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# TOPOGRAPHIC AND MANAGEMENT EFFECTS ON BUNG DISTRIBUTION BY GRAZING SHEEP

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## *Abstract*

In both summer and winter, measurements were made of the rate of accumulation of dung by grazing sheep on both "easy" and "steep" land. The effect of the proportion of "easy" land (0, 25, 50, 75 or 100%) was studied in combination with grazing duration (3, 6, 9, 12 or 15 days) using a common pasture allowance in each situation.

The rate of accumulation of dung was faster on "easy" than "steep" land, especially in summer. The rate of build-up in total dung tended to fall off during grazing and in this way largely reflected the pattern of pasture utilisation.

In both seasons total dung accumulation tended to decline as the length of the grazing period increased. Correction for differences in pasture utilisation did not modify the trend and no other explanation can be offered at this time.

In summer the most dung was collected from "easy" slopes when these occupied only 25% of the paddock. This effect did not occur in winter. Most dung was dropped on steep areas when they comprised the total paddock. Other less extreme variations in paddock topography had no obvious effect.

Compared with other treatments the extra P provided in the highest total amount of dung on steep slopes was estimated to be about 2.3 kg ha/year. In order to achieve this, paddocks should, where possible, be fenced into topographically uniform areas either all "easy" or all "steep".

## INTRODUCTION

In any grazed pastoral scene the primary sources of plant nutrients are either through release from previously unavailable inorganic and organic forms in the soil, or, if rapid pasture growth is required, from added fertiliser. However, as pointed out by Sears and co-workers (Sears and Newbold, 1942; Sears and Thurston, 1953), and emphasised subsequently by many others, the nutrients redistributed in the excreta of grazing animals form a major supplementary supply to pasture plants. The usefulness of dung and urine as nutrient sources depends on both their nutrient content and the distribution pattern within the pasture.

In considering phosphorus (P) recycling via the grazing animal, attention can be limited to dung since only very small amounts of P are excreted via urine (Sears and Newbold, 1942; Peterson *et al.*, 1956). The total P content of dung is closely related to the total P intake by the animal (Bromfield and Jones, 1970). Where pasture of varying P content is present, as occurs within many hill blocks, the P content of dung from animals will represent an integration of their grazing preferences and pressures over that pasture.

It is well known that in hill country in particular the tendencies for grazing

sheep to establish well defined camp sites leads to a disproportionately high accumulation of dung, and therefore P, on such areas. The level of accumulation of dung declines sharply with increase in land slope (Gillingham and During, 1973; Gillingham, 1980) so that moderate to steep slopes suffer significant net transfer losses of P annually (Gillingham and During, 1973; Gillingham, 1980). Such areas need higher amounts of fertiliser, relative to the amount of pasture grown, in order to compensate for the relatively low return of P in dung. While steepness itself will limit dung accumulation, no evidence is available to indicate what other factors, which could be manipulated by a farmer, may also be important. This study was made to examine some factors relating to dung accumulation and to identify the effect of both grazing duration and overall paddock topography in modifying dung patterns and to assess if any significant associated change in the P economy of "steep" slopes in particular could be expected.

#### EXPERIMENTAL

The study was made at Whatawhata Hill Country Research Station, near Hamilton. An initial trial occurred in summer (February) and was repeated in a modified form in winter (June-July) 1980. The design is shown in Table 1. Treatments were on a paddock basis, the area of each ranging from 0.4 to 1.0 ha. Grazing was by Romney ewes in mob sizes ranging from 59 to 490 according to season and treatment. All stock had a common pasture allowance of 2 kg DM/ewe grazing day.

TABLE 1: GRAZING AND TOPOGRAPHY TREATMENTS USED IN COMBINATION.

Summer:	Grazing duration: Paddock topography (% "easy"/% "steep")	3, 6, 9, 12 days 0/100, 25/75, 50/50, 75/25, 100/0
Winter:	Grazing duration: Paddock topography (% "easy"/% "steep")	3, 9, 15 days 25/75, 50/50, 75/25.

Measurements of dung distribution were made at times equivalent to 33, 66 and 100% of the total grazing duration. Records of dung accumulation were obtained by visual assessment within a 250 cm<sup>2</sup> quadrat at 1 m intervals along several permanently located 30m long transects established within both "easy" and "steep" areas of each paddock. "Easy" land comprised discrete areas of predominantly less than 20° slope whereas "steep" areas contained well defined stock tracking and had a general slope in excess of 30°. Land surface slope was recorded at each quadrat site.

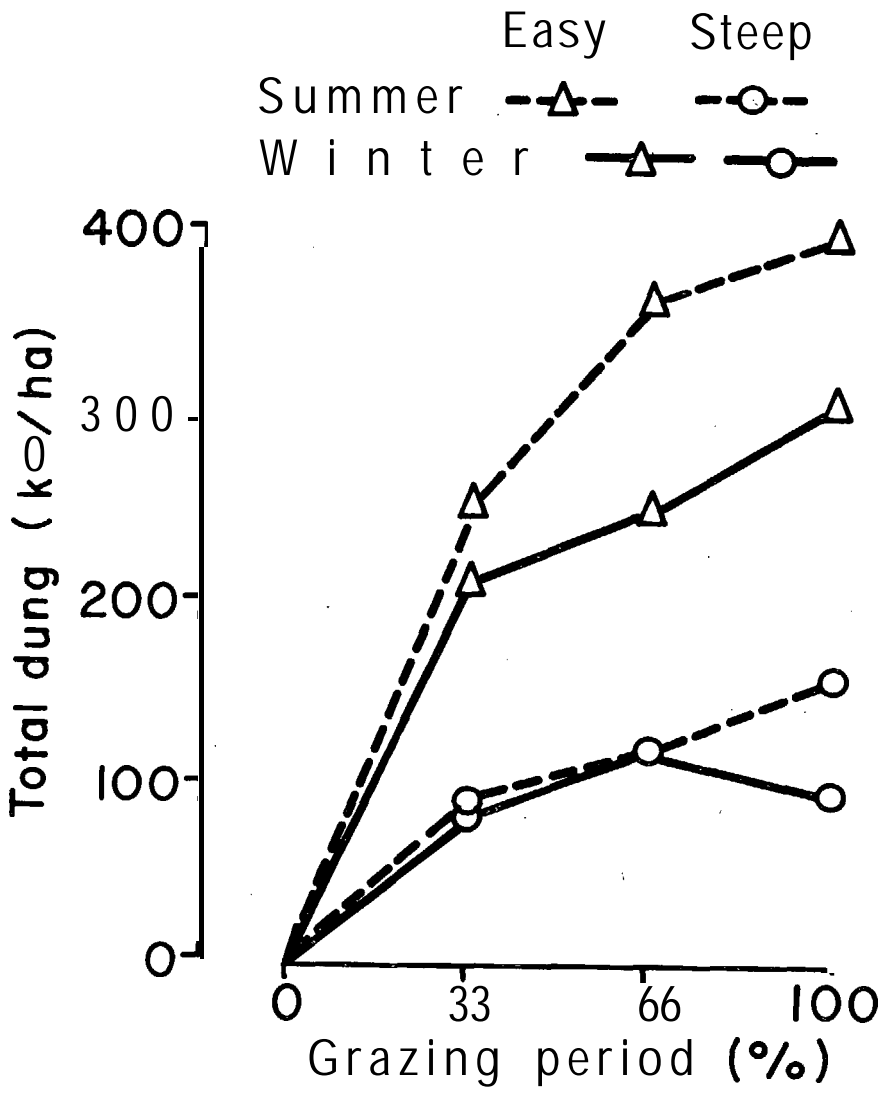


FIG. 1: Dung accumulation during grazing.

## RESULTS

The effect of either grazing duration or topography on dung distribution was not consistent for both summer and winter where common treatments were used. The major effect demonstrated was that the frequency of dung on "steep" slopes appeared to be related to the frequency on "easy" slopes and that at times the variation in both was due to factors other than topography or grazing duration.

### FREQUENCY OF DISTRIBUTION OF DUNG

On both "easy" and "steep" land the measured frequency of dung increased linearly during the grazing period in both summer and winter. However the final frequencies in summer were about twice those of winter (Table 2). Dung frequency increased at a faster rate on the "easy" than on the "steep" land during all phases of the grazing period. The seasonal effect was so large that

**TABLE 2: MEASURED FREQUENCY OF OCCURRENCE OF DUNG DURING GRAZING (%)**

		Grazing Period (%)		
		33	66	100
Summer:	"Easy"	33	49	70
	"Steep"	21	33	46
Winter:	"Easy"	14	25	35
	"Steep"	7	16	21

the frequency of dung on "steep" slopes in summer was higher than on the "easy" slopes in winter. Within any one season however the presence of dung declined with increase in slope, especially on "steep" land areas. This is illustrated by the summer results (Table 3).

**TABLE 3: EFFECT OF SLOPE ON RECORDED FREQUENCY AND MEAN DUNG SIZE AT THE END OF GRAZING (SUMMER)**

	"Easy"			"Steep"			
	0-10	11-15	16-20	0-20	21-30	31-40	41-50
Slope range (°)							
Frequency (%)	74	71	68	60	49	42	36
Mean size (g DM/250 cm <sup>2</sup> )	1.81	1.45	1.12	1.38	0.78	0.57	0.60

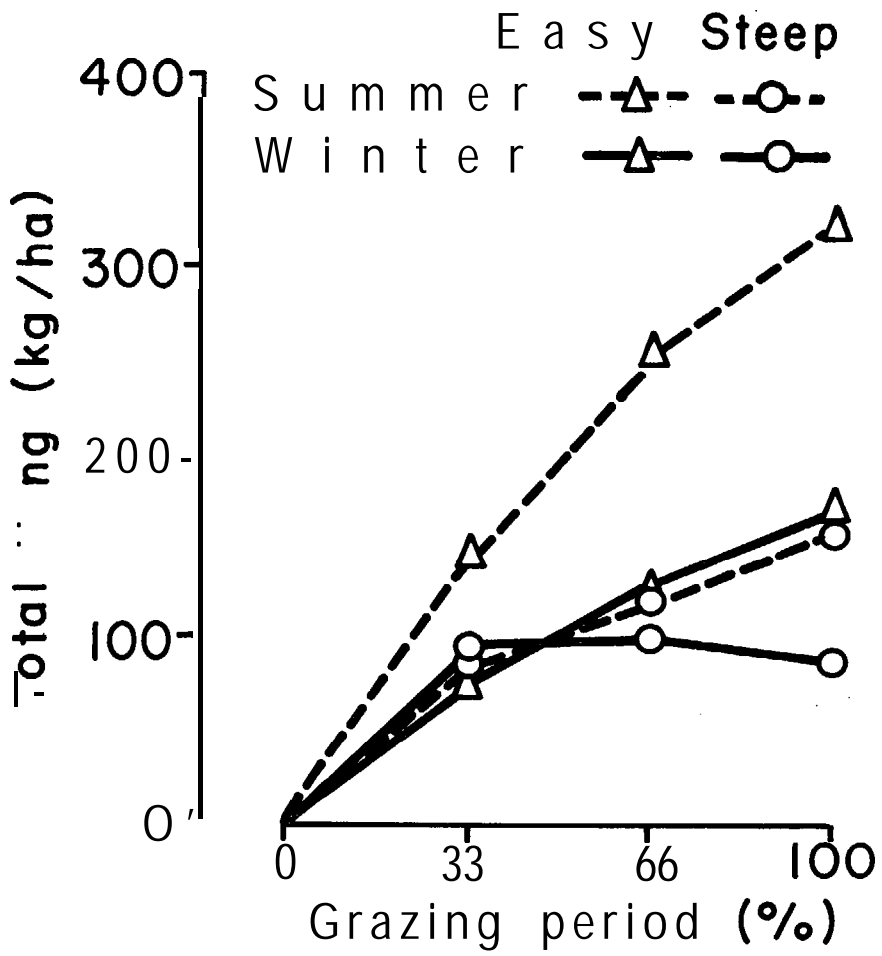


FIG. 2: *Dung accumulation per unit utilization of pasture.*

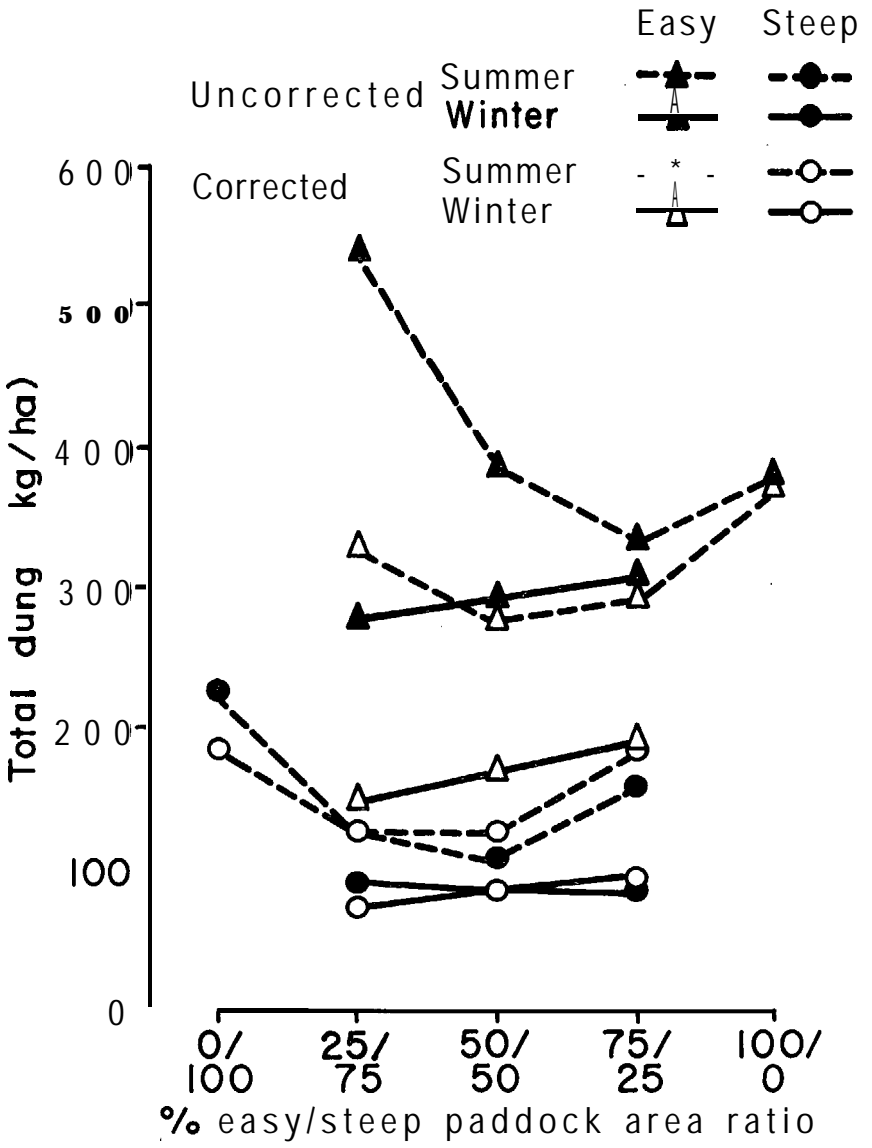


FIG. 3: Effect of paddock topography on dung accumulation.

In summer the highest frequency levels on “easy” land were recorded where these comprised only 25% of the total grazing area. By contrast the density of distribution of dung on “steep” slopes was highest when they comprised the whole paddock area, i.e. when all “easy” slopes were excluded.

In winter there was no significant effect of topography on dung distribution on either “easy” or “steep” slopes.

#### DUNG SIZE

The mean size of dung samples recorded per 250 cm<sup>2</sup> area was much greater in winter than summer and in both seasons declined during the grazing period (Table 4). The decline in mean size during winter grazing was much greater than in summer. It is probable that some of this effect can be attributed to washing of dung by heavy rain during the trial, therefore leading to some under-estimation of dung size in winter. It is unlikely however that this would explain all the changes in mean dung size during grazing.

Mean dung size declined sharply with increase in land slope, as illustrated by summer results (Table 3).

Dung size on “easy” and “steep” land at the end of grazing was little affected by either length of grazing period or overall paddock topography.

TABLE 4: MEAN SIZE OF DUNG SAMPLES AT STAGES DURING GRAZING (g DM/250 cm<sup>2</sup>)

		Grazing period (%)		
		33	66	100
Summer:	“Easy”	1.88	1.81	1.41
	“Steep”	1.04	0.89	0.84
Winter:	“Easy”	3.75	2.47	2.16
	“Steep”	2.92	1.80	1.52

#### TOTAL DUNG ACCUMULATION

Dung accumulation rate diminished during grazing (Fig. 1) and was therefore closely related to the distribution pattern (Table 2) but with the effect of lower dung size (Table 4) in the latter part of the grazing period causing a decline in the rate of total dung accumulation during this time.

Although pasture dry matter allowance per animal was similar in both seasons a greater amount of dung accumulated in summer than winter on “easy” land. The measured total on “steep” land in both seasons was very similar. However, as indicated above, possible under-estimation of dung size in winter would mean an associated under-estimation of total dung in that season, especially in the latter part of the grazing period. This may in part explain the measured apparent decline in total dung on “steep” slopes over the final 33% of the grazing period in winter. It is probable that the correct total

should be nearer that measured for the "steep" land in summer. Similarly it follows that the total dung accumulation for "easy" slopes should also be marginally higher in winter than shown.

When total dung accumulation was corrected for treatment differences in pasture utilisation (Sheath, 1981) on "easy" compared with "steep" land, results still showed high totals ( $P = 0.5$ ) present on "easy" slopes in summer but in winter the corrected level of dung accumulation was much nearer that on "steep" slopes (Fig. 2). These results suggest that the same degree of camping did not occur in winter as in summer, or more correctly that a much smaller proportion of dung was excreted during camping in winter time.

Topography differences between paddocks appeared to have some influence on dung accumulation levels. Highest totals in summer were measured on "easy" slopes where these occupied only 25% of the paddock area and on "steep" slopes where they comprised the total available grazing area (Fig. 3). The same effect did not occur on the "easy" slopes in winter and may be a further reflection of reduced dung drop during camping in winter. Correction of dung totals for differences in pasture intake showed that most of the difference between paddocks in total dung accumulation on "easy" slopes in summer could be attributed to associated induced differences in pasture utilisation. Similar adjustment of the winter results showed that the difference between "easy" and "steep" slopes in dung total due to camping was considerably less in winter than in summer and not modified by variation in paddock topography.

In both seasons total dung present at the end of grazing tended to decline as the length of the grazing period increased. While some erosion of dung by rainfall could explain the relatively small effect in winter this was not so in summer when the trend was more pronounced. Correction for treatment differences in pasture utilisation did not alter the trend. No other explanation can be provided at this time and further measurements are required to establish if this was a real effect.

#### DISCUSSION

In these trials land slope was reaffirmed to be the factor which predominantly determined dung distribution and accumulation patterns in hill pastures. Increase in land slope modified the normal manner of dung accumulation which occurred on any one slope. The normal pattern, as shown by comparing Tables 2 and 4, is for mean dung size to decrease as distribution frequency of dung increases. The modifying effect of increased slope was to induce a decrease in both frequency and mean dung size. The net effect was for "steep" zones to receive on average only about 38% of total dung returned to "easy" land. In comparison the total pasture removed from "steep" land during grazing was about 73% of that utilised from "easy" slopes (Sheath, 1981).

The relatively rapid rate of dung accumulation during the initial 33% of the grazing period must be related to the associated high proportion of total pasture utilisation occurring in the same period (Sheath, 1981). Dung

production is relatively high under high levels of feed intake (Blaxter *et al.*, 1956; Raymond *et al.*, 1956) with associated apparent digestibility levels lower than where a smaller allowance of the same feed is provided. Similarly the decline in mean size of dung samples during grazing can be related to the decline in quantity and quality of residual pasture as utilisation increased.

The difference in dung accumulation on "easy" compared with "steep" zones was much more pronounced in summer than winter. The greater camping during summer may be related to the greater "ballast" or gut fill associated with the slower rate of passage of less digestible material (Blaxter *et al.*, 1956), such as high dead matter content, summer pasture, than would occur with winter pasture. With higher gut fill in summer than winter, along with an associated reduced appetite, it could be expected that sheep would spend, in summer, a relatively large part of the total period in camp sites, rather than actively grazing.

Relatively high amounts of dung were deposited on "easy" slopes in summer when they occupied only a small part (25%) of the total grazing area. In winter the 25/75 topographic treatment did not have the same modifying influence on dung distribution. The winter trial did not include completely steep paddocks and it is therefore difficult to assess the significance of such topography on the total, annual return of P to "steep" slopes via dung. Although the trials were not intended to provide such information some assumptions can be made which help to indicate the order of magnitude of any benefit resulting from higher dung returns to "steep" slopes in completely steep paddocks.

If the topographic effect on dung distribution, as shown in Fig. 3, was limited to periods when pastures are of relatively low digestibility (i.e., summer and autumn), if each paddock was grazed 8 times per year, and dung P content from the well topdressed pasture averaged 1.0% P, then the additional P return to completely steep paddocks would be about 3.5 kg per hectare per year greater than to steep slopes in paddocks of mixed topography. Because of small paddock sizes and higher pasture utilisation levels in these trials than would occur on a farm scale, it is probable that a more realistic estimate of the expected benefit would be in the order of 2-3kg P per hectare per year. Such gains, although not large on an annual basis, would be significant over the life of the pasture. It is probable that separation of "steep" from "easy" topography will not fully compensate for the recognised transfer of nutrients from steep slopes. However, such fencing, where practicable does provide some compensation and together with associated better control of pasture utilisation patterns (Sheath, 1981) should be considered as worthwhile.

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