CHANGES IN THE PERENNIAL RYEGRASS COMPONENT OF GRAZED PASTURES

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Abstract

The contribution of perennial ryegrass to pasture production is dependent on the stage of development of the pasture, climate and pasture management. Although variability in the percentage of rye-*grass in* improved pastures *is* less than in developing pastures, changes in the ryegrass component in response to different managements can be marked. Tiller counts demonstrated a lower population of ryegrass tillers under rotational grazing by cattle than under sheep. This was increased by changing either from cattle to sheep grazing or by hard set stocking with sheep during spring. Grazing to 3 cm produced more dense ryegrass pasture than grazing to 6 cm. Severity of grazing appeared to be particularly important in dry conditions when grazing below 3 cm is likely to reduce tiller density. A range of management options is therefore available to encourage the perennial ryegrass component, and thus total dry matter production, of improved pasture.

INTRODUCTION

THE TRUISM nurtured by New Zealanders that our pastures consist of the ideal combination of perennial ryegrass and white clover is a contradiction of fact. The ideal combination of ryegrass and white clover defies definition and is likely to vary from situation to situation. However, the importance of perennial ryegrass in New Zealand pastures can be seen in Table 1, which shows the

TABLE 1: PERCENTAGE OF RYEGRASS IN ANNUAL PASTURE YIELDS FROM RATES OF GROWTH STUDIES

Site	*Mean Annual Yield (kg DM/ha)*	*% Confribution of Ryegrass in DM*
Mona Bush (Southland)	14 610	53
Invermay Flat	10 390	46
Invermay Hill	8 890	56
Westport	10 920	39
Motueka	11 560	48
Marton	11 380	45
Wairakei Flat	5 740	14
Wairakei Hill	9 000	35
Gisborne	11730	60
Dargaville	17 160	27

percentage contribution of the ryegrass to the annual pasture dry matter (DM) yields recorded in rate-of-growth mowing studies (Radcliffe, 1974a, 1974b, 1975, 1976; Radcliffe and Sinclair, 1975; Baars et *al.,* 1975; Baars, 1976; Round-Turner et *al., 1976).* These represent long-term-studies which have been conducted throughout New Zealand on improved pastures.

Typical seasonal variation in the perennial ryegrass composition of pasture is shown in Table 2, again using rate-of-growth experimental results.

TABLE 2: SEASONAL VARIATION IN PERCENTAGE RYEGRASS IN PASTURES FROM RATES OF GROWTH STUDIES (% of total DM)

Site	*Spring*	*Summer*	*Autumn*	*Winter*
Mona Bush	59	45	65	93
Invermay Hill	60	49	56	68
Motueka	46	37	57	58
Gisborne	67	63	63	53
Dargaville	‘39	18	18	38

Variation in the botanical composition of pastures is dependent on their stage of development. Pastures under development are likely to change more rapidly and radically than improved pastures, which can be expected to have a more stable composition. The object of this paper is to demonstrate the degree of change that can be expected in the perennial ryegrass component of pastures in the two development situations. Results of hill country pasture development experiments and of pasture management experiments at Invermay will be used to represent developing and improved pastures, respectively.

DEVELOPING HILL COUNTRY PASTURES

Much of New Zealand hill country is in a state of, development, *i.e.,* farmers are in the process of improving pasture fertility and introducing more productive pasture species which require this improved fertility. The resulting changes in pasture composition are becoming increasingly well documented, especially from North Island studies. The foundation work of Suckling (1959, 1975) demonstrated the change from low fertility-demanding species typified by browntop *(Agrostis tenuis* Sibth), to pasture dominated by high fertility-demanding species typified by perennial ryegrass *(Lolium perenne* L.). With oversowing of such species as perennial ryegrass, crested dogstail, red clover, white clover, subterranean clover and lotus, annual topdressing of 250 kg/ha of superphosphate, and increases in stocking rate from 2.4 to 12 ewes/ha, large-scale changes in the pasture composition resulted over the 20-year experimental period at Te Awa (Table 3).

TABLE 3: PERCENTAGE COVER HITS ON IMPROVED SUNNY HILLSIDE (from Suckling, 1975)

Year	Ryegrass + Dogstail	Browntop	Other Grass	Legumes	Broad-leaved Weeds	Bare Ground
1948	7	22	31	6	19	11
1957	27	17	24	27	4	1
1963	30	16	24	28	1	0
1968	35	15	15	34	1	0

Pasture productivity and composition are extremely variable within hill blocks. Leaving aside the obvious effects of aspect, differences result from micro-environmental effects and especially from the transference of fertility by the grazing animals. Gillingham and During (1973) have characterized the transference of nutrients from hillsides to relatively small camp areas at the ridge tops. The range in the summer botanical composition of herbage DM reported by Gillingham and During (1973) is shown in Table 4. They found that annual pasture production ranged from 14 800 kg DM/ha in stock camps to 4500 kg DM/ha in stratum E.

TABLE 4: VARIATION IN SUMMER BOTANICAL COMPOSITION WITH FIVE VEGETATION STRATA IN HILL PASTURES (from Gillingham and During, 1973)

Stratum	% of Block Area	Composition (% of DM) Rye-grass	Brown-top	Other Grasses	White Clover	Broad-leaved Weeds
A Stock camp	6.4	57	21	10	3	6
B ↓ order of	27.6	34	20	17	4	20
C decreasing	37.6	22	26	11	6	30
D pasture	25.8	12	36	11	2	33
E vigour	2.6	0	62	17	0	13

The rate of increase in the ryegrass component in a developing pasture is more rapid under high stocking rates than low (Radcliffe, 1973; Suckling, 1975) . Although grazing management systems have not been shown to markedly affect the rate of increase of the ryegrass in developing pastures (Radcliffe 1973; Grant et al., 1978), the type of grazing animal has affected it

(Suckling, 1975; Grant et *al.*, 1978). Thus Grant et *al.* (1978) reported a more rapid increase in white clover and perennial ryegrass in cattle pastures than in sheep pastures during the early stages of development at Ballantrae.

The pattern of change in pasture composition with development is represented simplistically in Fig. 1. Oscillations in the perennial ryegrass component follow an obvious increasing trend as development progresses. The expected result of increased ryegrass is a concomitant decline in clover together with browntop and other "weed grasses". The extent to which the increase in ryegrass occurs depends on the fertility, but it is unlikely to reach 100% in New Zealand pastures. A pure ryegrass stand requires regular inputs of nutrients (especially artificial nitrogen fertilizers) for its maintenance; stock camp areas in hill pastures are the nearest approximation to this situation in New Zealand.

In developing hill pasture it is possible to obtain almost the whole range of compositions shown in Fig. 1. This is a consequence of necessarily limited managerial control. The long-term annual DM production can also be expected to cover a wide range, e.g., 400% between undeveloped (3300 kg DM/ha) and developed (13 200 kg DM/ha) pasture (Suckling, 1975).

In improved pastures at Invermay, with close control of management, fluctuations in DM production are more likely to be of the order of 20 to 25% than 400%. Another consequence of this

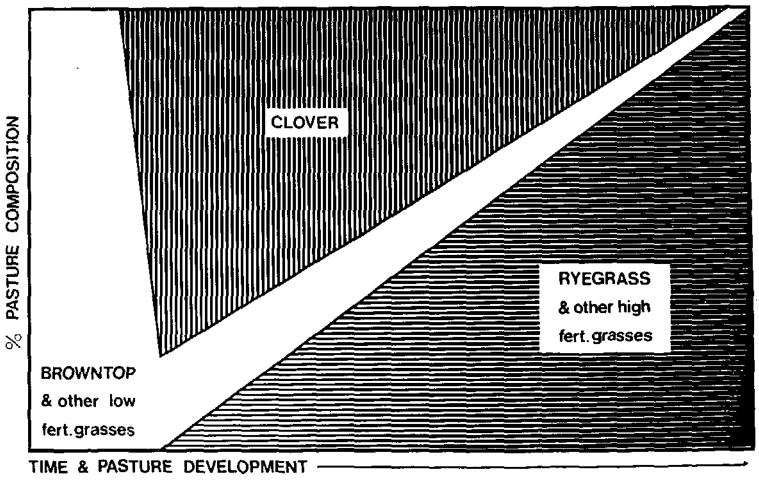

FIG. 1: *Pasture composition changes with development.*

increased managerial control is that the range over which pasture composition can oscillate is similarly reduced.

PERENNIAL RYEGRASS IN HIGH FERTILITY IMPROVED PASTURES

The association of species in improved pastures can be intentionally simple, such as perennial ryegrass and white clover, or intentionally complex. A complex association generally results from the typical pasture mixture sown in Otago and Southland which includes 'Grasslands Ruanui' perennial ryegrass, 'Grasslands Manawa' ryegrass, 'Grasslands Apanui' cocksfoot, 'Grasslands Turoa' red clover, and 'Grasslands Huia' white clover. Detailed results of pasture tiller analyses will be presented from a series of experiments at Invermay which will demonstrate the effects of different grazing animals, short-term changes in pasture management, and the severity of grazing under rotational grazing systems, upon the perennial ryegrass component of intensively managed pastures.

EFFECT OF DIFFERENT GRAZING ANIMALS

Pasture composition data have been recorded by tiller counts from two experiments monitoring the effects of cattle and sheep grazing on the pasture at lnvermay for at least 4 years. One pasture involved a simple mixture of *Lolium [(multiflorum* × *perenne*) X *perenne*] ('Grasslands Ariki' ryegrass) and 'Grasslands Huia' white clover planted on a Wingatui silt loam (recent alluvial soil). Pastures (0.072 ha plots) were grazed by either cattle or sheep according to a rotational grazing management which involved grazing pastures when they reached a mean height of 15 cm and removing the animals 2 to 3 days later with the pasture at a mean height of 3 cm. During periods of slow growth (e.g., in dry autumns), pastures were grazed at intervals not longer than 6 weeks. The mean results of tiller counts recorded from 10 cores per paddock (core diameter 10 cm; 4 replicate paddocks per treatment) in January and June of each year from 1975 to 1978 are shown in Table 5.

The mean density of ryegrass tillers did not vary much between summer and winter in cattle paddocks, but in sheep pasture the mean summer density was $73.1/dm^2$ and the mean winter value 55.9 $tillers/dm^2$. The density of rooted clover nodes was greater under cattle grazing than under sheep. The changes occurred within 1 year of the start of the experiment and the pattern continued in subsequent years.

TABLE 5: MEAN TILLER DENSITY IN RYEGRASS-WHITE CLOVER PASTURE GRAZED BY SHEEP OR CATTLE

	Ryegrass (tillers/dm²)	Clover (rooted nodes/dm²)
Sheep grazing	63.4 A	14.5 b
Cattle grazing	38.1 B	19.5 a
s.e.d.	2.91	1.73

Note: In this and the following tables, Duncan's hotation applies within columns.

A second experiment was conducted on two pastures sown to the typical mixture already mentioned on a Warepa silt loam (a YGE-YBE intergrade soil). One pasture had a history of cattle grazing prior to the start of the experiment and the other a history of sheep grazing. The two paddocks were each subdivided into small paddocks and an experiment was conducted to measure the effect of changing the grazing animal on pasture composition and production. The four experimental treatments were: cattle grazing only, CC; cattle grazing changed to sheep, CS; sheep grazing changed to cattle, SC; sheep grazing only, SS.

The same fixed management as was applied on the ryegrass-white clover pasture was used. Figure 2 shows the pattern of changes in the tiller densities of perennial ryegrass.

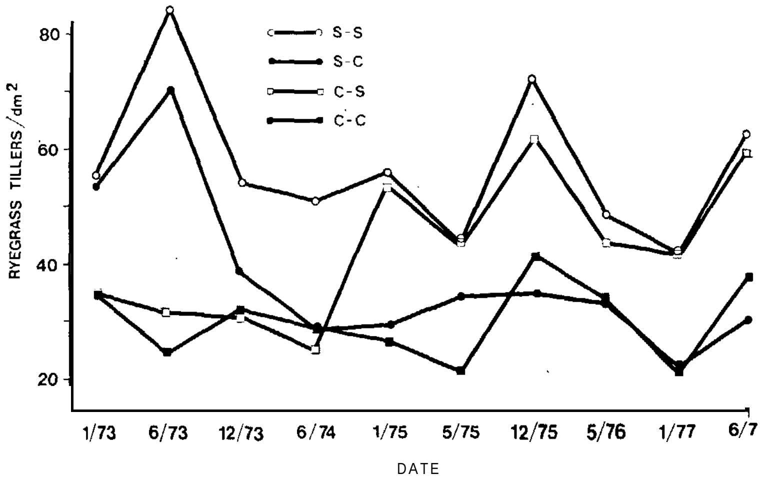

FIG. 2: *Effects of changes in grazing animals on ryegrass filler densities.*

Higher densities of perennial ryegrass tillers were again recorded in pastures grazed by sheep (SS) than pastures grazed by cattle (CC). When cattle were grazed on a sheep pasture (SC), there was a steady decline in ryegrass tiller numbers over a period of 2 years and the density settled at a level similar to the "typical" cattle pasture (CC). When sheep were grazed on a cattle pasture (CS) , the density of ryegrass tillers remained low for 2 years, but appeared to increase rapidly in the winter and spring of the third year to level off at a density similar to the "typical" sheep pasture (SS).

Prolonged grazing with cattle resulted in a lower population of ryegrass tillers compared with sheep grazing under the same management, and very similar densities were recorded from both simple and complex grass/clover pastures. This suggests that there is a lower density of ryegrass tillers per unit area associated with cattle grazing than with sheep. However, it can be modified by simply changing the type of grazing animals.

The response to cattle grazing in pastures at an earlier stage of development differed from these results from improved pastures. Grant *et al.* (1978) at Ballantrae showed that during the early stages of development out of browntop pasture, cattle grazing produced a better rate of pasture improvement than sheep. This was probably because the intensive cattle grazing opened up the mat of browntop better than sheep grazing and allowed better clover establishment. Consequently, better perennial ryegrass establishment followed the clover development.

EFFECT OF A SHORT PERIOD OF SET STOCKING

In spring 1977 the effect of a limited period of hard set stocking on pasture composition was compared with the fixed system of rotation grazing (from 15 to 3 cm) . Half of the paddocks of the preceding experiment were set stocked with sheep from the beginning of September to mid-December 1977. The pasture was maintained at a height of 1 to 3 cm during this period. All other paddocks were rotationally grazed by cattle or sheep according to the pattern of the previous 5 years. After mid-December, management of the paddocks set stocked by sheep was the same as the fixed rotational grazing management applied to the other treatments (i.e., 15 to 3 cm) . A summary of the treatments is given below:

Treatment No.	*Previous 5 years' grazing*	*Spring 1977*	*Summer/Autumn 1977-s*
1	Cattle rotational	Cattle rotational	Cattle rotational
2	Cattle rotational	*Sheep set stocked*	Sheep rotational
3	Sheep rotational	Sheep rotational	Sheep rotational
4	Sheep rotational	*Sheep set stocked*	Sheep rotational

The effect of the period of set stocking on the density of perennial ryegrass tillers is shown in Table 6. Spring set stocking greatly increased the tiller density of all grasses and also rooted nodes of white clover in the summer analysis. The most obvious effect was in perennial ryegrass, which was more than doubled in the pastures previously grazed by cattle. The effects of the set stocking had disappeared in sheep pastures by the following autumn. However, the short period of *set* stocking followed by rotational grazing by sheep had apparently altered the composition of a cattle pasture (Treatment 2) from that typical of cattle (Treatment 1) to one typical of sheep within a single year.

TABLE 6: EFFECT OF CHANGES IN MANAGEMENT ON RYEGRASS TILLER DENSITIES (tillers/DM²)

Treatment Previous Grazing	*June 1977*	*Spring Management*	*December 1977*	*Summer/Autumn Management*	*June 1978*
Cattle	33.3 c	Cattle rotational	40.7 c	Cattle rotational	44.4 a
Cattle	37.0 c	Sheep set stocked	88.8 ab	Sheep rotational	56.7 a
Sheep	53.0 b	Sheep rotational	61.6 bc	Sheep rotational	60.4 a
Sheep	70.3 a	Sheep set stocked	96.2 a	Sheep rotational	61.6 a
s.e.d.	5.65		13.85		12.55

As with the effect of grazing animals, the effect of set stocking on the ryegrass component of swards depends on the stage of pasture development. Hard set stocking in the initial stages of pasture development can promote ryegrass growth at the expense of browntop (Radcliffe, 1973). In more developed pastures prolonged set stocking can be expected to favour the ingress of browntop (Harris and Brougham, 1968). In improved pastures the greatest advantage would be expected from short periods of intensive set stocking either in spring or late autumn when ryegrass is actively tillering.

EFFECT OF SEVERITY OF GRAZING

Earlier studies conducted at Invermay (Boswell, 1976) have shown that rotational grazing to a mean pasture height of 3 cm above ground level favoured production from perennial ryegrass compared with grazing to 6 cm. Grazing to 3 cm allowed a more dense sward to develop than grazing to 6 cm. This was particularly evident in the perennial ryegrass component (Table 7).

TABLE 7: PERENNIAL RYEGRASS TILLERS FROM LAX AND SEVERELY GRAZED PASTURES (tillers/DM²)

Severity of Gruzing	1973	1974	1975
Lax (6 cm)	52.9 B	28.1 B	23.9 B
Severe (3 cm)	79.0 A	42.0 A	41.7 A
s.e.d.	7.42	3.28	4.20

Harris and Brougham (1968) found that lax rotational grazing of improved pasture (22-30 cm grazed down to 7-10 cm) maintained a less dense ryegrass tiller population, but excluded browntop altogether. Despite the advantage of browntop control, grazing to this degree of laxness could be expected to result in wastage of much of the DM production. A cutting trial on improved pasture (Boswell, 1977) clearly demonstrated that defoliation to 3 cm resulted in a greater harvested DM yield than defoliation to 6 cm. Further, grazing to 3 cm promoted a higher density of ryegrass tillers than grazing to 6 cm (Table 7). Bircham (1976), in a cutting experiment on less-improved hill pasture, found no advantage from defoliation closer than 3 cm. Defoliation to this level increased the proportion of ryegrass in the pasture.

Severity of grazing is most important in dry summer and autumn conditions when close grazing is likely to reduce the population of ryegrass tillers (Suckling, 1975) . The close grazing mentioned by Suckling is likely to equate to the 1 cm (severe treatment) cutting level of Bircham (1976) in similar North Island hill pastures. Both were agreed on the need for a relatively lax (e.g., Bircham 3 cm) severity of defoliation during this period. Harris and Brougham (1968) also recommended lax grazing during summer to reduce the competitive advantage of browntop over ryegrass. Grazing to 3 cm above ground level in dry conditions appears to offer a good compromise of effective utilization of pasture grown while retaining the ryegrass component of the sward in improved and developing pasture alike.

Effect of Stocking Rate

Results from a grazing trial on a complex grass-clover pasture at Hindon (Cossens, unpublished data) are summarized in Table

8. Within limits, an increase in stocking rate can be expected to improve the contribution of the perennial ryegrass components of the pasture. In this experiment much of the ryegrass increase was at the expense of the cocksfoot components. This contrasts with the rapid replacement of browntop by ryegrass in response to higher stocking rates in developing North Island hill pasture (Radcliffe, 1973).

TABLE 8: EFFECT OF STOCKING RATES ON BOTANICAL COMPOSITION OF IMPROVED PASTURE AT HINDON

(Cossens, unpublished data)

	Mean Stocking Rate (su/ha)	*Botanical Composition (% of annual DM)*		
		Ryegrass	*Cocksfoot*	*Clover*
Low stocking treatments:				
1967-73	14	24	29	24
1974-76	18	55	15	21
High stocking treatments:				
1967-73	17	37	16	25
1974-76	18	59	12	23

CONCLUSIONS

A range of management alternatives is available to assist the rapid development of depleted pastures by increasing the proportion of perennial ryegrass in the pasture, and also to modify the composition of improved pastures. However, the effect on composition of a management technique is likely to change with the stage of development of the pasture.

A problem of declining ryegrass composition of improved pastures is more serious in the South Island and southern North Island because of the absence of suitable species to fill the role of paspalum and kikuyu grass which compensate for the reduced ryegrass production in northern North Island pastures. Cocksfoot is the usual species grown for summer production in the South. The standard cocksfoot cultivar 'Grasslands Apanui' has proved only moderately satisfactory. There is an obvious need for an aggressive prostrate and dense-growing grass which may more adequately complement perennial ryegrass. The susceptibility of ryegrass to dry summer and autumn conditions makes such a companion species a necessity for easy pasture management. Meanwhile, in the absence of a satisfactory plant there are a range of variations in pasture management available which can be used to exploit perennial ryegrass and thus improve the pasture productivity. These include:

(a) Hard set stocking with sheep during the spring period of active ryegrass tillering.

(b) Alternating sheep and cattle grazing or employing mixed grazing.

(c) Grazing to about 3 cm above ground level (e.g., leaving a grazing residual of approximately 1000 to 1500 kg DM/ha). Grazing below 3 cm in dry conditions is not recommended.

(d) Increasing stocking rates under an intensive rotational grazing management.

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