A Relationship Between Pasture Availability and Animal Production

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Summary

An experiment with Merino sheep grazing on phalaris-subterranean clover pasture has shown that as the availability of green pasture increased above zero animal production increased. The increase, however, was at a lesser rate for each successive increment of pasture, the maximum being achieved at and above 1400 lb. (dry weight) of green material per acre. Dry pasture in the presence of green pasture appeared to have no effect on animal production. When the whole pasture was dry, its level of availability had only slight, though positive, effect in ameliorating liveweight loss.

The implications of the foregoing are discussed with reference to investigations concerned with the betterment of pastures.

The form of the pasture availability-animal production relationship curve would indicate that continuous grazing should give greater animal production than that from other types of pasture management.

INTRODUCTION

Woodward (1936), and Johnstone-Wallace and Kennedy (1944) reported that the grazing cow required to be presented with approximately 1000 lb. of green pasture per acre (measured on a dry weight basis), of height approximately 4 to 6 in., in order that the maximum daily intake of 150 lb. of green material (30 lb. dry) could be obtained. Consumption fell when the pasture was shorter or less dense than this, or when it increased in length and became more mature.

Brody (1945) has discussed the law of diminishing returns as it applies to animal growth in relation to intake, and Ferguson, Carter and Hardy (1949) have demonstrated this principle in the case of nitrogen intake and fleece growth of sheep.

Under free grazing conditions the combination of both of these factors would be expected to give a direct relationship between pasture and animal, increasing availability (and/or quality) of pasture above zero giving increasing animal production, but not proportionately, the latter eventually reaching a maximum rate unaffected by further increases in pasture.

A grazing trial at the C.S.I.R.O. Experiment Station Canberra, designed to study effects of management of a seasonally fluctuating pasture on sheep production, has provided information on the relationship between the availability of a phalaris-subterranean clover sward and the liveweight response of young Merino sheep grazing thereon.

EXPERIMENTAL

Experimental methods relevant to the whole trial will be published elsewhere, but were briefly as follows: Six groups each of 4 sheep were grazed for successive periods during a full cycle of pasture growth and maturity, on a number of separately fenced plots each one third acre in such a manner that each plot at any one time was stocked at the rate of 0, 4 or 8 sheep per acre.

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Re-randomization of flocks between plots was performed at the end of each period-generally of 6 weeks duration.

As a result, at identical periods within the autumn and winter when pasture growth was slow, within the spring when pasture growth was extremely rapid, and over the summer when the pasture had ceased growth and only dry mature material remained, groups of sheep were presented with a range of availability of pasture. This latter was measured to ground level at frequent intervals and the liveweights of the sheep were recorded.

RESULTS

When green pasture was available, the liveweight response of the sheep was strongly related to the amount of this component, and not to the dry material carried over and still remaining from the previous spring. When the current green pasture itself dried the animals were presented only with dry material during the summer.

The overall relationship (i) between availability of green pasture during the autumn-winter and spring (dry component being omitted) and liveweight gain or loss, and (ii) between availability of dry pasture during the summer and liveweight loss, is recorded in Figure 1. With the green pasture, maximum animal growth was not achieved until approximately 1400 lb. per acre (dry basis) was available. With the dry pasture, reduction of weight loss was only slightly ameliorated by very high increases in the amount of dry material presented.

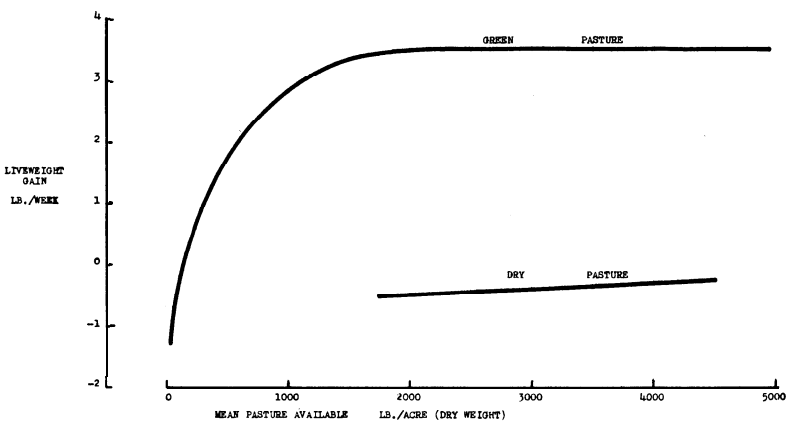

Fig. 1.—The overall relationship between the availability of dry and green pasture and animal liveweight gain or loss.

DISCUSSION

Johnstone-Wallace and Kennedy (1944) concluded that the mechanical operation of gathering daily 150 lb. of green herbage, of volume 1 cu. yd., and dry weight 30 lb., with an apparatus 2½ in. wide, required considerable effort on the part of the cow. The task became impossible and only a proportion of the desired intake was achieved when the pasture was less than 1000 lb. dry weight per acre as measured to within ½ to ¾ in. from ground level. This deficiency could not be lessened by increasing the number of acres. In our experience sampling to a height of ¾ in. underestimates the actual amount of pasture available to the animal by as much as up to 1000 lb. per acre. It is therefore reasonable to assume

that the critical point below which Johnstone-Wallace and Kennedy's animals failed to obtain their maximum daily intake was nearer the order of 1500 or 2000 lb. per acre.

The sheep's objective of gathering approximately 3 lb. of dry matter per day (volume 16 x 16 x 16 in. green material) must be achieved with smaller mouthparts. Even at 1400 lb. per acre (dry matter) each square inch ***to ground*** *level* has only 0.1 g. At such densities sheep do not normally graze to this intensity per bite, and it is more reasonable to assume that only 0.05 g. is obtained (= 3 g. min., 180 g./hr. or 3 lb. in 7½ hrs). On shorter pasture the amount per bite is less, but this is compensated by biting closer to ground level and increasing grazing time. However there is a limit to both of these factors, and the intake is increasingly reduced.

At higher than optimum availability of pasture the animal has more time to select. If the various components of a pasture mature differentially, this selective ability enables the animal to continue to achieve optimal intake from ageing swards, at least whilst the selected material is above the critical point in quantity or is of adequate quality. The failure of the liveweight gains to decline as the pasture aged in this experiment would suggest that the sheep were selecting the greener components of the excess material, and were thereby maintaining optimal intake. However when all the material dried, as happens rapidly in many sown pastures in southern Australia, selection of green material was no longer possible, liveweight gains ceased and liveweight losses commenced.

On the completely dry pasture the reduction in severity of liveweight loss with increasing availability of material suggests that the sheep were again selecting some more attractive component, the denser the pasture the greater being this component's availability.

Though it is reasonable to suppose that the form of the curve presented generally applies to the free grazing animal at pasture, the values will no doubt vary with type of animal, age, weight, previous nutritional history, health, etc. and with type of pasture, qualitative status, botanical composition, physical structure etc. Nevertheless such a relationship has important implications in the fields of pasture production and management.

(i) ***Pasture*** *Production*.-In southern Australia the annual period of adequacy of green pasture is relatively short, whilst that of its inadequacy, or of occurrence of dry pasture only, is relatively long. The form of the relationship illustrates

(a) the nature of increased animal production achievable by relatively small increases in the availability of green pasture when the latter is generally inadequate-e.g. autumn and winter;

(b) the advantages in animal production to be gained by extending the length of the period of spring growth (as distinct from increasing the ***quantity*** of spring growth, which is normally in excess);

(c) the desirability of improving the quality of dry pasture on the basis that the principle is the same as that applying to quantity, viz. large increases in animal production due to small increments in quality when the latter is at low levels.

(ii) ***Pasture Management***.-The form of the relationship indicates that more animal production should be achieved by having the whole of a pasture continuously available to the animals than by alternately grazing portions of the pasture.

If for example there are two paddocks each of one acre, each with green pasture at 1400 lb. per acre growing at 12 lb. per day, then 4 sheep, each consuming 3 lb., on each paddock will maintain the pasture at 1400 lb., and the 8 sheep will produce at their maximum rate. Transferring all the sheep to one acre will increase

the potential consumption thereon to 24 lb. per day, but this will reduce the total pasture below 1400 lb., so maximum intake will not be achieved. The longer the animals are restricted to the one paddock the less (and increasingly so) will be their daily intake and production.

The pasture on the spelled paddock in the interim will increase by 12 lb. per day above the 1400 lb. level, and when the 8 sheep are transferred thereto, maximum daily intake and production will be re-established. However the reduction experienced on the first paddock cannot be regained. This process will continue as the sheep are alternately moved between paddocks. The same circumstances apply irrespective of the initial starting point on the pasture availability curve.

The data of Brougham (1956) indicated that there was a critical level of pasture to which defoliation could be imposed without depressing the maximum rate of regrowth. Increasing defoliation below this level increasingly reduced the rate of regrowth. On Brougham's pasture the critical level was 1450 lb. per acre. If in the above hypothetical example the critical level was 1400 lb. per acre, then the rate of regrowth where 4 sheep were kept on each paddock would remain at 12 lb. per acre per day. Grouping and transferring the sheep from paddock to paddock would depress the regrowth rate on the pasture being grazed without increasing it on that being spelled. The effect of this additional factor in reducing pasture availability would be to even further reduce animal production from alternately grazed paddocks below that from those continuously grazed.

Moore, Barrie and Kipps (1946), and Freer (1956) did not however decrease animal production by rotational (as against continuous) or strip (as against rotational) grazing respectively, so that it must be assumed that compensatory factors acted to maintain production at the same levels as achieved from the more continuously grazed swards. However the evidence presented is such as to suggest that there is no sound reason for the fairly commonly held belief that transfer of stock between paddocks should be expected to increase pasture and animal production-rather the reverse.

It is appreciated that in the management of breeding animals, if fluctuations in the supply of pasture do not coincide with changes in dietary requirements, it may be advantageous to restrict pasture use at one less essential period for greater availability at a later more essential period; and it may be possible to achieve this by confinement of stock to a limited area for later transfer to a spelled portion. However such a procedure, wherein wool and liveweight gains at one period are purposely depressed in favour of the foetus at a later period, does not contradict the general thesis presented.

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