Overgrazing: Present or absent?

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Abstract

This paper discusses the criteria needed for quantitative evidence of overgrazing and outlines some of the main pasture and external factors that promote overgrazing by herbivores.

Overgrazing is defined as occurring where there is a concomitant vegetation change and loss of animal productivity arising from the grazing of land by herbivores. Confirmation of the loss of productivity requires the measurement of departures from the linear relationship between animal productivity and stocking rate for any given animal-pasture system. In the *ex-ante* situation of an experiment, overgrazing will be observed as a loss of linearity with time. In the *ex-poste* situation of a comparison between 2 paddocks of the same range type, but different grazing history, overgrazing will be observed as a difference in the optimum stocking rate.

The outcome of a species change in terms of productivity is shown to be complex because of the interaction of the quality and quantity influences in both pasture and product. Influences that promote lower stocking rates include low cost-price margins and a negative relationship between product quality and grazing intensity. Conversely, higher stocking rates are promoted by the use of mineral supplements and products such as wool that have a positive relationship between product quality and stocking rate.

Key Words: overgrazing, stocking rate, rangeland

A claim is commonly made that the rangelands of the world are overgrazed and hence producing edible herbage and animal produce at less than their potential. This applies to many countries, including Australia (Newman and Condon 1969), USA (Herbel 1979), and those of the African continent (Lamphrey 1983). It is a regular topic of books, articles and symposia, and a common justification for further research. It is therefore surprising that there is not more concrete evidence available of the effects of overgrazing on animal production as opposed to the resource base. Changes in botanical composition are common and patches of accelerated erosion are not hard to find. The question for this paper is whether or not these changes translate through to lower animal production and foregone economic returns?

The absence of hard evidence may simply mean that it is difficult to quantify, but equally the door is left open to the argument that overgrazing is more imagined than real. This situation represents a serious deficiency, potentially leading to the misallocation of research and restoration resources on the one hand, or to a lack of a generalized understanding of overgrazing effects on the other. In common with other controversial issues, the answer is probably in between: overgrazing is present but hard to quantify, yet is also not as widespread as is supposed. How then may 'overgrazing' be quantified and what are its characteristics? In this paper an approach is outlined for the measurement of overgrazing of rangelands, and the factors that may enhance or reduce its potential occurrence are discussed.

A Definition: Plant or Animal?

A fundamental problem with the term *overgrazing* arises from its use in many different contexts. For example, it may refer to the effects of livestock grazing on various attributes of rangelands such as botanical composition, forage cover, erosion, livestock production, or even wildlife habitat. One source of confusion arises from its occasional application to any rangeland where there has been a vegetation change arising from grazing, irrespective of whether that change has affected animal or plant productivity (Dyksterhuis 1949). It is doubtful if there are any range types that do not exhibit some species change with grazing. This would be true of all grazers, domestic and native, and so might *all* rangelands be classed as 'overgrazed'. However, in some range types there may be an almost complete change in botanical composition, with no change in animal productivity. The change from saltbush (*Atriplex* spp.) dominance to grassland (*Danthonia caespitosa dom.* spp.) with grazing on the Riverine Plain of southeastern Australia provides one example (Wilson and Leigh 1967). Change may, in certain circumstances, even be favourable for productivity. An example is the change from *Themeda* to *Brachiaria* in the Ankole region of Uganda recorded by Harrington and Pratchett (1974).

Because some degree of vegetation change is almost universal, and its impact may vary from deleterious to favourable for animal production, it is not on its own a useful or suitable criterion of 'overgrazing'. Such a term clearly carries the connotation of deleterious effect on livestock production. It would be better for vegetation change to be defined simply as 'change'. The value of the change may be assessed subsequently, according to productivity for a particular land use. In this instance it is the grazing activity that caused the change in the first place. Therefore, land use for grazing may be specified as 'overgrazed' when there has been a vegetation change that is deleterious to future animal production.

Some readers may wish to omit the requirement for vegetation change from this definition. However, it will be apparent from the ensuing discussion that such a rider is necessary to exclude production losses attributable to other causes, such as simple case of grazing more animals than can be fed. Hence the definition pro-

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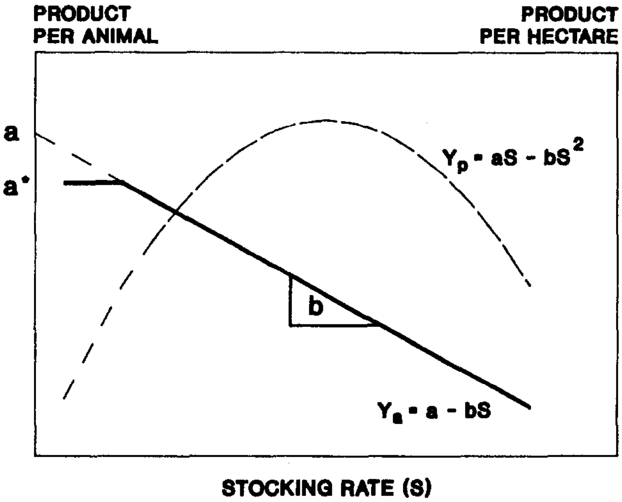

Fig. 1a. The linear productivity per animal (— — —) and quadratic productivity per unit area (— —) models for animal-pasture interactions without overgrazing.

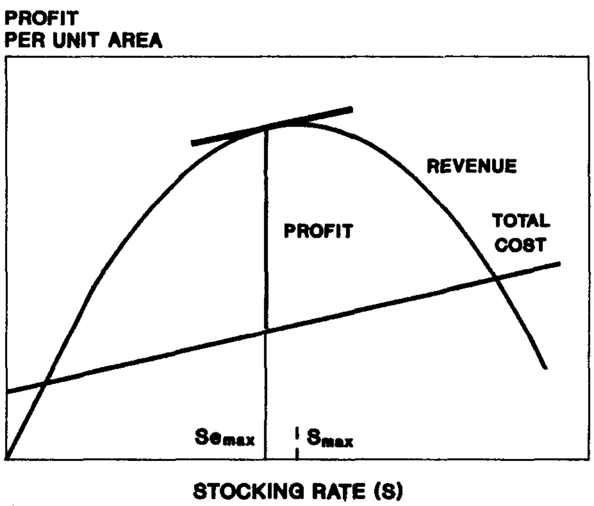

Fig. 1b. The economic model derived from the application of product values to the physical model of Figure 1a. Note: the relationship between the biological optimum stocking rate (S_{max}) and economic optimum stocking rates (Se_{max}).

vided includes the 2 important and separable elements of vegetation change and consequent loss of animal production or productive potential.

The Stocking Rate Model and Its Application to Overgrazing

There are many factors in addition to the botanical composition of rangeland pastures that influence the level of production achieved by a flock or herd . For example, some animals may have a greater growth potential than others; or disease may restrict the achievement of that potential. More importantly, the stocking rate level itself will influence animal performance through restricting the amount of feed available to each animal, or by limiting their choice of the more nutritious pasture components.

It is important that these other factors be recognized and standardized in any examination of overgrazing to ensure that the cause of difference may be correctly ascribed to any change in botanical composition or forage growth. The stocking rate is a necessary element of any observation because of its functional relationship to animal productivity, and so the animal productivity of a pasture cannot be defined in its absence.

An appropriate animal production model that expresses the relationship between animal production and stocking rate is that of Jones and Sandland (1974). The basis of this model is the linear relationship between individual animal performance and animal numbers, expressed as:

$$Y_a = a - bS \quad (1)$$

where:

Y_a = the weight gain of the individual animal.
S = the annual stocking rate.
a = an approximation of the phenotypic potential of each animal.
b = the incremental change in per animal weight gain as stocking rate increases.

This theoretical relationship is shown in Figure 1a. A large number of experiments have been reported in which a linear relationship has explained more than 90% of the variation in individual animal production (Riewe 1961, Hart 1978, Malechek 1984, Bransby et al. 1988). It is, therefore, argued to represent a relatively simple and robust expression of a given animal-pasture system. An alternative is to express animal production as a function of grazing pressure, as developed by Hart et al. (1988). This shows the same linear relationship, with the advantage of eliminating some of the effect of season on forage production and the disadvantage of confounding year-to-year variation in diet quality with grazing pressure.

Over wider ranges of stocking rate, however, the animal production relationship cannot conceptually remain linear. For example, a plateau of production (a*) is found at very low stocking rates when available forage becomes non-limiting and/or an increasing rate of mortality would become evident at very high stocking rates (Hart 1978). There is, nonetheless, likely to be little error encountered in assuming linearity over normal ranges of stocking rates, provided that extrapolation is not conducted beyond the range of available data (Connolly 1976). The linear relationship of equation (1) provides a benchmark against which overgrazing can be assessed. If the relationship changes while the previously cited animal factors have been held constant, it may be fairly concluded that a deleterious change has occurred in pasture composition. That is, evidence has been found of 'overgrazing' of the pasture.

The ability to differentiate between 2 pastures will be dependent on the variability associated with these linear relationships. Methods for calculating the standard errors of the estimated parameters of such regression based relationships are contained in a standard reference such as Snedecor and Cochran (1980).

One further valuable feature of the linear model is that it may be easily extended to define the so-called 'optimum stocking rate' for the pasture. The total growth or productivity of the animal population as a whole can be expressed as a quadratic of the form:

$$Y_p = aS - bS^2 \quad (2)$$

where:

Y_p = the total weight gain per unit area.
a,b,S remain as previously defined for equation (1).

This theoretical relationship is also shown in Figure 1a. The stocking rate for maximum weight gain per unit area (S_{max}) is given by a/2b, with a corresponding total weight of $a^2/4b$ (Hart 1978, Jones 1981). However, this 'biological optimum' stocking rate is usually less useful for practical management purposes than the 'economic optimum' stocking rate (Se_{max}). The latter measure is easily derived by placing monetary values on the inputs and outputs of the physical model (e.g., Wilson et al. 1984, Workman 1984, Bransby 1989). The total profit per unit area can be expressed algebraically as a quadratic of the form:

$$\pi_p = P[aS - bS^2] - cS - FC \qquad (3)$$

where:

π_p = Total profit per unit area.
P = Price per unit of weight of animal products.
c = Variable cost per animal.
FC = Fixed cost per unit area.
a,b,S remain as previously defined for equations (1) and (2).

The individual expressions $P[aS - bs^2]$ and $[cS - FC]$, respectively represent the total revenue and total cost per unit area. A theoretical example of the revenue and cost relationships are shown in Figure 1b. The economic optimum stocking rate (Se_{max}) is achieved when animal numbers are set such that the difference between the total revenue and total cost per unit area is at a maximum. This equates to the standard microeconomic optimization principle of maximizing net profit by equating revenues and costs at the 'margin' (Doll and Orazem 1984) and occurs for a stocking rate set at $[a-c/p]/2b$. While this principle is relatively well known to many rangeland science practitioners, its value in the present context lies in providing a point of reference which may reasonably be equated to 'high' stocking (Wilson et al. 1984). Departure from this may then be specified as multiples or fractions of that value, thus providing a means of comparison between experiments.

The variability in derived estimates of productivity-stocking rate relationship, that is a feature of all rangeland production systems, will also impact on the estimates of the biological and economic optimum stocking rates. Methods for calculating the standard error of S_{max} and Se_{max} may be found in Finney (1964, p 63) and Kendall and Stuart (1969, p 231).

Deficiencies of the Model

Despite the inherent advantages of the linear model, it does possess one major deficiency that does not negate its application value, but rather reduces its apparent simplicity. This is that Se_{max} and the relationship from which it is derived varies from year to year according to seasonal conditions. An example is provided in the series of relationships recorded by Bransby (1984) for a tallgrass pasture in a summer rainfall environment. In that situation, while linearity of the relationship was maintained, the intercept coefficient (a) of the average liveweight gain equation changed continuously within the 500 mm to 1,000 mm rainfall range.

The result introduces 1 further restriction in using the model for assessing the presence of overgrazing: the comparisons between pastures must be made in the same year. Limited comparison may be made between years of similar rainfall, or where appropriate rainfall corrections may be applied, given that for some rangeland observations the slope of the production-stocking rate relationship remains constant between seasons (Harrington and Pratchett 1974, Tupper 1978). In these limited situations the use of grazing pressure as the independent variable may eliminate the year-to-year variation (Hart et al. 1988).

Examples of Overgrazing Using the Model

For any practical attempt to examine the effects of overgrazing, 1 of 2 different situations will exist. The first is an 'ongoing' situation where overgrazing is observed as it is actually occurring; the second is a 'historical' situation in which overgrazing is presumed to have occurred at some time in the past and the present research interest lies in its quantification. These may be respectively thought of as *ex-ante* and *ex-post* investigations of the overgrazing phenomenon.

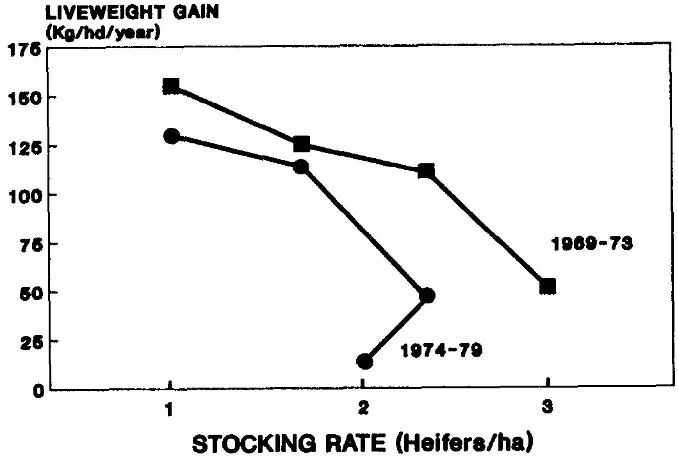

Fig. 2. Effect of stocking rate on annual liveweight gains of heifers grazing a Siratro-Setaria pasture in Queensland (Jones and Jones 1980). Data points are shown from original study.

The ex-ante approach may typically be observed in grazing experiments in which a range of stocking rates are applied to a previously uniform tract of rangeland pasture. For this approach the occurrence of overgrazing will be observed as a loss of apparent linearity in the animal production-stocking rate relationship. Such a case was first suggested by Cowlishaw (1969) and subsequently confirmed in a South African cattle grazing trial by Bransby and Tainton (1979). In statistical terms the phenomenon will be observed as an increasingly significant quadratic term in the regression of average weight gain on stocking rate over a period of years. The practical interpretation of this result is that the paddocks under observation with the highest stocking rates will either no longer contain the same pasture or that those pastures are now absolutely less productive than at the time the trials commenced.

An example is illustrated by the data of Jones and Jones (1980), which is reproduced in Figure 2. In this trial the average weight gain-stocking rate relationship was close to linear in the early years of the trial, but became progressively less so in subsequent years as the high quality element (a legume) was lost from the more heavily grazed pastures. In the final years of the trial, the highest stocking rate had to be reduced (from 3 to 2 heifers/ha), and weight gain was only one quarter of that expected from the original linear relationship.

Conversely, if there is no change in the basic linearity of the relationship over time, the pasture has not been 'overgrazed'. Animal productivity may be low because the optimum stocking rate has been exceeded, but there is no definitive evidence of more permanent pasture damage. An example is found in the steer grazing experiment conducted by Bement (1969) on blue grama *(Bouteloua gracilis)* rangeland in Colorado. The favourable change in pasture species composition, cited earlier for Themeda pastures observed by Harrington and Pratchett (1974), is probably an exception. However, it should be noted that for the latter case there would also be a loss of linearity in the relationship, albeit that the quadratic term is becoming increasingly positive.

The classical example of the ex-post overgrazing approach lies in the common 'fence-line' study in which well-maintained and 'overgrazed' pastures are compared via a grazing experiment established across a separating fence. One example is the saltbush-nil saltbush comparison reported by Graetz (1986) from a wether sheep trial conducted in the arid shrub-steppe of South Australia. In this particular example, it is noted that there was no significant difference in animal production between treatments. Therefore, the pasture was not 'overgrazed' within the present definition of the

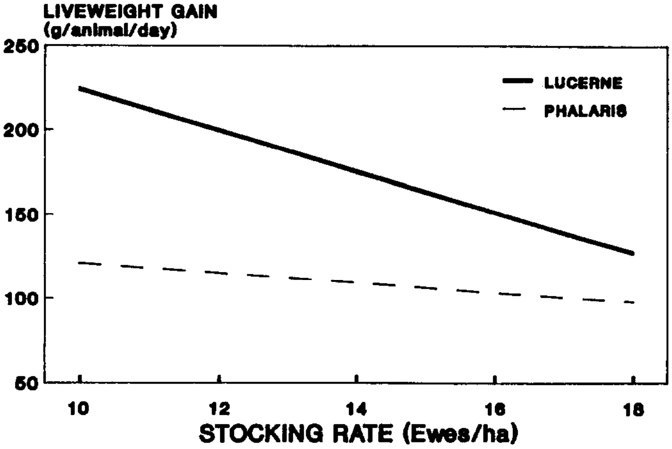

Fig. 3a. Average lamb growth per day on lucerne and phalaris pastures, derived from an experiment at 6 stocking rates (Donnelly et al. 1985). Fitted regression lines are shown from original study.

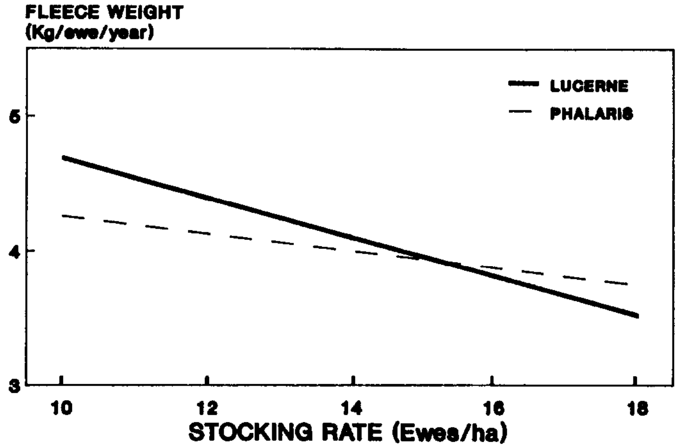

Fig. 3b. Average fleece weight per year from Merino ewes on the same lucerne and phalaris pastures (Donnelly et al. 1983). Fitted regression lines are shown from original study.

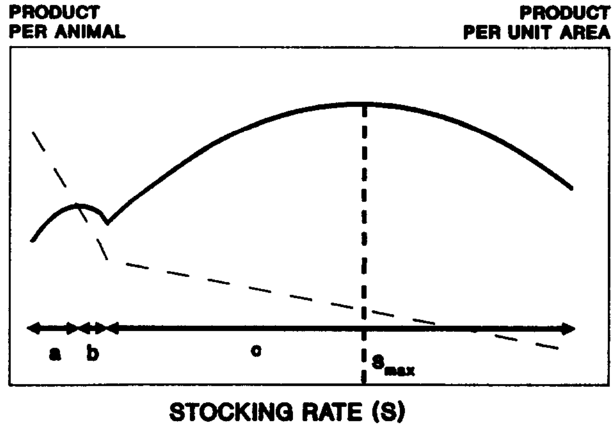

Fig. 4a. Theoretical case for overgrazing where a new equilibrium is established (zone c) after the loss of a small but nutritious species from the original pasture (zone a), when the threshold for overgrazing (zone b) occurs at relatively low stocking rates.

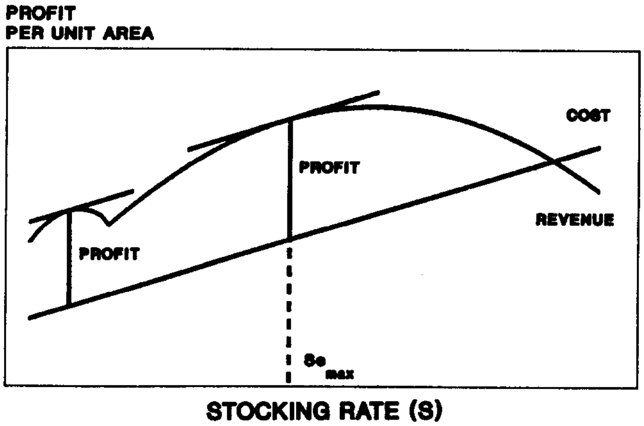

Fig. 4b. Theoretical economic model derived by applying product values to the physical model in Figure 4a. Note the difference between local and global maxima (Se_{max}).

term, despite a change in botanical composition of the 2 pastures.

A search of the literature has not revealed any formal evidence to confirm the presence of 'overgrazing' on natural rangeland pastures that is defined in this way. However, this is not to accept that the phenomenon is uncommon but rather to suggest the lack of adequate experimentation. As an interim measure, potential application of the model is shown below by way of reference to a sown temperate rangeland pasture.

The example is for lucerne *(Medicago sativa)* and phalaris *(Phalaris tuberosa),* which are alternative pastures on the tablelands region of southeastern Australia (Donnelly et al. 1983, 1985). Lamb weight gains and wool growth were compared at 6 stocking rates and the results are reproduced in Figures 3a and 3b. The relationship of both average liveweight gain and fleece weight to stocking rate was linear for both pasture types, although differences were reported for both the slope and intercept coefficients. This result indicates differences in both quality and carrying capacity, with lucerne being of higher quality but of lower potential carrying capacity. If such a change in pasture had been induced by grazing, the possibility of lucerne being readily removed by continuous stocking being acknowledged, then the definition of 'overgrazing' becomes complex.

When the constant (a) and slope (b) parameter values are substituted into equation (2), lucerne has the highest productivity in terms of meat production with a theoretical maximum of 2.5 kg/ha/day at a stocking rate of 14.3 ewes/ha. Alternatively, phalaris has the higher productivity in terms of wool production with a theoretical maximum 94 kg/ha at a stocking rate of 38 ewes/ha.

When both products are combined in the profit equation (3), the respective economic optima occur at 13 and 21 ewes/ha for the lucerne and phalaris based on present values (Jones 1989). These results should be treated with some caution as the maxima are falling well outside the stocking rate set in the original experiments (Connolly 1976) and, as such, are indicative rather than definitive. Nonetheless, it is likely that such complex interactions may be found in natural pasture situations where the change in pasture composition is dramatic. A conceptual example would be that in which a change occurs from a perennial grass to an annual grass-forb pasture in a winter rainfall environment. This also highlights the possibility that overgrazing may occur without there being a change in the number of animals being carried on a particular pasture. For this reason, the long-term change in regional livestock numbers is only a crude measure of overgrazing (Condon 1986, Perry 1970).

Overgrazing Thresholds

The level of stocking rate required to induce overgrazing is an important characteristic of any range type. Conceivably every rangeland pasture can be overgrazed, although for the most resilient types such as Mitchell grass (*Astrebla* spp; Orr 1980) and Blue-grama (*Bouteloua gracilis;* Bement 1969), the threshold is above the stocking rate normally observed for commercial purposes. In these cases, the setting of stocking rates according to animal production and economic criteria should also satisfy pasture management objectives. That is, while overstocking is possible, it is both an unlikely and economically irrational event

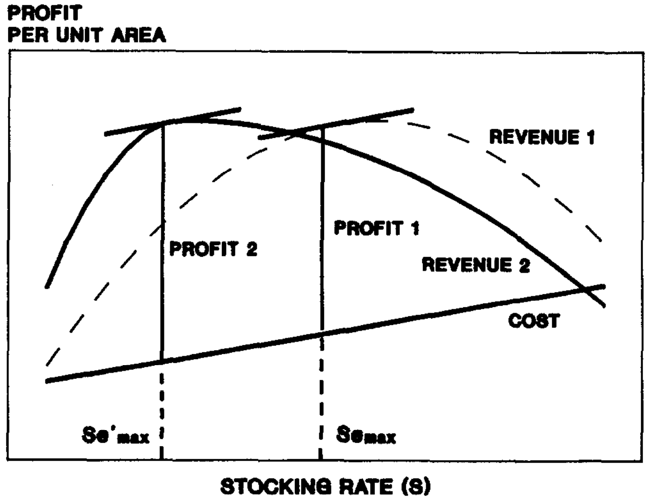

Fig. 6a. The theoretical impact of quality differences that deteriorate with increasing stocking rates.

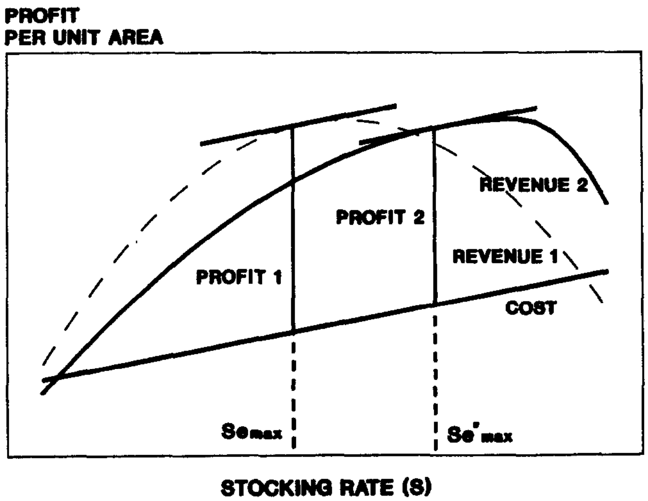

Fig. 6b. The theoretical impact of quality differences that are enhanced with increasing stocking rates.

stocking rate optima per se, the ratio of variable to fixed costs is important. The economic optimum stocking rate will rise as the proportion of fixed to variable costs rise for a given level of total cost per hectare (Seligman et al. 1989). In an extreme case in which all costs are fixed costs the biological (Se_{max}) and economic (Se_{max}) optima will coincide. This phenomenon has been used by Workman (1984) to explain the common observation of stocking rate differences between private and leased rangelands in western USA. It is also the basis for recommendations that grazing fees for public lands be set on a per animal basis, rather than as a flat fee, if land management authorities are concerned at the possibility of overgrazing of such leases.

A further consideration is that of the existence of seasonal and year-to-year lags in animal sales relative to production. For example, the higher prices that are commonly observed in livestock markets after drought breaking rains will encourage the retention of animals in drought at stocking rates in excess of the short-term optimum (Wilson 1984, 1986). Similarly, optimum stocking rates will be higher than the current Se_{max} if prices are expected to rise, and lower if they are expected to fall in the short-term.

Quality

The simple animal production-stocking rate model has been presented in purely quantitative terms with no consideration given to quality attributes of livestock produce and the possible existence of market premia or penalties attached to them. However, quality is an important issue for many livestock products because it can vary directly with stocking rate.

For example, meat prices are scaled according to several quality attributes with price per unit of weight being generally higher for animals in good body condition or that have reached a certain weight at a younger age. The presence of such quality premia will skew the total revenue component of equation (3) to the left (Fig. 6a). A lower optimum stocking rate (Se_{max}) and less potential for overgrazing is encouraged by the existence of such a premium.

The converse situation will generally apply when wool is the target product of a rangeland livestock enterprise. There is a direct relationship between wool fleece weight and average fibre diameter (Yeates et al. 1975), both of which are affected by the prevailing level of grazing pressure. Moreover, in most seasons there is a definite premium available in terms of prices received for finer diameter wool. This premium structure has the effect of skewing the total revenue component of equation (3) to the right (Fig. 6b), with some of the loss in fleece weight per unit area induced by higher stocking rates being temporarily offset by the increasing unit value of the remaining produce (White and Morley 1977). This premium structure gives rise to an otherwise higher optimum stocking rate (Se_{max}) and an increase potential for overgrazing relative to a market structure with no price differentials.

Enterprise Selection

Much of the available evidence points to the relative prices received for different animal products, and the extent to which these are feasible in a given environment, as having prime importance in the selection decision between livestock enterprises carried on rangeland pastures (McKay 1973, Doll and Orazem 1984, Workman 1984). These factors, in turn, have given rise, in the majority of cases, to near complete specialization in one enterprise at the expense of others. These choices are of particular importance to considerations of overgrazing because the optimum stocking rate is clearly dependent on the target product.

In the study of wool and meat production by Donnelly et al. (1983, 1985), cited earlier, the slope co-efficient of the fleece weight-stocking rate reltionship (Fig. 3b) is much less than the corresponding co-efficient for weight gain (Fig. 3a). The corresponding biological optimum stocking rate for wool production is higher than that for liveweight gain with the result that stocking rates set for pastures whose principal use is wool production will be higher than would be the case when liveweight gain is the target. A practical illustration of the consequences of this phenomenon for the impact of overgrazing is seen in the case of wool producing enterprises in the semiarid woodlands of eastern Australia on severely degraded pastures. Many holdings run only wether (male castrate) sheep for wool production, by which it is possible to maintain sheep numbers despite the overgrazing. On the basis of economics, overgrazing is a more likely occurrence on land grazed by wool sheep than that used for cattle production because there is less financial penalty for that overgrazing.

Supplements

The feeding of mineral or nitrogen supplements to livestock is practised in some rangeland production systems as a means of increasing animal production, without any specific intention of changing the pasture. This may occur, nevertheless, because one effect of such supplements is to increase the amount of forage that is utilized by the livestock. An example is found in a trial reported by Winks et al. (1983) which incorporated a molasses supplement fed to steers grazing a grass (Panicum maximum) and legume

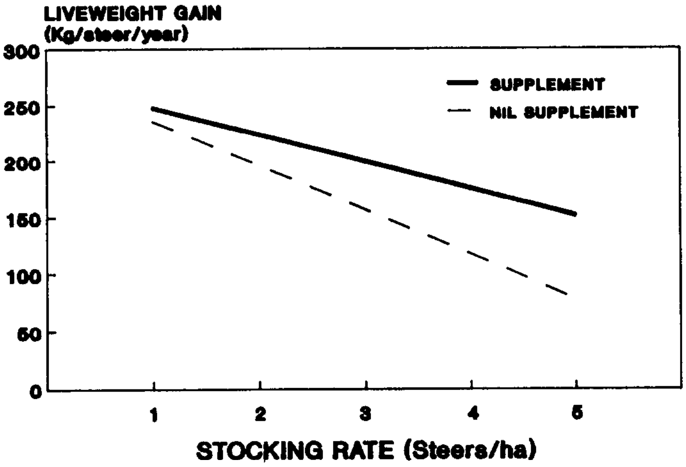

Fig. 7. The linear productivity per animal mode for animal-pasture interactions with and without supplements (Winks et al. 1983). Fitted regression lines are shown from original study.

(Neontonia wightii) pasture on the Atherton Tableland of northern Australia (Fig. 7). The supplement had a substantial result on cattle growth, raising the economic optimum stocking rate Se_{max} from 2.5 steers/ha to 4.0 steers/ha based on market values at the time of writing (Ryan 1989, Nicol et al. 1984), an increase of approximately 60%. This represents a substantial increase in pasture utilization rate and hence potential for overgrazing, confirmed in the study by a decline in legume percentage at higher stocking rates over the course of the trial.

Discussion

Although there are some notable exceptions, there are reasonable grounds to suspect that many rangelands are not overgrazed to the extent that is frequently claimed. This view is conditional on exclusion of simple botanical composition from the definition of the term. While it is accepted that vegetation change is widespread, this has had relatively less effect on livestock production than is commonly supposed because of the positive value of replacement species.

The changes that are clearly deleterious to future rangeland productivity are those in which a major desirable species is replaced by an inedible species, such as is common with shrub encroachment (Moore 1972). Such changes are usually obvious and accepted by pastoralist and researcher alike. For other changes in composition, such as the loss of a minor palatable species or the replacement of perennial species by annual species, the effects on livestock production have not been quantified. The outcome of empirical testing could be complex, as in the case of the lucerne-phalaris example cited above. In some cases the total productivity of the changed pasture may be higher than the original pasture in spite of a loss of nutritious species. This could occur simply because the remaining species sustain a greater number of livestock, albeit at a lower individual growth rate. Theoretically, the productivity of individual animals could be raised by reintroducing the nutritious species to the pasture, but little would be achieved if the reintroduction can only be achieved at a much lower stocking rate or subject to more complex and costly rangeland management techniques. The vegetation change may well be lamented by botanists, but accepted by agriculturalists.

A method has been proposed in this paper for quantifying these changes. The basic requirement is for experimentation over a range of stocking rates, ideally conducted on a continuous basis for 5 to 10 years to encompass a range of rainfall sequences and give sufficient time for treatment effects to become manifest. Such an experiment will ideally be conducted with young animals that are responsive to differences in nutrition. The evidence of deleterious change in the vegetation, or overgrazing, is a loss of linearity in the average production-stocking rate relationship. It may subsequently be confirmed by a further period when all paddocks are stocked at the economic optimum stocking rate, Se_{max}. Alternatively, when the focus is for rangeland pastures that are hypothesized to have changed prior to commencement of an experiment, the evidence sought is for a reduced optimum stocking rate (S_{max} or Se_{max}). Evidence of vegetation change per se is insufficient evidence for overgrazing.

The acquisition of specific knowledge on the animal productivity implications of a change in range composition is essential for both management and research. For example, Westoby et al. (1989) have recently outlined a model of vegetation change in grazed rangelands which recognizes several relatively stable states for any rangeland pasture. That study contained a proposal for future research to be concentrated on the management necessary to move the vegetation between states. However, it would seem equally important to propose that future research be conducted on the relative value of those states for animal production. The consequence of not doing so may well be to propose a management action to change a pasture that otherwise does not need to be changed, from a livestock production viewpoint at least. This is evident when examining an example cited by Westoby et al. (1989) which contrasts a saltbush (*Atriplex* spp) dominant versus wallaby grass *(Danthonia caespitosa)* dominant pasture that are alternatives on the heavy clay soils of the Riverine Plain of eastern Australia. The obvious implication is that a shift from saltbush to Danthonia dominance is of concern, whereas animal production trials cited earlier have shown the latter to be of greater (Wilson and Leigh 1967) or equal (Graetz 1986) productivity to the former state. Further research on managing the transition of the pasture back to saltbush dominance would, therefore, be unwarranted from an animal production viewpoint, despite its scientific interest.

One further value of the suggested approach to examining the impact of grazing lies in the potential for objective description of different stocking rate regimes. The terms 'light', 'moderate', or 'heavy' stocking may be placed in a clearer perspective by comparison with the optimum stocking rate S_{max} or Se_{max}, depending on whether a biological or economic focus is adopted. This would have particular value in reviewing the outcome of the results of grazing management procedures applied to different rangeland types. A lack of response in some experiments may thus be seen to arise from the stocking rates applied, rather than to the treatment itself.

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