PRODUCTIVITY DECLINE IN SOWN TROPICAL GRASS PASTURES WITH AGE: THE PROBLEM AND POSSIBLE SOLUTIONS

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SUMMARY

The productivity of sown tropical grass pastures declines rapidly as pastures age because of a reduction in available soil nitrogen (N). Initial productivity following establishment is high but pasture quality and growth rates soon decline, leading to lower liveweight gains, increased age of turn-off and/or reduced stocking rates. This loss in production prompts the adoption of management practices which might augment levels of soil available N and hence improve pasture productivity. The likely effectiveness of crop/pasture rotations, fertilizer N, sowing a legume, renovation with or without oversowing a forage legume, and burning are discussed with respect to the maintenance of productivity of newly-sown pasture and the rejuvenation of old, rundown pasture. (Key words: pasture rundown, nitrogen, management practices.)

INTRODUCTION

It is widely recognized by beef cattle producers in Queensland that the productivity of sown grass pastures declines as the pastures age. For commercial operations this decline may be reflected in reduced stocking rates or increased age of turn-off of cattle grazing these pastures (Rudder et al. 1982). In Queensland there are currently about four million hectares of sown grass and grass/legume pastures (Weston et al. 1981) and it is estimated that grass-only pastures occupy 2.5 million hectares (B. Walker, personal communication). The present productivity of most of these pastures is probably only a fraction of their potential. Thus, various management practices to maintain production of new pasture or to rejuvenate old, rundown pastures need to be explored. This paper considers such practices, but we first quantify the extent and rate of decline in productivity with age, and outline possible causes of the problem.

PRODUCTIVITY DECLINE

Extent and rate of rundown

Despite the widespread commercial recognition of sown pasture rundown in Queensland there are few quantitative data describing the problem. Rudder et al. (1982) monitored cattle production on a commercial property in central Queensland, where steers grazed year-round from weaning to age 41 months on improved pastures sown between 1968 and 1972. Annual liveweight gains were greatest in 1973/74, averaging 150 kg/head for cattle of all ages. It can be calculated from their results that, for the next four years, there was an average annual decline in liveweight gain of 13 kg/head/yr. However in their study the effects of pasture age were confounded with year to year seasonal effects.

Such confounding was avoided when cattle grazed pastures of green panic (*Panicum maximum* var. *trichoglume*) at Brian Pastures Research Station, Gayndah, south-east Queensland. Green panic, annually fertilized with 58 kg/ha of nitrogen (N) as urea, was grown as part of a 10-course ley rotation of crops and pasture; each year there were five green panic pastures which varied in age from one to five years. These pastures were grazed only during winter and spring of

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each year from 1976 to 1981 (Robbins and Bushel1 1984). Average weight gains varied considerably over these years, reflecting variable seasonal conditions. Irrespective of seasonal differences, however, liveweight gains declined substantially with increasing age of pasture in all years (Fig. 1). When averaged over all years, liveweight gain decreased linearly with age by 9.4 kg/head/yr, from 74 kg/head on one year old green panic to 35 kg/head on five year old pasture. No equilibrium had been reached by age five years.

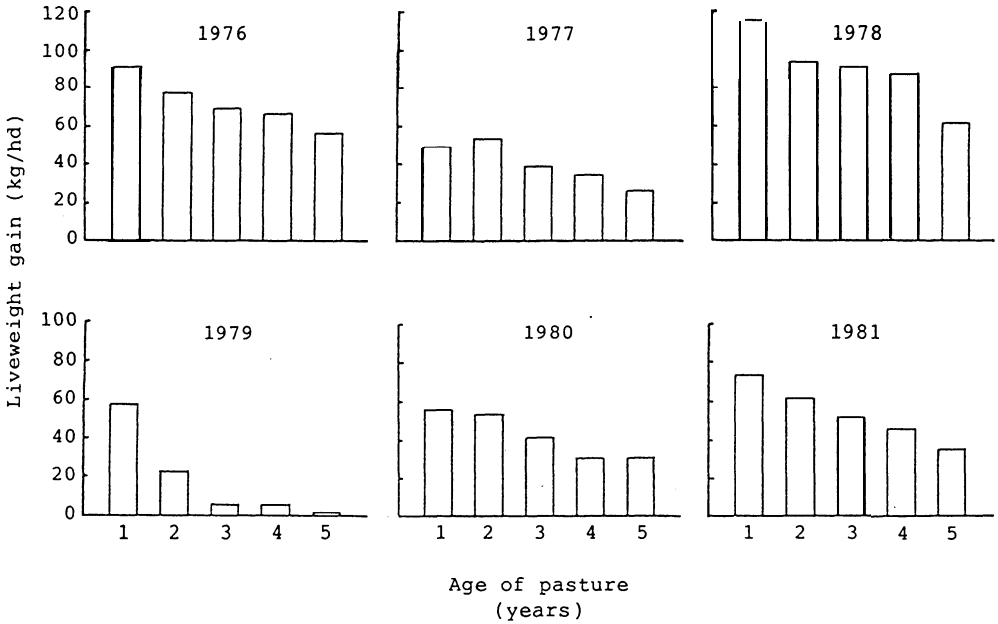

Fig. 1. Combined winter/spring liveweight gain on green panic pastures of different ages

Many parameters of pasture quality, particularly those relating to N concentration, responded to increasing age of pasture in a pattern similar to that of liveweight gain (Robbins 1984). For example, leaf N concentration averaged over the six years declined markedly as pastures aged (Fig. 2). Although cattle grazing each age of pasture selected a diet with a greater N concentration than that in the leaf on offer, animals grazing young pasture selected a diet of higher quality than those grazing old pasture (Fig. 2).

The decline in productivity of sown grass pastures is costly to the beef industry. The 2.5 M ha of these pastures in Queensland probably carry one million head of cattle. For an annual liveweight gain per head on newly-sown productive pasture of about 160 kg, net return from the area would be $M80/yr, assuming a net return per head of $80 (B. Walker, personal communication). If stocking rates remain constant and weight gains decrease by 50% after 5 to 10 years, as suggested by our results and those of Rudder et al. (1982), then the annual return from these pastures would drop by $M40.

Cause of pasture rundown

The productivity of sown grass pastures declines with age because of reductions in the level of available soil mineral N (Graham et al. 1981; Robbins

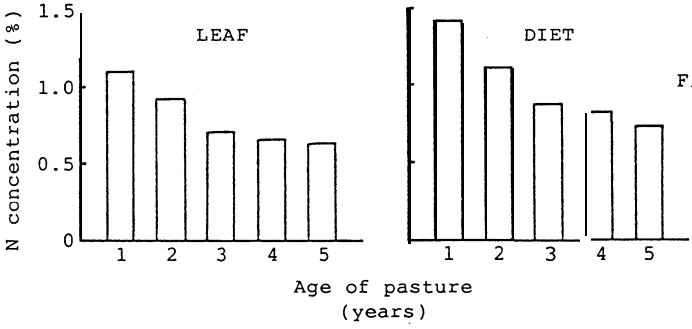

Fig. 2. Average leaf and dietary N concentrations in green panic pastures of different ages

1984). We suggest that, for most soils, levels of available N are paramount in influencing total pasture productivity. For pasture in a natural equilibrium (e.g. native pasture or very old sown grass pasture), the productivity depends on annual net mineralization of N from the soil organic N pool. The mineralization capacities of soils vary widely, depending on soil total N contents. For example a brigalow clay soil annually releases more N for plant uptake than a sandy soil.

When a soil is cultivated for pasture establishment, conditions favour N mineralization, leading to a rapid increase or "run-up" in the level of available soil N (Fig. 3). Initial productivity of newly-sown pastures is high, reflecting the high available N levels in the soil. Subsequently these levels decline, and pasture and animal production fall as a result. Eventually an equilibrium level of available N is again reached. The extent of the run-up and the rate of the rundown are both modified by soil and climatic factors but it is most likely that rundown takes only a few years on most soils.

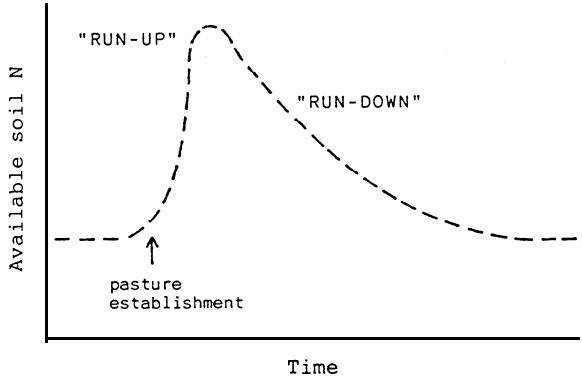

Fig. 3. "Run-up" of available soil N levels with pasture establishment, followed by "run-down" over time

POSSIBLE SOLUTIONS

The importance of available soil N in influencing pasture productivity is considerable. Most of the perceived differences in productivity from morphologically-different grass pastures are, in fact, simply reflections of the amount of available soil N (Robbins and Bushel1 1985). Thus methods which might economically augment soil available N need investigation. Two clearly different circumstances exist. Firstly, management practices are needed to maintain the productivity of a newly-sown pasture at a high level for as long as possible. Secondly, methods are needed to rejuvenate old, rundown pasture.

The options available for both circumstances are similar although the way they could be implemented may vary for each case. Options likely to be effective include:

(i) develop crop/pasture rotations;
(ii) fertilize with N;
(iii) sow a legume;
(iv) renovate;
(v) renovate and sow a forage legume; and
(vi) burn.

The development of crop/pasture rotations seems the most viable alternative on arable soil. Cropping can help pay for the re-establishment of a productive pasture. However it is not known how long a cropping phase needs to last so that the following pasture is highly productive. The relative advantages of grass vs. legume crop are also not clear although it is reasonable to assume that any N returned via a legume crop would be beneficial.

Fertilizer N is known to be effective if not always economic. It has been hypothesized that an annual application of 100 kg N/ha will maintain the productivity of a newly-sown pasture (Robbins 1984) but this has not been tested. Fertilizer N will boost the productivity of old pastures but the amount required to rejuvenate a pasture increases with age of that pasture (Robbins 1984).

Legumes can increase animal production directly by ingestion, or indirectly by supplying extra N to the associated grass. Calculations suggest that a legume must annually fix 125 kg N/ha to maintain the productivity of an associated grass at a high level (Robbins 1984). Few legumes are likely to achieve this in sub-coastal pastures in Queensland so the main benefit of a legume has to be direct.

Renovation gives a temporary increase in soil mineral N levels, with the benefit increasing with severity of treatment (Catchpoole 1984). The benefit of renovation may be greater if a forage legume such as lab lab (Lab lab purpureus) is sown at the same time. There are conflicting opinions as to the commercial role of renovation in ameliorating pasture rundown so it is essential that its effect be quantified, particularly in relation to animal production.

Burning may give a short-term increase in animal production and may also reduce the rate of rundown in the longer term by removing pasture litter which has the capacity to immobilize soil N.

We suggest that several management options are available which may successfully combat the decline in sown grass productivity with age. Future work will test the influence of these practices on pasture and animal production in the field.

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