TUSSOCK GRASSLAND INVESTIGATIONS

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This paper deals with investigations in the Waimakariri River Basin. It is an area of moderate rainfall between 35 and 50in. Soils there are low in lime and phosphate and rabbits are practically non-existent.

The area lies in the montane belt of tussock grassland of dominant fescue tussock, *(Festuca novae-zelandiae)* and studies have been made on flat and moderately sloping country at altitudes ranging from 1900 to 2300ft.

Observations have been made, on the following:—

1. The growth and development of the principal tussocks and grasses.
2. The effect of spelling "on the grassland.
3. The effect of burning on the grassland.
4. Introduced plants have been sown for test under conditions which prevail in this area.

GROWTH OBSERVATIONS

Three species, fescue tussock *(Festuca novae-zelandiae)*, blue tussock *(Poa colensoi)*, and sweet vernal *(Anthoxanthum odoratum)*, were pegged and linear measurements made at fortnightly intervals throughout the spring and summer 1946 and 1947. The number of seed heads produced was counted and the times of flowering and seeding recorded. Seed was collected and germination tests conducted for both fescue and blue tussocks.

Subsequently, in 1949, a further series of tussocks were marked to record the annual development of fescue tussock and blue tussock. Forty plants were pegged in each of five sites including two sunny, one flat, one terrace lying sway from the sun, and one shady site.

If one considers the flowering stage as an indicator of maximum vegetative growth, there is an order of growth. Sweet vernal flowers first in November, followed by blue tussock in December and fescue tussock in early February. Most growth occurs before the drier period of February and March, when hot desiccating winds sweep through, this area.

The dominant fescue tussock grows slowly (see Table I). Leaf counts of small tussocks have shown that in their early stages of development they increase in density, or number of leaves, and slowly in height and spread. Large tussocks have tended to decrease in height. Spread has varied according to site. Twenty-four of the 50 large tussocks measured have partially died back by an estimated amount of 20 per cent to 80 per cent over four sites. On the shady site there has been no dieback and plants have tended to increase in height and spread. This is probably due to more available moisture on the shady site.

Dieback may not necessarily result in the death of the fescue. tussocks, as observations support the view (1) that tussocks die in the centre, but the perimeter grows outward and divides to form independent tussocks.

Small blue tussocks (Poa *colensoi)* have increased in height from 3.3ins. to 3.9ins. and spread from 4.8ins. to 5.6ins. in diameter (see Table II). Large tussocks have remained at a uniform height and spread.

Sweet vernal is the earliest flowering grass in November and seeds in December and January. Observations indicate that it is able to establish in March and April in the shelter of fescue tussocks. Once established seedlings are able to withstand the frosts of winter when protected by tussocks and commence growth early in spring.

During August and September 1946 sweet vernal was green and being eaten by sheep. This suggests that it provides the earliest green bite in the late winter and early spring and as such is of value as feed in tussock grassland.

From germination tests and seed counts it has been calculated that up to 200 viable seeds are produced by average large fescue tussocks and 50 viable seeds by blue tussocks (2). Observations have indicated that germination occurs in the accumulated dead

leafage and humus found in the shelter of fescue tussocks. Though ,a number' of viable seeds are produced, very few of them germinate and establish in the field and then only in the dead material round the base of tussocks. Sweet vernal establishes most readily.

These observations have shown the extraordinarily slow growth rate of fescue tussock. Its tall leaves give shade and shelter and provide a microclimate in which the palatable species grow. If fescue tussock is destroyed, the microclimate is lost and conditions are rendered unfavourable for the growth of palatable species.

SPELLING

To follow the effect of spelling small enclosures were erected on four sites, 2 sunny, 1 terrace, and 1 flat, where there are predominantly native species with. few introduced plants such as browntop *(Agrostis tenuis),* and sweet vernal ***(Anthoxanthum*** *odoratum*), and Yorkshire fog *(Holcus lanatus).*

Visual observations have been made at the end of February each year to compare differences between spelled and grazed plots over the past 5 years.

There has been very little difference as a result of spelling on the sunny and flat sites, but on the terrace site. there has been an increase in cover due mainly to the increase in dead material and blue tussock.

Common to all plots in all sites has been a general decrease in fescue tussock.

Two other enclosures located where there are predominantly introduced species among the tussocks have shown that both browntop and sweet vernal respond to spelling. There has been considerable increase in growth and cover after spelling for 1 to 2 years. One enclosure is situated on a flat to gentls sloping site and the other on a steep, sunny site.

These observations have emphasised that the growth of native species on tussock grassland is very slow.

Spelling increases the growth of introduced species after 1 to 2 years, but native species are slow to respond.

In any consideration of spelling, account must be taken of the slope, aspect and vegetation. Mixed silver

and fescue tussock grassland and fescue tussock grassland where introduced species are plentiful will respond to. spelling. after. 1 to 2 years with an increase in growth and cover. On areas of predominantly native species, little improvement occurs after spelling for up to 5 years.

Sloping, sunny; or- shady faces appear to respond better than flat 'areas;

BURNING

An area which had been burnt in September 1946 as part of run practice was observed (3). Regular recordings on the growth of fescue tussock and blue tussock were made throughout the following growing season. Observations were made by walking over the area and at 10 pace intervals recording the following data from tussocks nearest the. toe of the boot.

1. The height of the burnt' butts.
2. The height of the tallest leaves.
3. A count of the number of seed heads..

The grazing of tussocks was noted and at the last regular observation in May the percentage of each tussock which had died as a result 'of burning was estimated.

Two further recordings were taken in 1949 and 1950 (see Table III).

It was apparent a week after the burn that the fire burnt deeply into the crowns of fescue tussocks fairly widely spaced growing on steep slopes. Where tussocks were growing closer together in a damp locality the fire burnt the drier tops, but left taller butts.

Blue tussock has a dense 'tufted growth form. As it is low growing and was probably damp, the fire swept over it and merely singed the tips of the leaves.

During November and December. after the burn sheep grazing on the area ate the new green leaves growing from the burnt fescue tussocks apparently in preference to the grasses and herbs between. They did not seem to favour blue tussock. After January the leaves of fescue tussocks became harsh and were not grazed.

Fescue tussocks are the more susceptible to burn-. ing. They are partly killed and seed production is

prevented for 3 years after the fire. Blue tussock is not greatly affected and produced seed heads later in the same season as the burn occurred.

By the removal of the leaves and leaf litter. of fescue tussocks, fire destroys the microclimate for the palatable plants and bares the soil. Grazing of the new leaves of the burnt tussocks further weakens them. As tussocks are weakened they cannot hold the steeper slopes. The bared soil starts to move and conditions are rendered more unfavourable for re-seeding.

PLANT INTRODUCTION

Since 1943 a number of species of grasses, legumes, and herbs have been on trial at Craigieburn Station to find suitable species which can be introduced into moderate rainfall tussock grassland areas.

Seed has been spring sown in single rows on cultivated land and, intercultivated until established. No fertilisers have been used.

Species sown include a number of wheatgrasses, wild ryes, and brpmes from North America, cocksfoot, alsike and ***Lotus*** species, as well -as a collection of native blue wheatgrasses (supplied by Mr H. E. Connor of the Botany Division), including ***Agropyron*** *scabrum*, ***A.*** *kirkii* and ***A. enysii.***

Intermediate wheatgrass ***(Agropyron*** *intermedium)* and northern wheatgrass ***(Agropyron*** *dasystachium)* are the most promising species and have extended by rhizomes up to 5ft. on either side of the original rows. Others showing promise are Californian bromegrass *(Bromus* ***carinatus),*** cocksfoot, ***(Dactyl&*** *glomerata),* sheeps burnet ***(Poterium*** *sanguisorbae)* and alsike ***(Trifolium hybridum).*** Some 'types of native blue wheatgrass ***(Agropyron*** *scabrum)* are doing particularly well and have grown as well, if not more vigorously, than any of the introduced grasses.

The promising species have been sown out in plots on cultivated ground in grass-legume mixtures and topdressed with lime and superphosphate. Perennial ryegrass, cocksfoot, white clover and Montgomery red clover, which were sown for comparison, establish much more rapidly than either intermediate wheatgrass or northern wheatgrass, which appear to require two years to establish. Alsike established better than either white or red clover.

The characteristics required of a grass for introduction are that it will, if possible, establish from surface sowings and will reseed. Sweet vernal, browntop, Yorkshire fog, and cocksfoot possess these characteristics and have been established in tussock grassland areas for many years.

Most of these trials have been conducted on cultivated ground and seed has been sown in single rows or broadcast and raked. Broadcast sowings on the grassland have been tried, but there has been no establishment of the promising species intermediate wheatgrass or northern wheatgrass. Lotus species germinated, but have not established.

Methods of sowing have shown that for successful establishment seed should be sown on a disturbed surface or introduced directly into the soil. It is desirable, too, that seed should be sown without destroying the tussock cover. The drill points developed by Mr L. W. Blackmore have proved successful for direct drilling of seed into fescue tussock grassland of the Mackenzie Plains and could be used wherever machinery can be worked.

Cocksfoot has been surface sown successfully on silver tussock *(Poa caespitosa)* grassland (4), but there still remains the problem of establishing a suitable species on the steeper, harder, fescue tussock grassland.

CONCLUSIONS

These investigations have shown the importance of tussock in the fescue tussock grassland. On its preservation depends the growth of palatable grasses and herbs which grow between and around the base of the tussocks.

Practices which destroy the tussock shelter destroy the microclimate, bare the soil, and ultimately lead to the destruction of palatable feed. It is therefore important that burning should not be practised so that tussocks can be maintained. If a burn does occur, the area should be spelled immediately for the following 4 to 5 months to allow the leaves of fescue tussocks to become unpalatable to stock and shelter maintained.

To be effective, spelling should, if possible, be carried out in the spring and early summer to allow species to make their maximum growth and seed be-

TABLE I. FESCUE TUSSOCK *(Festuca novae-zelandiae).*

Locality	Maximum Height of Leaves (In.) LARGE TUSSOCKS Jan. 1949	End Feb. 1950	Beg. March 1951	Beg. March 1952	Maximum Spread of Leaves (In.) (average of 2 diameters) LARGE TUSSOCKS 1949	1950	1951	1952
Sunny	17.6	17.6	16.8	16.8	19.3	19.2	19.7	24.7
Flat	19.6	17.4	16.3	16.4	19.5	18.5	18.3	18.6
Sunny	18.5	17.2	16.9	16.8	19.3	18.6	18.8	16.9
Terrace	19.2	18.8	17.8	17.6	23	21.4	20.9	20.0
Shady	18.8	19.7	19.9	20.0	21.4	21.7	22.8	22.4
Average	18.7	18.1	17.5	17.5	20.5	19.9	20.1	20.5

	SMALL TUSSOCKS				SMALL TUSSOCKS				Total Number of Leaves SMALL TUSSOCKS 1949	1950	1951	1952
Sunny	6.8	7.0	6.9	7.5	4.0	4.5	4.5	5.4	106	141	164	186
Flat	5.6	5.0	4.7	5.4	3.2	3.0	3.1	3.3	43	47	55	87
Sunny	7.5	7.6	8.3	8.7	4.6	5.1	5.2	6.3	106	139	165	203
Terrace	6.6	6.3	6.5	7.7	4.1	4.1	4.5	5.6	112	132	146	200
Shady	9.6	9.1	8.8	9.3	6.8	6.4	6.4	7.6	110	131	168	189
Average	7.2	7.0	7.0	7.7	4.5	4.6	4.7	5.6	95.4	118	140	173

fore being grazed. Where native species predominate results from spelling are likely to be slow on fescue tussock, grassland, but where introduced species are plentiful, one or two .year's spell will give a good increase in growth and cover on both fescue and mixed silver and fescue tussock grassland.

Several introduced species are already widely established throughout the grassland, namely sweet vernal, browntop, Yorkshire fog, and catsear. Cocksfoot is well established on silver tussock grassland. All these species can reseed or expand by means of rhizomes. New introductions are slow to establish and up to the present some of the native blue wheatgrasses appear to grow more rapidly than the other species, followed by cocksfoot, intermediate wheatgrass, Californian brome, northern wheatgrass and sheeps burnet.

Methods of sowing indicate that sowing on a disturbed surface is more successful than broadcast sowings. The development of special points for direct drilling of seed into tussock grassland without destroying, the tussock cover gives promise, that much of the flatter and rolling country can be sown wherever machinery can be worked.

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TABLE III

MEASUREMENTS AND ESTIMATIONS MADE ON BURNT TUSSOCK

I. FESCUE TUSSOCK (*Festuca* novae-zelundiae).

Date of Observations	Locality	Mean Height of Butt. (in.)	Mean Height of Tallest Leaf (in.)	Number of Seed-heads	Percentag Dead	Number of Samples
May, 1947	Shingle Fan	2	8	1 plant with 1 seedhead	57	15
	Hill	2	7	Nil	84	8
March 1, 1949	Shingle Fan	2	8	Nil	50	12
Feb. 20, 1950	Shingle Fan	Not Distinguishable	10½	9 plants with 3 seedheads		20
	Hill		108	12 plants with 4 seedheads		20

II. BLUE TUSSOCK (Poa *colensoi*).

May, 1947	Shingle Fan	2.5	5 6	7	15 23	15
	Hill	3		6		9
March 1, 1949	Shingle Fan	Not Distinguishable	4½	8	Not Distinguishable	15
Feb. 20, 1950	Shingle Fan	Not Distinguishable	5	9	Not Distinguishable	20
	Hill	Not Distinguishable	4	6	Not Distinguishable	20

TABLE II
BLUE TUSSOCK (Poa *colensoi)*

Locality	MAXIMUM HEIGHT OF LEAVES (IN.) LARGE TUSSOCKS				SPREAD OF LEAVES (IN.) (Average of 2 diameters) LARGE TUSSOCKS			
	JAN.. 1949	END FEB. 1950	BEG. MAR. 1951	BEG. MAR. 1952	JAN. 1949	END. FEB. 1950	BEG. MAR. 1951	BEG. MAR. 1952
Sunny	7.2	7.5	7.5	8.1	10.0	10.3	10.3	9.8
Flat	6.7	6.2	6.7	6.6	11.5	11.6	11.1	12.4
Sunny	7.7	6.7	6.7	6.9	11.3	10.7	10.7	10.5
Terrace	7.2	6.8	7.0	7.4	11.3	11.1	11.8	11.4
Shady	7.1	7.2	6.7	7.4	10.0	9.9	9.9	10.9
Average	7.2	6.9	6.9	7.3	10.8	10.7	10.8	10.9
	SMALL TUSSOCKS				SMALL TUSSOCKS			
Sunny	3.0	3.6	3.4	3.9	4.3	4.6	4.6	4.7
Flat	3.0	3.3	3.4	3.4	5.0	5.3	5.2	5.9
Sunny	3.0	3.2	3.6	3.5	4.5	5.0	5.0	5.3
Terrace	3.8	3.8	3.9	3.8	5.1	5.5	5.9	5.8
Shady	3.9	4.6	4.6	4.9	4.9	5.2	5.7	6.4
Average	3.3	3.7	3.8	3.9	4.8	5.1	5.3	6.6

DISCUSSION

Q. What progress has been made in examining plant behaviour on grazed as opposed to ungrazed country ?

A. Up to the present research has been concerned with plot work, but in Central Otago and Mackenzie Country two large. areas have been sown and stocked to try out new species. In the Waimakariri Basin one small area has been sown with promising species with a view to extending it to a grazing trial. We haven't the seed at present to-conduct large-scale grazing trials.

Q. Does' the Plant Breeding Station do anything in the investigation of plants suitable for hill country? Is there any possibility of better plants being bred; or of establishing a station in the South Island where plants could be bred under the environmental conditions under which they will grow?

A.. No work has been done 'other than the selection of native species by Mr H. E. Connor.

L. Corkill: There has not been any work on plants of value to Messrs Dick and Sewell. They are trying out grass species rather than legumes. Mr Coop made it evident that legumes would be more valuable. Have those who read papers investigated the possibility of using legumes? Zigzag clover, though it does not set seed well, is a plant with which we have been working at Palmerston North and which may produce a plant that may be of use. Rose clover in California has moved extremely valuable in areas of low phosphate availability. What results have workers here had from birdsfoot trefoil?

A. (Dick): Clover introduction is the first step in improvement of tussock country. You have seen examples of the plot work at "Ribbonwood." The areas I sowed included suckling and white clover with superphosphate and there was remarkable development of white clover.

Sewell: I received some types of zigzag clover and planted them at Craigieburn. It is doing well,. but does not produce seed. It extends by rhizomes. It is not being grazed. Lotuses are doing well, all in the absence of superphosphate. Alsike establishes and grows as well as any of the legumes. In trials on land that could be cultivated it established better than white or red clover at first. It was established with superphosphate and lime and is up to 6 to 9in. and doing well-much better than white or red clover at present.

Q. Could it be explained how the winter feed supply position was going to be met in high country ?

A. (Coop): It is clear that it is in the winter that feed value is at its absolute lowest. It declines in value through spring and late summer. Then the severe winter climate further reduces the food value of the roughage that is left. Unless we can get some grasses that will establish and give winter feed, the alternative is supplements.

H. M. Sievwright: The runholder from observations over four generations can tell you what his sheep are eating. The impression may have been created that work on clover

introduction on the 14 million acres mentioned by Mr Ireland has just started. Plots were established in the high country by Cockayne in 1910. In spite of rabbit grazing, burning, and the use of the plots as holding paddocks, white clover there is thriving and seeding. Danthonia at Holden Station in spite of rabbits has established, is setting seed, and spreading downwind. In a trial at Holbrook 7 acres was enclosed with rabbit-proof fencing in 1948 and sown using the Blackmore noints on the drill. The establishment of legumes is encouraging. Zigzag clover in the plot has covered 12 sq. yds. in the enclosure. There are no native legumes in the 14 million acres and they must be introduced. I am certain alsike will do well and it must fit into the picture in this country, Certified broad red clover is not holding a place at present. Unfortunately there has been a long interruption since some of the early work in the high country, but the threads are there and if they can be picked up, as some of them are being, we can cash in on the information that is spread. throughout this country.

Q. The matter seems to call for a team of all the specialists in this particular field to produce a plan of action.

A. (Sewell) : At present we are getting information on what plants will grow where to improve the amount of edible feed. We are also trying to map different classes of vegetation to find where particular species are and where we can apply the information we are gathering.

D. A. Campbell: It is high time attention was riveted on this class of country. We must integrate thinking on land use. One cannot help remarking on the remarkable character these plants have shown to survive man's attempts with grazing, fire, etc., to destroy them. In the natural state of this high country the plants were protected by the vegetation. It has taken a long time to destroy that balance, but we have nearly succeeded in doing so. We have now got back to appreciating that the cover is something more than feed, and its protective value is being appreciated. It is the protective value of pastures that. must be appreciated and must be evaluated. Protective values must be predominant on high country and productive values on lowlands. In the world's *grasses* there is *a* deficit in legumes. One of the most striking cases is near here at the 2500ft. level where I saw one of the nicest patches of white clover sown 20 or 30 years ago. Two hundredweight of superphosphate dropped from an aeroplane brought it into production again. Evidence is accumulating that more and more areas will be responsive to superphosphate and grazing management.

Q. Are Catchment Boards doing anything to provide vegetation on the shingle fans that are moved with every successive Storm?

A. (Dick): Catchment Boards in South Canterbury are finding out ways and means whereby work might be done even on shingle fans. The mountain country has to be looked over again in the light of recent knowledge and experience of 100 years. Where there is insufficient winter country we must try to realign boundaries without being forced to overgraze any pastures coming away. There is a lot of

individual work and good work being done, but we need to take a comprehensive view integrating landholders and research workers.

Q. (R. E. Beattie): Sheep on high country have a very wide choice of feed and are very selective feeders over wide areas. They keep their health better than low-country sheep. Men on high country are doing their best to look after it and preserve the very effective natural cover. No speaker mentioned insect pests that are destroying a third of the tussock area. Is there any information on this point?

A. (Kelsey): The Department of Scientific and Industrial Research started 2 years ago on the insect problem in high country. There are 4 experimental areas and it has been found that there are more than 30 species involved. We are trying to find the effect of insects on tussocks. Trial areas have been fenced against rabbits and stock. Results are yet inconclusive, but the effects of spelling from grazing show very clearly. There is an improvement in the tussock itself and in clover.

Q. (L. P. Chapman): When the high country was first occupied the first thought was the making of an economic living without regard to the ultimate fate of the country. The thought of the last generation has been occupation without deterioration. Now it should be occupation with improvement. Burning was not done maliciously, but to make a living. If we do away with burning, there will be great difficulty. What are we to do to get rid of the rank growth, particularly in high-rainfall areas? Even if stock are taken off, we will not get the return of the same association of growth as we had before. All improvement of grasses today is aimed at grasses for high-fertility conditions. Is there any possibility of selecting within those grasses and clovers already in the high country for high-country strains? Seed from some of the white clover selected from areas on the high country where it has survived for 20 or 30 years might be worth breeding on.

A. (Dick): In the last 10 or 20 years there has been comparatively little burning. North Canterbury Catchment Boards circularised runholders for their opinions on which the boards based oermits to burn, The majority did not like burning and there was only a very small area-on which it was considered necessary. There is a small proportion of the country that cannot-be handled by sheep. We want to turn vegetation into beef and mutton rather than ashes. Then we have to find a way to control growth. Beef cattle have been mentioned. We must introduce clovers among the unpalatable vegetation to bring in first the cattle. Mr Ireland said he had not used fire for many years on "Ribbonwood." Several runholders are saying the same. On the higher-rainfall country we must see if there is a method whereby we can reduce burning, because it is up in this mountain country that floods arise.

D. McLeod: The majority of runholders today on low-rainfall areas do not burn for rank scrub growth. In the higher-rainfall areas where there is scrub you must use fire.

There is no practicable alternative. No cattle will control matagouri; no cattle will control alpine scrub. If you don't burn the country is gone.

E. B. Levy: The tussock grasslands had no legumes initially. There may have been some scrubby ones, but no clovers. White clover is probably the best bet, provided it can be aerially topdressed with superphosphate. Mother white is the only type we should try. Had we not developed that good type, I would not have been an advocate-of surface sowing. But today I am a strong advocate, provided we can build up fertility either from the ground or the air. Alsike offers scope for the whole of the backbone of the South Island, whereas in other parts of New Zealand it is disappointing. Alsike is generally non-persistent and is not as palatable as white clover. There is probably scope for the breeding of alsike and it could be commended to plant breeders. To the question whether there are any plants in the tussock country capable of improvement I would say only one-speargrass or bluegrass (***Poa scabrum***). It would take probably a hundred years to breed a slant much use to us even in that group. Probably we-should import any plants likely to be of use. It is a moot point whether we should set up a station in the South Island. We have done most of our breeding at Palmerston North and tested the plants at Lincoln and Gore. A good plant reared at Palmerston North has proved the best plant when tested at Lincoln and Gore.

C. C. Leitch: Seed must be multiplied in areas that are good for seed production. The resultant plant may not be as good at high altitudes as it would be on the lower country but at least it will be better than the poorer plant already there.

G. A. Holmes: New Zealand Mother white clover is an excellent plant on high-fertility land or on lower fertility soil where fertility can be built up. Alsike is all right in plots, but it will not creep. S184 wild white clover is a strain I have seen doing a good job on the marginal lands of Britain. S143 cocksfoot produces well in the mountains of Wales. In Sweden they have had wonderful results with ***Poa pratensis,*** though experience with it here has been disappointing. The Swedes have found the strain they have developed spreads well and holds a face together. Most of our ***Poa pratensis*** came from the United States.

K. L. Anderson: My first impression of your high country was of amazement. It is greatly different from our range country, though from a distance it appears not a great deal different from that in our western States. There is obviously depletion of much of the high country and many areas-in the very high parts are seriously eroded. It is difficult to say how much is new or accelerated erosion and how much is geological. Movement of rubble is evidence of accelerated erosion. No doubt there is good cover on lower areas and in and between tussocks. If change from the original condition of the country is evidence of depletion, then you have it.

There is apparent a serious threat to stream beds, to lands downstream, and to hydro-electric schemes in operation and proposed.

It is evident that something has to be done and that quickly. You can't wait another century to see what happens. Mr Dick's proposal for a comprehensive survey is imperative. Such a survey will have to include all facets and danger points. There will have to be a botanical survey to determine species. Those who advocate improvement of present species and those who advocate introduction of new plants will all have to have a say. An erosion survey is also necessary. The degree of protection necessary will have to be determined. You will have to assess the place of grazing in the maintenance of cover. It will have to be remembered that grazing is only one of the uses of land.

The rabbit, problem will have to be brought under control, as it is in many areas. I was amazed to see so few rabbits after hearing so much about them before I came here. The deer problem will also have to be considered,

After hearing the story of "Ribbonwood's" development and increased carrying capacity I feel sure that your lower slopes and flat areas will have to have attention like that. Irrigation offers one of the many ways of increasing carrying capacity in high country and of taking the grazing pressure off high country.

Emphasis in the United States has been on the animal side, and we will have to change to the plant side in study of this problem. We must maintain the vegetation and learn to use it in the most efficient and practical way if we are to maintain the productivity of our hill lands.