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SYMPOSIUM

Invited Review: Grazing management options in meeting objectives of grazing experiments[1,2]

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ABSTRACT

Decisions on which grazing-management option to use in grazing experiments can be critical in meeting research objectives and generating information for the scientific community or technologies that meets the needs of forage-based enterprises. It is necessary to have an understanding of animal-performance relationships with stocking rate (SR), forage mass, and forage allowance to make informed decisions on how to best manage forages and grazing in an experiment. Stocking rates can be varied using the put-and-take procedure to maintain the optimum grazing pressure as forage growth varies during the grazing season. The alternative to put-and-take stocking is to use a range of fixed SR that generate light to heavy grazing-pressure responses. Put-and-take controls grazing pressure in evaluating animal-performance and stocking-rate responses to treatments, whereas fixed SR controls SR to evaluate animal-performance and grazing-pressure responses on treatments and treatment-by-SR interactions. Decisions to use either continuous or rotational stocking methods will be based on a need to complement existing grazing practices of the forage-based livestock industry or to determine best management practices. Relationships of animal performance with SR, forage mass, and forage allowance will be presented and used to discuss the advantages and disadvantages of put-and-take and fixed stocking procedures, and the considerations for using either continuous or rotational stocking methods.

Key words: forage allowance, forage mass, grazing research, grazing pressure, stocking rate

INTRODUCTION

Grazing research has a long history of generating applicable information and technologies to livestock producers, as well as improving our understanding and knowledge of the biology and ecology of defoliated grasslands. Mott and Lucas (1952) stated that pasture measures using livestock productivity rather than mowing or other simulation means are essential in providing results that are applicable to farming practices. They further warned that variation in animals and pastures are major sources of error that can bias results if inappropriate experimental designs or sampling techniques are used.

Blaser et al. (1959) stated that ADG or milk production per animal was influenced by DMI and digestibility, whereas output per unit land area was dependent upon performance per animal and pasture carrying capacity. Carrying capacity has been defined as the maximum stocking rate (**SR**) to achieve a certain animal performance

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[2] Mention of trade names or commercial products in the article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA. The USDA is an equal opportunity provider and employer.

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over a period of time without deterioration of the ecosystem (The Forage and Grazing Terminology Committee, 1992). Management decisions on rate and method of stocking that pastures are grazed have a direct effect on availability of forage and grazing pressure (number of animals or BW units per unit of forage), which are targeted to meet sustainable production goals (Mott, 1960).

There are 2 questions to address when planning and designing a grazing experiment. First, is it desirable to adjust SR to maintain an optimum grazing pressure as plant growth and weather patterns change during the grazing season (Mott and Lucas, 1952), or should a range of fixed SR be used to provide a range of grazing pressures (Riewe, 1961)? Second, should treatments (e.g., forage species or cultivars, fertilizer source or rates, nutrient-supplement feeding, and so on) be compared using either continuous or rotational stocking methods? Depending on the objectives of the experiment, each of these grazing-management options can be useful in generating applicable results for either or both the scientific community or practitioners. The objectives of this literature review were to discuss relationships of per animal and per hectare output with SR, forage mass (**FM**), and forage allowance (**FA**); the advantages and disadvantages of using fixed versus variable SR; and the circumstances necessitating the use of either continuous or rotational stocking methods.

EFFECT OF FORAGE QUANTITY AND QUALITY ON ANIMAL PRODUCTION

Relationships of Animal Performance and Output per Hectare with Stocking Rate

Stocking rate has a profound effect on animal performance and has been the primary management tool used by producers in targeting production. Generalized mathematical models depicting relationships of per animal and output per hectare with SR have been generated (Harlan, 1958; Mott 1960, Conniffe et al., 1970; Jones and Sandland, 1974). However, these have been extensively debated, and consequently, a single model has not been universally accepted (Hart, 1993).

Mott (1960) combined data from SR experiments that were across livestock and forage species to fit exponential models deriving relationships between per animal output (ADG or milk) and output per hectare with SR. To account for environmental differences among experiments, output variables and SR were adjusted to be relative to those for the optimum SR (Y' and X', respectively) to derive the equations $Y' = 1.1214 - (0.0014)(85.54)^{X'}$ for output per animal relative to the output at the optimum SR, and $Z = (Y)(X)$ for output per hectare relative to the optimum SR (Figure 1). The optimum SR was subjectively established between the highest SR that generated the maximum output per animal and the SR that maximized output per hectare. The rationale in setting this optimum SR was that pastures grazed with a SR that maximizes per animal output are undergrazed and accumulate FM, and those pastures grazed at the rate for maximum output per hectare are overgrazed and eventually deteriorate. There was a curvilinear decrease in per animal output as SR was increased, with declines being minor with SR less than the optimum and stronger declines in per animal output as SR increased beyond the optimum. The animal product per hectare relative to the optimum exhibited a curvilinear increase to an apex where maximum product per hectare was achieved, beyond which there were sharp negative declines with increased SR.

Animal performance has been reported by other research to have a curvilinear response to SR. Harlan (1958) used a double exponential equation to fit a curvilinear model (BW gain = $16 - 2^{2SR/4}$) that re-

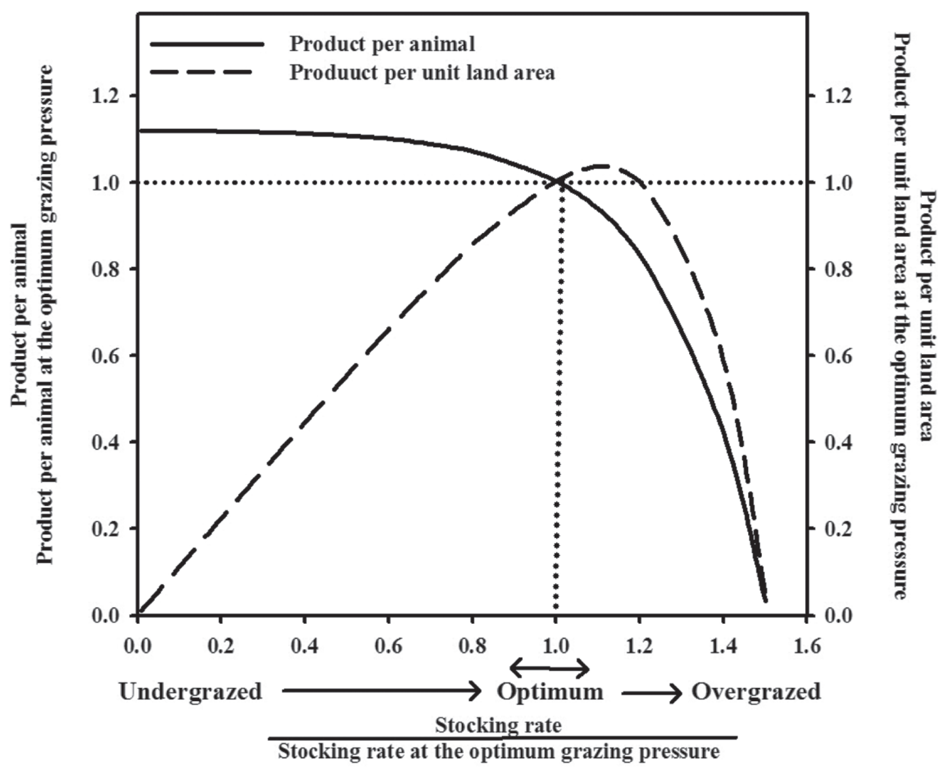

Figure 1. Relationships of per animal and per hectare output with stocking rate (SR), as derived by Mott (1960) using data from grazing experiments conducted under different environments and forage species. Per animal and per hectare outputs were adjusted to be relative to outputs for the optimum SR, and SR were adjusted to be relative to the optimum.