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SOME EFFECTS OF TREADING ON PASTURE

D. B. Edmond*

FOR THE DURATION of its grazing, an animal treads the pasture. Surely this treading must have a profound and important effect?

In New Zealand, where treading is heavy and recurrent (see McCulloch and Connell, 1934), it is surprising that little attention has been given to its study.

Pugged and poached pastures are clear evidence of the effects of treading when the soil is wet, especially in winter, as are pathways, at all times of the year. Perhaps the differences between cow and sheep pastures, and the controversy revolving around the set stocking and rotational grazing systems of management, might be resolved in terms of treading effect.

In these various situations it has been seen that some species are more susceptible to treading than others. Levy (1926) reported a use of this phenomenon in the North Island hill country where cattle were used to tread out susceptible weeds. Perennial ryegrass has usually been considered to be tolerant of treading, indeed it has been a common belief that, for vigorous growth of perennial ryegrass, plants must be continually trodden and pushed into the soil.

Bates (1930, 1935, 1951), Chandler (1940), Crocker (1953), Davies (1938), Klecka (1937), Kudelin (1952), Levy (1926), Lieth (1954), and Steinbrenner (1951) have observed that treading can damage pasture species. Bruising and destruction of plants, and compaction and puddling of soil have been specially noted. Treading was seen to alter pasture composition. Thus, the immediate effects of direct injury to plant and soil must be distinguished from the persistent effects of altered botanical composition and changed soil conditions, physical and chemical.

When the treading work commenced at Grasslands Division, D.S.I.R., there was no known systematic investigation of the subject. However, O'Connor (1956), has since reported briefly on some aspects of the subject. As a first approach it was decided to study short-term treading effects, where treading was free from the effects of defoliation and soil fertility.

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A Technique

From a suggestion by E. O. C. Hyde, a technique was evolved and is under test at Grasslands Division (Edmond, 1958a). In summary, narrow fenced plots are used, up and down which sheep are driven a specified number of times. Herbage is mown off before treading, and by keeping the sheep walking during treatment, defoliation is kept at a minimum, while excretion is reduced by underfeeding them for some hours before treading.

The technique is not completely satisfactory. For instance, herbage is removed before treading and O'Connor (1956) has reported that, when leaves are long, treading damage is reduced. Further, the sheep walk quite differently on the plots and on pasture and the centre of each plot is trodden more than on the sides. By and large, the treatments have been like a special kind of mob stocking.

The assumption used was that a sheep would walk about 1.7 miles per day. Louw *et al.* (1948) and England (1954), had reported distances from 3 to 7 miles per day, while Hughes and Reid (1951), with a few sheep, reported distances ranging from 0.44 to 1.71 miles per day. Cresswell (1957), has reported pertinent data which suggest that the assumption used here was 50 to 60% in excess of actuality. However, the fact remains that treading is by far the greatest influence in the technique, and as such it can be studied.

Using the technique, the treading of 0, 4, 8, 12, 16 and 20 sheep per acre was imitated in the winter of 1956, on a short-rotation ryegrass-clover pasture, with high initial fertility and good soil structure. Treadings were applied with the soil moisture at about field capacity—approximately 40% for top 3 in. The results are summarized in Fig. 1, which was constructed from dry weight yield of herbage data secured 30 days after one treading of the uniform pasture.

Experimental treading at the heaviest rate reduced dry weight yield of herbage by about 60%, while the lightest rate reduced it by 10 to 20%. In this investigation white clover (*Trifolium repens*), *Poa annua*, *P. trivialis* and *Cerastium glomeratum* were more susceptible to treading than short-rotation ryegrass. Because of these species differences in susceptibility, the effects of treading over a period of 3 to 4 months included marked changes in botanical composition. Generally speaking, however, the main effects of the first treading in terms of damaged plants and changed soil were repeated with little

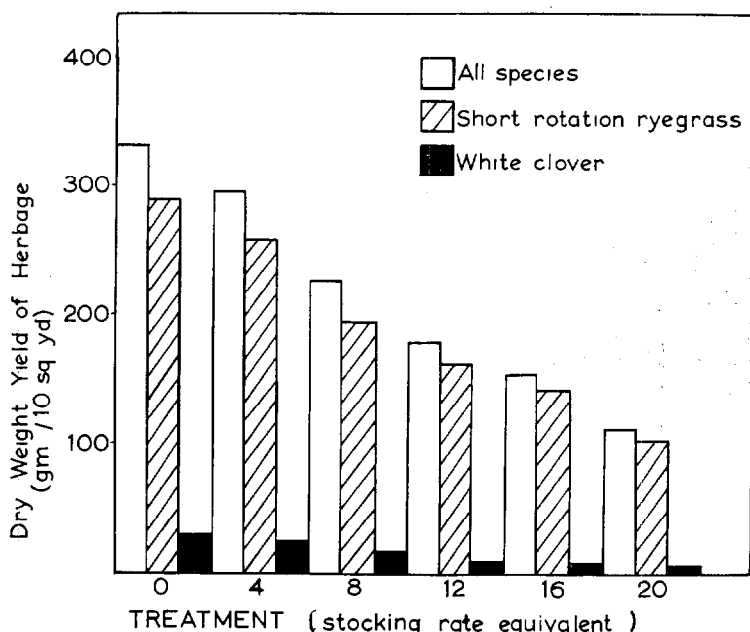


Fig. 1: The relationship between dry weight yield of herbage and treading.

change at succeeding treadings. Perhaps some of the intensification of effect which did occur could have been attributed to changes in soil condition, for the soil was more dense under heavy treading and gleying, typically indicative of oxygen deficiency, appeared in the densest layer.

Clearly, treading damaged the pasture. Perhaps in exceptional cases of loose soil and treading tolerant plants a pasture might be trodden with immediate beneficial results, but it seems more likely that treading will cause immediate direct damage.

Further, increased rates of treading caused increased damage.

In a further experiment, the treading of 0, 6 and 12 sheep per acre was imitated in the summer 1956-57, on a short-rotation ryegrass-clover pasture, with reasonably high initial fertility, weakly developed soil structure, and at three levels of soil moisture (Edmond, 1958b). The moisture levels, which were dry, moist and wet (free surface water), were created using spray irrigation.

TABLE 1: RELATIVE DRY WEIGHT YIELD OF HERBAGE, FOLLOWING ONE AND THREE TREADINGS OF UNIFORM PASTURE (SUMMER 1956-57).

	One Treading		Three Treadings	
	All Species	Short-rotation Ryegrass	Short-rotation Ryegrass	
Control	100	87	100	
Dry soil 6 sheep	84	100	69	
Dry soil 12 sheep	85	97	68	
Moist soil 6 sheep	74	64	30	
Moist soil 12 sheep	80	43	32	
Wet soil 6 sheep	78	66	32	
Wet soil 12 sheep	65	49	17	
Sig. diff. at 1% level	—	37	—	
Sig. diff. at 5% level	17	—	—	
Sig. diff. at 10% level	—	—	46	

Table 1 summarizes the influence, after 30 days, of the first treading of the uniform sward.

Treading reduced herbage yield irrespective of soil condition, except for short-rotation ryegrass after the first treading when clover competition was reduced in dry soil treatments. In general, short-rotation ryegrass was very susceptible, being greatly reduced by repeated treadings.

Vigorous clover growth and declining soil fertility clouded the issue but it did appear that treading was most damaging in wet soil conditions and under the heaviest treading.

Although the surface soils of the wet treatment plots were puddled, there was no evidence of gleying. This might be explained by cracking of the soil owing to alternate wetting and drying which no doubt reduced the puddling effect.

It is important that pasture trodden under dry soil conditions was reduced in vigour.

Cattle and sheep grazing were compared during the period July to October, 1955, using a new short-rotation ryegrass-clover pasture. Stock were grazed for the shortest time possible, until the pasture was closely and evenly defoliated. Herbage yield measurements were made using the well-known cage technique.

The only clear difference between the grazing treatments was the presence of pronounced soil gleying to 4 to 6 in. depth under cattle grazing.

At the first grazing, the cattle were introduced to one replicate while there was free water lying in pools on the surface. Within half an hour the surface soil was badly puddled and pasture vigour was seen to be reduced within a few days.

Water lay on the surface for weeks after the treading, and soil gleying became pronounced.

At the next harvest, the difference in herbage production between this replicate and the others was significant at the 10% level, the effect persisting until the end of the investigation.

Thus the evidence from this and the first experiment indicates that puddling of the surface soil may reduce pasture vigour markedly, and that puddling was easily effected when water lay in pools on the surface.

The importance of soil condition was determined using ryegrass seedlings in pot and plot experiments in 1955, when the soil was compacted and puddled (Edmond, 1958c). Under pressures ranging from 25 to 200 lb/sq.in. (*cf.*, hoof load of stationery cow 35 to 40 lb/sq. in.—Myers, 1956), soil compaction did not produce any significant effect on perennial and short-rotation ryegrass seedlings, but when the soil aggregates were destroyed and puddling achieved, growth was reduced greatly.

Observations

Another consideration was plant density which varied from treading to harvest, yet at harvest there was little variation from treatment to treatment. Exceptions were short-rotation ryegrass in the summer and both white clover and *Poa* spp. in the winter-spring. Immediately after treading, particularly under heavy treading in moist soil conditions, plant density was reduced. The survivors, being relatively free from competition, developed new tillers rapidly until density was approximately the same in all treatments, this point being reached within about two weeks in the spring.

Discussion

The reduced yields of damaged plots might be explained by lowered mean daily plant density and by the relative immaturity of the plants present at harvest time.

The failure of short-rotation ryegrass in the summer situation or of white clover in the winter is not explained. Perhaps dormant plants may be relatively susceptible to treading damage—particularly in the presence of competition.

Treading the soil appeared to compact the surface layers with reductions of large pores, and to destroy aggregates with reduction of even fine pores. This occurred most easily when the soil was moist. When the soil was wet, destruction of aggregates was high and a slurry was formed which was only

about as dense as normal soil (Gradwell, 1956). The soil conditions of increased compaction, oxygen deficiency, etc., of which gleying was evidence, no doubt adversely affected plant growth.

Usually within 2 to 3 weeks, worm activity, plant growth and drying appeared to have restored some structure to the surface soils of the most severely damaged plots. The degree of improvement needed to benefit plant growth is not known, but it is plain that an extended spell from treading, implying marked improvement in soil structure, must be beneficial.

Perhaps periodical treading damage can be tolerated if weeds are reduced as a result and it may be that pasture growth will improve but both weed control and improved pasture growth might better be achieved by less damaging methods.

Care should be taken to restrict treading damage on wet soils which are particularly unstable. Although, in these investigations, shallow dense soil layers did not appear to impede plant growth, there are instances in Taranaki and South Auckland where soil pans apparently produced by treading have interfered with normal plant growth.

It is probable that the influence of treading must vary from one soil type to another.

Conclusion

The work reported here has been done under short-term experimental conditions on one pasture type and on one soil type. Treading damaged all pasture plants immediately but some species were affected more than others so that in the recovery growth botanical composition was changed. In high production pasture, where balance between species is important and where treading is heavy, this could have a marked depressing effect on pasture production—particularly where plants such as white clover are reduced to a low density. Further, the effect the soil has on plants, when it is modified by treading, seems likely to be important.

Recovery of plant and soil follows treading damage, but the ways in which it happens are not yet understood, and so it is not possible to predict degree of damage and persistence of its effects.

Soil structure should be stable, plants should be tolerant of treading, and animals should walk only short distances if pastures are to produce at a maximum. At present, there is no fully effective stabilizer of soil structure, while at the Grasslands Division an investigation is under way to test the treading

tolerance of several common pasture species. There is little information available concerning walking habits of animals, and much remains to be done in this line. From Cresswell's data it appears that there is opportunity for selecting animals on their walking behaviour.

Meantime, to keep pasture production at the maximum possible, management of animals and pasture must be critically scrutinized. Every effort should be made to prevent unnecessary treading, at all times, but particularly when the soil is wet.

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DISCUSSION

Q: : *Would the effect of 100 sheep for one day be comparable with that of 10 sheep for ten days?*

A: : I do not know. My opinion is that the former situation would be the more damaging, but the point is to be investigated.

Q: : *It seems possible that the different effects of treading in different areas may explain differences between those areas, in the relationship of production per acre (in lb butterfat) and stocking rate of dairy cattle.*

A: : This seems reasonable.

DR. L. R. WALLACE: : The damaging effect of treading is one of the real problems associated with the utilization of autumn saved pasture. More work is needed on types of 'on and off' grazing systems, in view of the results reported earlier in this conference, which showed that cows could obtain their requirements in a very short period, when their time on pasture was restricted.

Q: : *It seems that our animals will need incentives to graze quickly. It is fortunate that many of the North Island soils are of volcanic origin, and that they are likely to be effected less than is the soil studied by Mr. Edmond. However, there are areas where the soil type may limit the total carrying capacity. On a soil which pugs badly, what does a farmer do to minimize the effects of treading, and what comments can be made on the 'sacrifice paddock' system?*

A: : Where pugging is likely, keep the animals off, if possible. Once the top inch or two of soil is clear of free draining water, it seems likely that treading damage will be reduced, and the animals may then be grazed with moderate safety.

DR. P. D. SEARS: : The 'sacrifice paddock' system has proved to be quite successful, but the farmer should not adhere slavishly to it. The system involves concentration of the stock on one paddock during the winter, with short grazing periods on other pastures. The sacrifice paddock is then generally ploughed and cropped in the subsequent season. In this way, treading damage is restricted, but I maintain that a pasture needs one good pugging in the winter to control weeds such as *Poa trivialis*.

I. J. INKSTER: : The system used by Mr. Edmond may have over-estimated damage due to treading as grazing sheep may be less damaging than driven sheep.

Q: : *One question that needs to be answered is whether sheep wander at random, follow one another, or move on an established beat over the pasture?*

A: : I agree with you both and suggest that animal behaviour studies might follow this line, with profit.