HILL PASTURE BEHAVIOUR UNDER DIFFERENT STOCKING RATES

F. E. T. SUCKLING

Senior Scientific Officer, Grasslands Division, *D.S.I.R., Palmerston North*

IN 1948, the Te Awa hill pasture research area was established, and a programme of subdivision, oversowing with legumes, and topdressing with phosphate was undertaken. As the area has now been in operation for a little over fifteen years, this is an appropriate time to take stock of the improvements that have been made.

At a recent conference held by the Department of Agriculture and Federated Farmers at Waipukurau, and at the Massey University Sheepfarmers' Meeting in Palmerston North (Suckling, 1964) the animal side of the story was dealt with, and there is no doubt that Te Awa has shown a great improvement in overall stock carrying while still maintaining stock thrift, and has given some indication of the potential of the higher-rainfall areas of the North Island hill country. The stocking of the 180-acre area has been increased from approximately 270 ewes and some cattle in 1948 to 965 ewes plus cattle in 1964. Because of the present stocking-rate trials, rates as low as three ewes per acre and as high as seven ewes per acre have been maintained throughout the last five years. Were it not for the fact that these trials involve low stocking on some of the paddocks, the total stock numbers would be even higher than they are.

Having established the fact that the activities at Te Awa have greatly increased animal production, the question arises as to the changes that have taken place in pasture composition over the 15-year period, In this paper, an endeavour will be made to give some idea of the changes in species contribution and pasture quality and to discuss the possibility of further improvement in the future.

Over the past few years there has been a tendency for certain people to criticize the drive for increased production on the grounds that the soil is being "milked" to satisfy immediate demands for animal production. The question posed is : What of the future? It is hoped that this question may also be answered in this paper.

The Research Area

The area is situated some 30 miles north-east of Palmerston North, on a ridge of hills between the Pohangina and

Oroua rivers. The altitude is approximately 1,100 ft above sea level, and rainfall has averaged 40 in. over the 15-year period. The soil type is classified as Raumai sandy loam (N.Z. Soil Bureau, 1954). In general, the natural fertility is low, and pastures run to browntop dominance.

The country is deeply dissected by gullies, with ridges running east and west. The shady country is prone to scrub and fern reversion and is generally dominated by moss. Earth temperatures on these shady faces in mid-winter are below 42°F and there is little winter production. The sunny faces, however, reach a trough of 45 to 46°F in July, but at this temperature there is some growth on the more fertile areas such as the stock camps and easy slopes.

Pasture Improvement

In order to understand more clearly the long-term behaviour of the Te Awa pastures, it will be necessary to describe briefly the treatment given to them, and also to give an indication of the composition of the pasture when the area was taken over in 1948.

In the summer of 1948-49, the area was subdivided into small paddocks for experimental purposes, and in the early autumn all paddocks were mob-stocked with all the available stock on the area in an endeavour to clear off roughage and long grass preparatory to oversowing. A complex mixture containing both grass and legume seed was used on all paddocks. The mixture comprised 10 lb perennial ryegrass, 3 lb crested dogstail, 2 lb Montgomery red clover, 2 lb certified white clover, **1** lb Mt Barker subterranean clover, 1 lb Tallarook subterranean clover, and ½ lb Lotus *major* per acre (Suckling, 1954). As each paddock was grazed as bare as possible it was sown by hand; all paddocks were sown by the middle of April. Establishment counts were made two months after oversowing and again two months later. From these counts it was apparent that the grass oversowing was not successful, but a small percentage of clover established which proved sufficient to effect a marked increase in legume content. The establishment counts indicated that only about 2% of white clover, 1% red clover, 12% subterranean clover and 1% of *Lotus major* seed actually established from oversowing.

Shortly after oversowing was completed, the sown areas were topdressed with 2 cwt/acre of superphosphate. In each of the ensuing ten years the area was topdressed in

autumn with the same quantity of fertilizer, making a total of 20cwt for the period 1949-59. In the first three years, topdressing was carried out by hand, and thereafter by aeroplane.

When the stocking-rate trials were started in 1959, two heavy dressings of superphosphate were applied over most of the area *(i.e.,* in 1959 and in 1960, 6 cwt applications were made per acre, and thereafter back to 2 cwt annual dressings for the remaining three years). Over the period under review, two applications of DDT-superphosphate were made to endeavour to control the grass-grub and subterranean grass-caterpillar problem which is prevalent in the district.

NATURAL RESEEDING

Having established a nucleus of legumes of good quality throughout the pasture, the next step was to try to increase the legume population as quickly as possible. With this in view, various paddocks were summer-spelled to naturally reseed the sown legumes. In August, 1951, after the autumn germination of seed shed the previous season, random soil samples for counts of buried clover seed were taken to a depth of two inches, from stock camps, slopes, steep faces, and terraces or stock tracks (Hyde and Suckling, 1952). From these measurements it was apparent that large quantities of legume seed (approximately 1 cwt/acre) were returned to the top two inches of soil following one summer spell of relatively short duration. This seed, being in the "hard" condition, also had the advantage of being capable of germination over a very long period, and thus overcoming the difficulty, experienced with normal commercial seed, of false strikes due to adverse weather conditions. The success and practicability of this method for building rapidly the all-important legume population led to a systematic programme of reseeding over the whole area.

Original Pasture Composition

In the original state, the pastures on the area consisted of browntop-dominance with danthonia on the dry faces, some ryegrass, cocksfoot, crested dogstail, Chewing's fescue, *Poa pratensis,* sweet vernal, hairgrass, *Poa annua, Poa trivialis,* Yorkshire fop, paspalum, flat weeds, yarrow, bidibidi, toetoe, sedges, rushes, manuka, bracken and hard fern, and

a very thin sprinkling of white and suckling clover. The shady faces were more prone to scrub and fern invasion and were generally dominated by thick mats of moss. On the steeep banks there was much *Gunnera dentata* and *Nertera depressa,* a carry-over from the days when the country was covered by forest.

Because of low fertility and low pasture production, stocking rates were adjusted to the ability of the country to winter stock. This meant that spring growth was far in excess of animal requirements, and led to the inevitable carry-over of rank grass into the autumn and winter, when it was consumed, somewhat reluctantly, by cattle. Patch-grazing was general, with short patches maintained in a close grazed condition by sheep and cattle. With the original topdressing and oversowing in 1949 the position was aggravated, in that the natural legume population and the oversown species responded to the phosphate application and more grass production resulted. It was obvious from the outset that stocking rates had to be increased to cope wtih the increased production.

Comparison between Point-analyses of Original Pasture and Present Sward

Table **1** shows the original composition as determined by the point-analysis method (Levy and Madden, 1933) on permanent pegged transects taken in 1948, 1957, and 1963.

From the table it will be seen that ryegrass content has risen from 4% in 1948 to 28% in 1963. There has been a reduction in browntop, sweet, vernal and danthonia, and in the amount of bare ground. White clover has increased greatly from 4% to 19% while subterranean clover and *Lotus major,* not previously present, have added 8% to the total legume content, which was 6% in I948 and is now 28%.

Pasture Production Measurements

For measurement of pasture production, frame enclosures were placed on the area and cut monthly. The herbage was weighed and sampled for determination of botanical composition and dry weight. Samples of dried material were ground and protein analyses made. Table 2 shows average total dry matter production for the year 1948-49, compared with the average production for the last four years 1960-63 from the same paddocks.

TABLE 1: COMPARISON OF % PASTURE COMPOSITION AT COMMENCEMENT OF PASTURE IMPROVEMENT IN 1948, 1957, AND 1963

	1948	*1957*	*1963*
Ryegrass	*4*	*15*	*28*
Cocksfoot	2	1	1
Crested dogstail	3	*12*	2
Yorkshire fog	9	7	7
Browntop	23	*17*	16
Sweet vernal	9	*4*	5
Danthonia	7	5	4
Chewing's fescue	*4*	5	*4*
Other Grasses	2	2	3
TOTAL GRASSES	*63*	*68*	70
White clover	4	17	19
Subterranean clover	—	3	6
Lotus major	—	*4*	*2*
Suckling clover	2		1
TOTAL CLOVERS	*6*	*2:*	28
Catsear	16	2	—
Other species	*4*	2	1
TOTAL WEEDS	20	*4*	1
Bare ground	11	1	—

TABLE 2: HERBAGE PRODUCTION — TE AWA

Total D.M. production for the year 1948-49 as compared with average production on same paddocks in period 1960-63

	1948-49	*Ave. 1960-63*
Dry matter:		
lb/acre	*7,030*	12.004
per cent.	*27.7*	21.5
Crude protein :		
% of D.M.	*12.0*	*21.0*
lb/acre	*824*	*2,537*
Botanical composition (% of D.M.) :		
Ryegrass and dogstail	20	55
Other grasses	66	37
Clovers	2	6
Other species	12	2
Botanical constituents (lb of D.M./acre):		
Ryegrass and dogstail	*1,404*	*6,555*
Other grasses	*4,696*	*4,542*
Clovers	*132*	*647*
Other species	*798*	*260*

Table 2 shows a considerable increase in total dry matter production from 7,030 lb in 1948 to 12,004 in 1960-63. Dry matter percentage has fallen, showing that there is now considerably less dead material in the sward. Crude protein content of the herbage has risen from 12% in 1948 to 21% in 1960-63. In terms of botanical composition as a percentage of the total dry matter, it is apparent that ryegrass is now contributing nearly three times the amount it produced in 1948, having increased from 20% to 55%. Other grasses, including browntop, fog, etc., have fallen from 66% of the total production to 37%, while clovers have increased from 2% to 6%, a 300% increase. Weed species have fallen from 12% in 1948 to 2% in 1960-63.

From the above figures it is obvious that there is now a highly nutritious pasture of good quality, which produces nearly 200% more than in 1948. On the basis of this increase in quality and quantity of pasture production, stocking rates were increased gradually from 1 ½ to 5 ½ ewes per acre, over an S-year period.

Stocking-rate Trials

During the first ten years of the trials at Te Awa, comparisons have been made of the thrift of stock on improved and unimproved pastures ; of rotational grazing and set-stocking on improved pasture ; and of sheep-carrying capacity of sunny and shady faces.

In the course of these trials, pasture improvement was so dynamic that stocking rates were increased from 1 ½ to 5 ½ ewes per acre, plus some cattle to control surplus spring growth. It was then decided that a pilot trial should be started to determine pasture and animal behaviour under different stocking rates on pasture which had been improved to the standard required to feed adequately 5½ ewes per acre. Similarly, it was considered that further knowledge was required of the precise function of cattle on hill country.

In 1959, the stocking-rate trials were started with stocking rates of 3, 4, 5 and 6½ ewes per acre with and without cattle. In order to overcome possible fertility differences between paddocks, two heavy dressings of superphosphate were applied in 1959 and 1960. In these two years, 6 cwt dressings were made, and in the remaining three years 2 cwt of superphosphate was applied each year.

Each group of sheep was set-stocked on two paddocks, one on a sunny face and the other on a shady face, and for all practical purposes were completely set-stocked through-

out the five-year period. To obtain reasonably valid comparisons between stock behaviour, like-aged ewes were used throughout the trial (i.e., a complete flock of two-tooth ewes was taken on the area and these were carried through to five-year-old before being cast for age).

Five years have now passed since this trial began, and some interesting developments have taken place in the various pastures, particularly those which have been grazed by sheep alone.

Pasture Behaviour under Different Stocking Rates

SHEEP ALONE

A visual assessment of the pasture under different stocking rates of sheep alone shows a pattern of patch-grazing in three of the four rates. At three ewes per acre, only a small proportion of the total area is under close grazing, while the remainder is composed of patches of long rank herbage. At 4 ewes per acre there is a greater clearance of roughage, but the greater part of the surface is covered with rank grass. Even at five ewes per acre, there is a large area of the paddocks still uncontrolled but at 6½ ewes there is almost a complete absence of roughage. In the first year of the trial, 6 ewes were carried per acre on this treatment; however, even at this high stocking rate, there was a carry-over of spring-grown herbage which remained in the paddocks throughout the following winter. In order to achieve full utilization, an additional ½ ewe per acre had to be added. There is every indication that ewes tend to starve themselves in paddocks largely covered with rank dead herbage. They are most reluctant to graze any of this type of pasture. It is also apparent from the stock weights recorded from the three-ewes-per-acre treatment that the sheep are eating more than is produced from the one-fifth to one-third of the total area which is in short, fresh grass. On the basis of an assessment of the total area of closely-grazed pasture, it would seem that the ewes in this group are actually grazing at the rate of something like nine or ten ewes per acre, and that their liveweight would be extremely low in consequence — whereas in fact they are at a reasonably normal level (Suckling, 1964).

Close observation of the grazing habits of this group of sheep has shown that they supplement the small amount of herbage from the short-grazed patches by selecting new growths, or tillers, which spring from the upper nodes of the rank, dry plants, particularly browntop.

One of the most interesting observations from these trials is 'the fact that in the first year following the reduction in stocking rates, in spite of very heavy fertilizer applications, the legumes were smothered completely by long grass. It is very apparent that legumes will not survive under long grass for any prolonged period, and without legumes, and their associated nitrogen release to the grasses, pasture production rapidly declines.

The main effect of aerial topdressing is the obvious response of clovers to phosphate application, with resultant increase in pasture growth. The failure on many farms to utilize this increased production by increasing stocking rates has resulted in a situation very similar to that being observed and measured on the stocking-rate trials (i.e., the inevitable loss of clover and a renewed cycle of pasture reversion in spite of heavy phosphate applications).

At stocking rates of three, four and five ewes per acre there has been a very rapid reversion to bracken and hard fern, particularly on the steeper banks and shady faces. Manuka has once more become a problem, and weed species such as toetoe, bidibidi, pennyroyal, sedges and rushes, which were well under control, and in fact were not present in the sward, five years ago, are regaining dominance. In other words, after five years of this treatment, with heavy topdressing on pasture which was adequately supplied with clovers and stocked at higher-than-normal sheep-stocking rates, the area has gone back to where it was 15 years ago, because of lack of adequate biological control. At 6½ ewes per acre, manuka and fern are under control, but coarse weeds such as rushes and toetoe have increased markedly.

SHEEP AND CATTLE

The inclusion of cattle, grazing with the ewes, at the various stocking rates has led to marked improvement in the control of all the coarse weeds mentioned. At the lower sheep-stocking rates, where cattle rates are higher, an excellent clearance of all these weeds has been achieved, and rushes, in particular, are reduced to a minimum. As sheep-stocking rates are increased, however, there is a proportionate increase in rush content in the paddocks. This is because cattle numbers are reduced with increasing sheep numbers. At 6% ewes per acre, there is practically no feed for cattle: hence they are grazed. on the area only during the wetter summers when there is a small surplus of grass,

From these trials, it is apparent that a balance of sheep and cattle must be maintained even at the higher sheep-stocking rates in order to control the coarse weeds and shrubs which sheep will not consume. Certain schools of thought in the grassland research world have maintained that sheep alone can control adequately all pasture and weed growth on hill country. The present trials have shown that, **even** at levels of 7 ewes per acre, grazed on a further section of the Te Awa trials, sheep will not control all weed growth.

Comparative Pasture Height at Different Stocking Rates

In order to measure pasture height in the various paddocks under different stocking rates, three permanent pegged transects were set out in each paddock, each transect being one chain in length. From these transects, pasture height measurements have been taken seasonally each year for the past four years.

Table 3 shows a summary of the four-year seasonal average of pasture height in inches at the different stocking rates and the quantity of herbage remaining in the paddocks at four seasons of the year, expressed in terms of lb dry matter per acre.

The dry matter figures have been obtained by cutting herbage from 30 sq. ft quadrats in each paddock on four occasions during the year, in spring, summer, autumn and winter.

From the table it will be seen that in the sheep-alone paddocks the average pasture height decreases with increased ewe stocking rates. At three ewes per acre with no cattle, the four-year average height of pasture is 4.8 in.; at four ewes 1.7 in.; at five ewes, 0.8 in.; and at 6½, 0.7 in.

On the other hand, where cattle have been grazed with the sheep, the heights are all very similar, showing effective utilization of pasture at all stocking rates throughout the period. The figures are: At three ewes per acre plus cattle, 0.9 in.; at four ewes, 0.8 in.; at five ewes, 0.6 in.; and at 6½ ewes, 0.7 in. In terms of total dry matter of herbage remaining in the various pastures, it can also be seen from the table that the four-year average for the acre without cattle is 3,303 lb, with an average of 52% of the dry matter being dead material; at four ewes, 1,551 lb with 46% dead material; at five ewes with no cattle, 776 lb with 49% dead material ; and at 6½ ewes, 479 lb with 32% dead material.

TABLE 3: SUMMARY OF FOUR-YEAR SEASONAL AVERAGE OF PASTURE HEIGHT UNDER DIFFERENT STOCKING RATES AND QUANTITY OF HERBAGE REMAINING IN PADDOCKS IN LB DRY MATTER PER ACRE, 1960–63

Stocking Rate	Av. Height (in.)	Av. Total D.M. (lb)	Dead Material (lb/acre)
AUTUMN			
3 ewes/acre, no cattle	4.5	3,069	1,964
4 ewes/acre, no cattle	2.0	1,638	819
5 ewes/acre, no cattle	0.9	783	345
6½ ewes/acre, no cattle	0.3	407	113
3 ewes/acre + cattle	0.8	613	190
4 ewes/acre + cattle	0.9	508	162
5 ewes/acre + cattle	0.7	334	76
6% ewes/acre + cattle	1.2	608	176
WINTER			
3 ewes/acre, no cattle	3.4	2,870	1,492
4 ewes/acre, no cattle	1.1	1,296	583
5 ewes/acre, no cattle	0.5	594	463
0% ewes/acre, no cattle	0.5	288	63
3 ewes/acre + cattle	0.7	439	48
4 ewes/acre + cattle	0.6	463	37
5 ewes/acre + cattle	0.5	456	50
6% ewes/acre + cattle	0.4	259	21
SPRING			
3 ewes/acre, no cattle	4.1	3,522	1,197
4 ewes/acre, no cattle	1.7	1,544	432
5 ewes/acre, no cattle	0.8	931	195
6½ ewes/acre, no cattle	0.7	739	199
3 ewes/acre + cattle	1.2	1,046	199
4 ewes/acre + cattle	1.0	760	167
5 ewes/acre + cattle	0.7	634	101
6% ewes/acre + cattle	0.6	434	78
SUMMER			
3 ewes/acre, no cattle	6.4	3,751	2,176
4 ewes/acre, no cattle	2.1	1,726	1,070 413
5 ewes/acre, no cattle	0.8	783	
6% ewes/acre, no cattle	0.6	565	141 131
3 ewes/acre + cattle	0.9	494	207
4 ewes/acre + cattle	0.8	395	
5 ewes/acre + cattle	0.7	227	138 72
6% ewes/acre + cattle	0.7		
FOUR-YEAR AVERAGE			
3 ewes/acre, no cattle	4.8	3,303	1,707
4 ewes/acre, no cattle	1.7	1,551	726
5 ewes/acre, no cattle	0.8	776	354
6% ewes/acre, no cattle	0.7	479	154
3 ewes/acre + cattle	0.9	616	167
4 ewes/acre + cattle	0.8	556	143
5 ewes/acre + cattle	0.6	455	91
6 ½ ewes/acre + cattle	0.7	382	86

TABLE 4 : BOTANICAL COMPOSITION, STOCKING-RATE TRIALS, 1960 AND 1963
(% ground cover determmed by point-analysis method)

Stocking Rate and Year	Ryegrass	Chewing's fescue	Browntop	Danthonia	Sweet Vernal	Other Grasses	Clovers
3 ewes/acre, no cattle							
1960	4	17	33	4	23	11	8
1963	2	29	35	3	12	14	5
4 w&acre, no cattle							
1960	20	10	21	5	16	14	14
1963	16	18	24	9	7	14	12
5 ewes/acre, no cattle							
1960	26	4	22	3	7	17	21
1963	29	3	20	7	5	13	23
6½ ewes/acre, no cattle							
1960	24	5	18	5	8	17	23
1963	28	8	19	8	2	15	20
3 ewes/acre + cattle							
1960	13	6	22	3	12	17	27
1963	21	5	21	4	5	16	28
4 ewes/acre + cattle							
1960	23	4	20	6	6	16	25
1963	28	5	17	6	4	12	28
5 ewes/acre + cattle							
1960	24	6	20	3	6	14	27
1963	27	6	17	4	5	12	29
6½ ewes/acre + cattle							
1960	34	1	14	0	4	31	16
1963	36	0	16	1	6	18	23

Where cattle are grazed, the figures all show smaller amounts of herbage remaining in the paddocks, with a slightly higher quantity at the three-ewe level. At three ewes per acre plus cattle, herbage remaining was 666 lb with 26% dead material; at four ewes, 556 lb with 26% dead material; at five ewes, 455 lb with 21% dead material; and at 6½ ewes, 382 lb with 22% dead material.

Even where pastures are close-grazed throughout the year with both sheep and cattle, there is a proportion of dead material in the herbage remaining in the sward at all times during the year. This has, of course, some significance in regard to the fungus *Pithomyces chartarum* which causes facial eczema.

Botanical Composition of Pastures at Different Stocking Rates

Table 4 shows the botanical composition of the various paddocks under different stocking rates in terms of percentage ground cover of the various species. A comparison is shown between point analyses taken in 1960 and again in 1963. All analyses in this table are taken at 1 ft intervals along the permanent pegged transects in each paddock.

The table shows that, in the short period under review, rapid changes in pasture composition have occurred. Both ryegrass and clovers have been reduced at three ewes per acre with no cattle. Browntop and Chewing's fescue have increased markedly, compared with the paddocks which have been fully utilized.

As stocking rates increase. so also does the ryegrass and clover content, while all the other grasses remain at similar levels over the period. When cattle and sheep are grazed together to achieve complete utilization of pasture all the year round, the figures show increasing quantities of ryegrass over the four years with all stocking rates. High levels of clover cover are shown in these paddocks, particularly at three, four and five ewes per acre, plus cattle. There is a reduction in clover content at the 6½-ewes-per-acre level where grazing pressure is tending to suppress clover growth.

Botanical Composition of Random Samples

Herbage dissections were done seasonally on random samples from all of the various stocking rates and Table 5 shows a summary for three years. At the lower stocking rates of three and four ewes per acre with no cattle, a very high proportion of the total herbage is made up of dead

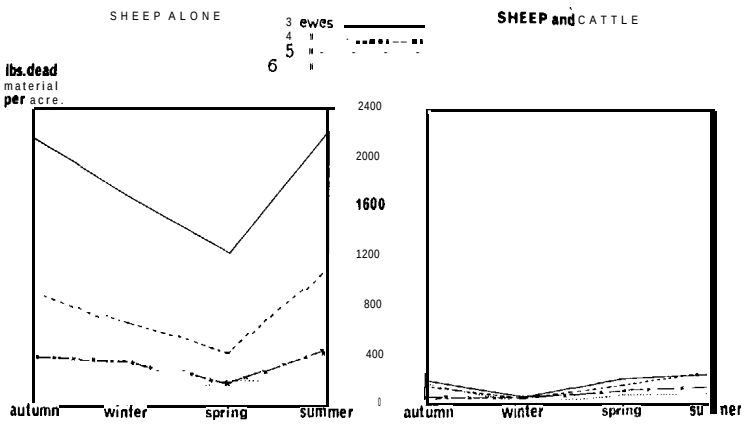

FIG. *1: Dead material remaining in paddock at four seasons of the year. Four-year average in lb/acre.*

grass. As the trial has progressed the proportion has increased, showing that the long rank patches are not being grazed and are lying down in dense mats of dead material. As stocking rates increase, the proportion of dead grass decreases. Where cattle are grazed with the sheep, there is a proportion of dead material at all stocking rates of the order of 20 to 30% of the sample.

In terms of percentage dry weight of herbage, there is a marked increase in rgegrass content where grazing pressure is high. It should be borne in mind that all paddocks were high in ryegrass at the commencement of the trial in 1959 and that the reversion shown has been extremely rapid. Browntop and Chewing's fescue dominate the lower-stocked paddocks where sheep alone are grazed, but Yorkshire fog appears to thrive better where sheep are stocked very heavily with little or no cattle grazing.

Clover content is highest where grazing pressure by sheep and cattle is not too severe.

Figure 1 shows graphically the amount of dead material remaining in the pastures at four seasons of the year, in pounds per acre, and represents a four-year average for each season. It is apparent that, with full utilization of the available herbage, very little dead material remains in the sward at any season of the year. Where sheep are grazed alone at low stocking rates, large quantities of unconsumed herbage are left in the paddocks which smother ryegrass and clover growth and lead to a rapid reversion of the pasture.

TABLE 5: PERCENTAGE BOTANICAL COMPOSITION OF RANDOM SAMPLES. STOCKING-RATE TRIALS
(Annual average for the years 1961-1963; % dry weight)

Stocking Rate and Years	% Dead Material	Ryegrass	Browntop	Yorkshire Fog	Clovers	Other Grasses	Other Species
3 ewes/acre, no cattle							
1961	46	9	18	2	Trace	25	Trace
1962	49	3	19	4	1	24	Trace
1963	63	4	16	3	Trace	14	Trace
4 ewes/acre, no cattle							
1961	42	11	12	4	2	29	Trace
1962	39	14	14	11	2	20	Trace
1963	59	4	15	3	1	18	Trace
5 ewes/acre, no cattle							
1961	22	5	10	2	30	1	1
1962	33	7	13	2	17	2	2
1963	19	9	7	2	11	Trace	Trace
6½ ewes/acre, no cattle							
1961	33	22	5	6	3	30	1
1962	30	25	6	22	4	12	1
1963	33	27	9	6	5	18	2
3 ewes/acre + cattle							
1961	33	27	5	3	4	26	2
1962	20	38	12	14	5	10	1
1963	23	39	7	7	10	12	2
4 ewes/acre + cattle							
1961	31	34	3	5	5	22	Trace
1962	19	51	6	10	4	9	1
1963	28	41	3	8	10	8	2
5 ewes/acre + cattle							
1961	21	46	3	5	4	20	1
1962	19	45	4	12	6	11	3
1963	24	47	5	5	10	7	2
6½ ewes/acre + cattle							
1961	27	30	5	9	3	25	1
1962	15	39	4	14	5	19	4
1963	22	63	4	5	6	8	2

Conclusions

All measurements that have been taken to record pasture changes and production have shown :

(1) That as stocking rates increase, so does ryegrass content increase, reflecting the natural ecological sequence of the fertility cycle as expressed so often by Sir Bruce Levy.

(2) That incomplete utilization of highly topdressed pastures, with adequate clover content, rapidly leads to deterioration in pasture composition and to a reversion into scrub, fern and weeds.

(3) That overgrazing with sheep alone tends to reduce slightly the clover content, and can lead to an opening up of the pasture during drought periods with consequent invasion by weed species.

(4) That there is an optimum high level of sheep and cattle stocking which not only gives maximum output in terms of meat and wool, but also maintains a dynamic, vigorous and dense sward.

(5) That it is necessary to consume as much of the available herbage as possible as it grows, particularly during the spring months, so that pastures remain palatable and highly nutritious at all times. It has been observed that any carry-over of roughage into the winter results in competition between sheep and cattle for short, succulent herbage. Only when all the fresh grass has been consumed will cattle graze rough grass. This means that, during winter, cattle subsist on this so-called "hay *in situ*" while sheep virtually starve and in some cases die of sleepy sickness.

(6) That sheep at very heavy rates of 6½ to seven ewes per acre will graze manuka and fern and keep these weeds under control, but rushes are merely pruned during mid-winter for a short period while there is a shortage of grass. As soon as spring growth comes away, rushes are neglected and soon thrive again.

(7) The trials have shown and confirm that the better utilization of pastures with a resultant higher output of animal products is achieved by simply putting stock on the pasture. At the higher rates of sheep and cattle stocking there is a depression in actual per-animal production, but, on the other hand, there is the compensating factor of much higher production per acre,

What of the Future?

It would be fair to say that there has been no apparent deterioration over the fifteen years of attempting to improve the hill pastures at Te Awa, and incidentally of carrying very much more than normally accepted stocking rates. The figures show that pastures are much more dense and cover the ground far better than before. Earthworm populations have increased to the extent that there are something of the order of 2 tons per acre on the heavily-stocked paddocks, whereas originally there were very few worms. This factor alone has led to a more efficient turnover of soil minerals.

It must be remembered, however, that all the improvements made have been achieved with varieties of grasses and clovers bred over 25 years ago. The potential is enormous, but what of the future when the new varieties of grasses and legumes now being bred for the hill country are incorporated in our pastures? The new winter-producing white clover, for example, could make an outstanding contribution in alleviating the inevitable winter **shortage** experienced on even the most highly improved pastures.

REFERENCES

Hyde, E. 0. C. ; Suckling, F. E. T., 1952: Dormant seeds of clovers and other legumes in agricultural soils. N.Z. *J. Sci.* Tech., ,434: 375–85.

Levy, E. B. ; Madden, E. A., 1933 : Point method of pasture analysis. *N.Z. J. Agric., 46: 267-79.*

N.Z. Soil Bureau, 1954: General survey of the soils of North Island, New Zealand. N.Z. *Soil Bur. Bull. (n.s.) 5: 72-3.*

Suckling, F. E. T., 1954: Pasture management trials on unploughable hill country at Te Awa. N.Z. *J. Sci. Tech., A36: 237-75.*

———— 1964: Stocking rate trials at Te Awa. *Sheepfmg. Annu. 1964 : 18-32.*