spelling the area from sheep and rabbits result in the native grasses re-appearing fairly rapidly and establishing strongly, So far as the sunny faces are concerned, regeneration of native grasses is disappointing, and it is doubtful if any really beneficial results would accrue from spelling such land even for lengthy periods, Summarising the results from the experience gained, the following would appear to be the main points originating from the experiments:-

1. Spelling is ineffectual unless the native grasses are already in existence on the ground, and-the effect of spelling is greatest on the higher country and particularly on the dark faces, where rapid recovery was experienced in the case of tall blue tussock, blue grass and N. Z. fescue tussock. On sunny faces where plants of D. Buchanani existed, spelling considerably increased their size. Generally speaking, however, spelling sunny faces resulted in very little regeneration taking place, even over a lengthy period of years, Poa maniototo and Poa Lindsayi as a result of spelling flowered abundantly, growth being best on the dark faces, It is obvious, despite the generally prevalent idea, that no regeneration of native tussocks will take place , even after a number of years, unless in the first place there are in existence actual plants on the ground being spelled, No regeneration of native grasses occurred from "dormant" seed, or wind-borne seed, The effect of spelling is naturally cumulative, but on dark faces recovery is fairly rapid and total recovery appears to take place in about four years' time;

2. In regard to seed sowing, excellent results can be obtained both from broadcast sowing and from harrowing in seed. The dark faces are more responsive than the sunny faces, and, as evidenced by Plots 13A. and E., sheep tramping as a means of securing germination, even on open sunny faces, is very effective. It appears essential that when sown the young plants should not be grazed for at least eighteen months or more to allow for establishment, and that over-stocking has to be guarded against. The most successful of the sown species were lucerne, cocksfoot, tall fescue, Chewings fescue, chicory and yarrow, The following, on -the whole, have not been very successful:- Ryegrass, sheep's burnet, subterranean clover, dogs tail, Danthonia pilosa, etc.

3. So far as time of sowing is concerned, seed gave best results on the sunny faces when sown in the late autumn, and on the dark faces when sown in the spring.

4. In regard to methods of sowing seeds, on dark and semi-dark faces broadcast sowing gave results nearly comparable with the raking-in of seed. On sunny faces broadcast sowing gave poor results, but raking resulted in fair germinations, Harrowing one poor plot (13C.) gave excellent results, as did sheep tramping after the seed was sown.

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5. The experiments did not give much data upon which to assess the relative intensity of grazing which different species would tolerate when established, but in the plots which were opened to stock from June, 1930, till December, 1932, when they were again visited, it was most noticeable that where the sole of grass was dense no apparent damage of any serious moment had occurred. Cocksfoot, Chewings fescue, lucerne and yarrow appeared to be standing up particularly well to 'the hard grazing experienced, but the native tussocks, with the exception, of fescue tussocks, were considerably checked in growth; When,, however, it is borne in mind that the grazing on these plots was exceptionally severe,. in fact they were excessively over-stocked, it can be assumed that given rational treatment, once a sole of native and introduced species is established, it should be quite practicable to retain their presence on the mountain slopes by judicious grazing,

6. Various species of eucalyptus trees and Pinus radiata thrive well when planted on the mount'ain' slopes, on both dark and sunny faces.,

Conclusion':

The Northburn regrassing experiments are a striking tribute to the memory of a great scientist, and as a result of his general observations whilst engaged on the investigation into the Montane tussock grasslands of New Zealand he has contributed materially to our store of knowledge regarding this vast area of native pasture which hitherto has received little attention from research, He pioneered the way in his investigations - most painstakingly carried out - and in doing so he tackled a problem beset with many difficulties and promising but little hope of success. One feels that too much of our grassland research is devoted to the improvement of what might be termed good pastures, and good pastures, postulating as they do suitable soil and climatic conditions, are relatively easy to improve, Whilst this laudable objective should still be aimed at, it is to be hoped that the presentation of this paper will in some small measure focus attention on the large areas of our comparatively neglected tussock grassland, and that "grassland research" will embrace these areas in the scope of its investigations emulating and following up the excellent work of the late Dr. Leonard Cockayne.

REFERENCES :

1. "An economic Investigation of the Montane Tussock Grassland of New Zealand," by Dr. L. Cockayne, F.R.S. Vols. 18, 19, 20, 21, 23, 24 25, N. Z. Journal of, Agriculture.

2. Report of Commission: "Southern Pastoral Lands," 1920.

3. "The Naturalisation of Animals and Plants in New Zealand," by G. M. Thomson,

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APPENDIX A.

The Seeds sown,

Seeds of the species cited below were sown in the different. sowings - late autumn, early spring, and early autumn. Along with each name is given the amount sown at the rate per acre (not the actual amount sown), and the percentage of germination as supplied by the Biology Section of the Department.

May, 1920, sowing: Chewings fescue (Festuca rubra var.), 3.2 lb., 63 per cent, germination; cocksfoot (Dactylis glomerata), 4.8 lb., 78 per, cent.; crested dogstail (Cynosurus cristatus) per cent.; danthonia (Danthonia pilosa), 3.2 lb., 26 per cent.; fiorin (Agrostis alba), 1.6 lb., 81 per cent.; Lotus angustissimus, 1.6 lb.; meadow-grass (Poa pratensis), 3.2 lb., 48 per dent.; tall fescue (Festuca elatior), 3.2 lb., 74 per cent.; Waipu brown-top (Agrostis tenuis var.), 1.6 lb., 8-i per cent.

September, 1920, sowing: Chewings fescue, 24 lb., 63 per cent.; chicory (Cichorium intybus), 1 lb., 5 per cent.; cocksfoot; 3.7 lb., 78 per cent.; crested dogstail, 1.8 lb., 68 per cent.; danthonia, 2.4 lb., 26 per cent.; fiorin, 1.2 lb., 81 per cent.; Lotus angustissimus, 1.2 lb.; lucerne (Medicago sativa), 4 lb., 85 per cent.; meadow-grass, 2.4 lb., 48 per cent.; tall fescue, 2.4 lb., 74 per cent.; Waipu brown-top, 1.2 lb., 81 per cent.; yarrow (Achillea millefolium), 1 lb., 84 per cent,

March 21, sowing: Catsear (Hypochaeris radicata), 1.2 lb., seed bad; Chewings' fescue, 2.4 lb., 79 per cent.; chicory, 1.2 lb., 51 per cent.; cocksfoot, 2.4 lb., 28 per cent,; danthonia, 1.2 lb., 45 per cent:: fiorin, 1.2 lb., 91 per cent.* Lotus angustissimus, 1.2 lb., 81 per cent,; lucerne, 2.4 lb., 99 per cent.; meadow-grass, 1.2 lb., 39 per cent.; rib-grass (Plantago lanceolata), 2.4 lb., 47 per cent.; ryegrass (Lolium perenne), 2.4 lb., 79 per cent,: sheep's burnet (Poterium sanguisorbae), 2.4 lb., 60 per cent.; tall fescue, 4 lb., 83 per cent.; tall oat-grass (Arrhenatherum elatius), 1.2 lb.., 44 per cent, ; yarrow, 1.2 lb., 81 per cent.; Yorkshire fog (Holcus lanatus), 2.4 lb., 85 per cent.