THE POTENTIAL OF UPGRADED PERENNIAL PASTURES TO REDUCE GROUNDWATER RECHARGE IN SOUTHERN VICTORIA

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Summary. The potential of high production perennial pastures to reduce recharge to groundwater was assessed in the medium rainfall environment of the Dundas tableland in south-west Victoria. Under continuous grazing, perennial pastures adopted growing season and water use characteristics typical of annual pastures. Root density was low and little soil water uptake occurred below 60 cm. The proportion of Phalaris in the pasture sward increased under rotational grazing, as did the amount of green foliage and evapotranspiration during summer. These preliminary results indicate that rotational grazing enhances the potential for perennial pastures to reduce groundwater recharge and assist in the management of dryland salinity.

INTRODUCTION

Promotion of productive perennial pastures is a major feature of salinity management plans in south-west Victoria. Perennial pasture improvement in groundwater recharge areas is promoted on the basis that it will increase farm profitability and greatly reduce the level of recharge to groundwater.

Two main features of perennial pastures suit them for a role in dryland salinity management, *viz*;

• *Deep root system* - Plants with a deeper root system have access to a greater volume of soil water and therefore can potentially sustain evapotranspiration and growth for more of the dry summer period than shallow rooted plants. A drier soil profile will require more rain in winter to replenish the soil water *store* before water will drain beyond the plant root zone.

• *Longer growing season* - Evaporative demand in most parts of Victoria is quite low during winter and early spring. There is little opportunity at this time of year for evapotranspiration from different types of pasture to vary. By contrast, prolonging the growing season in summer, when evaporative demand is high, offers considerable scope for increasing annual evapotranspiration.

Recent research (1, 2, 3, 4) has raised doubts as to the capacity of perennial pastures to control or even substantially reduce groundwater recharge in higher rainfall environments, roughly defined by the 600?mm isohyet. The objective of this project is to determine the difference in recharge potential of farmer managed annual and perennial pastures in the medium rainfall areas of Victoria's south-west.

METHODS

Investigations conducted on two sites on the Dundas tableland in south-west Victoria (annual rainfall 630 mm) are reported here. The main field site is at Vasey, 45 km north of Hamilton. The second site is near Cavendish and is about 20 km east of Vasey.

Two pasture treatments were tested at Vasey. *Upgraded* pasture was sown with Phalaris, Perennial Ryegrass and subterranean clover in 1988-9 and fertilised with 20-25 kg P/ha/y. The other pasture is considered typical of annual pastures on the Dundas Tableland. It is dominated by annual grasses and low fertility weeds and fertilised with 5 kg P/ha/y. Both treatments were stocked with August lambing Merino ewes, the upgraded pastures with 11/ewes/ha and the typical pastures with 5.5/ewes/ha. Annual live weight pattern of sheep on both pastures was similar. The paddocks were both 7 ha and were managed in the normal way by the landholder. A 1?ha plot was divided from the main upgraded paddock in 1994 and stocked at 8 ewes/ha to create a different pasture growth pattern.

The Cavendish site is part of the MRC Temperate Pasture Sustainability Key Program. The perennial pastures were sown in autumn 1992. Two of the twelve grazing practices considered in the MRC project are presented here, namely continuous and rotational grazing.

Evapotranspiration from pasture swards was measured at Vasey using ventilated chambers (6, 7). Five chambers were deployed on each treatment in 1993. Four chambers were deployed on the typical paddock and three each on the productive treatments during the 1994 growing season. Measurements were carried out over two full days every three weeks during the growing season (late autumn-early summer). Leaf area index (LAI) of pasture swards within the evapotranspiration measurement plots was determined during evapotranspiration measurement periods using a Li-Cor leaf area meter.

Changes in soil profile matric potential under the various pasture treatments were studied using gypsum blocks and an automated logger (Monitor Sensors). Sampling depths at Vasey were 0.3, 0.6, 0.9 and 1.2 m. Gypsum blocks were installed at 0.15, 0.3, 0.6 and 1.2 m depths at Cavendish.

Root distribution of upgraded and typical pastures was assessed at Vasey in late spring 1994. Twenty 1 m deep soil cores were collected from each of the three treatment areas. Cores were divided into 0.2 m segments, the roots washed from each segment and total root length determined using a Comair scanner.

RESULTS

Measured rates of sward evapotranspiration ranged between 0.3 and 2.5 mm/d. High rates of sward evapotranspiration were maintained for two months during spring. Evapotranspiration rates declined rapidly in early summer as annual grasses and clover senesced, residual green foliage from the perennial grasses was consumed by stock and as the upper part of the soil profile dried (Fig. 1). Total growing season evapotranspiration (Table 1) was estimated by linear interpolation (6). Growing season evapotranspiration of continuously grazed typical and upgraded pasture was similar. The late autumn break and early onset of warm summer weather was responsible for the shorter growing season and lower total evapotranspiration measured in 1994.

Patterns of growth of the upgraded and typical pastures were quite different during the two years of the study. Leaf area index (LAI) in the typical paddock exceeded that in the upgraded paddock by 0.5-1 units throughout most of the 1993 growing season. This trend was reversed in the following year. LAI of the two upgraded pasture treatments reached very high levels (>4) during spring 1994. At no stage in that year did LAI in the typical pasture exceed 2. Green plant material was low under all treatments between January and May of both years of the study.

Table 1. Total evapotranspiration and average root length density of upgraded and typical pastures at Vasey, south-west Victoria during the 1993 and 1994 growing seasons.

	Stocking rate	Evapotranspiration		Root length (cm/cm^3)	
Pasture type	(ewes/ha)	1993	1994	0.2-0.6 m	0.6-1.0 m
Upgraded	11	285 mm	210 mm	5.3	0.3
	8		220 mm	6.1	0.3
Typical	5.5	280 mm	230 mm	2.7	0.3

Variation in soil profile matric potential was similar under all treatments at Vasey (Fig. 1; upgraded pasture only). Soil at 30 cm dried almost to wilting point in the space of a few days in December in both years. Drying of the soil profile did not extend to 120 cm in 1993/4, but did under drier conditions in the following year. Limited water uptake at depth with the soil profile is consistent with low root densities under all treatments (Table 1).

Summer rainfall wet soil profiles almost to the point of saturation in both years of the study. The lack of transpiring plant material, even in perennial pasture, meant that not all summer rain was evaporated. The soil profile was wet up by the first major rainfall event in autumn (Fig. 1).

The soil profile at 30 cm also dried almost to wilting point under both rotational and continuous grazing at Cavendish by December 1994. The profile was wet up by subsequent rain events during summer, but unlike Vasey, dried out somewhat between these events. There were only very small changes in soil matric potential at 120 cm under continuous grazing (Fig. 2). Soil below the rotationally grazed plots dried out considerably at this depth over summer and autumn. Rotational grazing was able to delay the onset of soil saturation (Fig. 2) and hence potentially reduce the overall amount of recharge during the winter-spring period.

DISCUSSION

The continuously grazed upgraded pasture at Vasey has been of no more value in salinity management than the typical annual pasture it is proposed to replace. Reduced pasture utilisation in the upgraded paddock effected no significant improvement in total sward evapotranspiration, despite greatly increased LAI. Soil profiles under both types of pasture were saturated by the first major rainfall event in autumn (Fig. 1). Upgraded pastures were largely unable to exploit soil water stored at depth within the soil profile (Table 1).

Although perennial in name, the productive pastures were dominated by annual grasses (especially Silver Grass) and clover. Once the annual plants senesced in early summer, any residual green foliage on the perennial grasses was quickly consumed by the stock. The productive pastures consequently exhibited annual pasture growing season and water use characteristics.

Rotational grazing improved the water uptake of perennial pastures. The contribution of Phalaris to the sward biomass in late spring was greater in rotationally compared to continuously grazed plots (25% c.f. 11% in November, J. Graham pers. comm.). Although only small amounts of green foliage are sustained during summer, rotationally grazed swards were better able to evaporate summer rainfall than continuously grazed swards.

Periodic spelling also presumably affords the Phalaris plants the opportunity to develop a more vigorous root system than under set stocking, hence better use of soil water at depth (Fig. 2). The net effect is that under rotational grazing, upgraded pastures have a longer growing season than continuously grazed perennial and annual pastures. They are able to both dry the soil at greater depth and evaporate summer rain. Their capacity to reduce groundwater recharge is therefore enhanced.

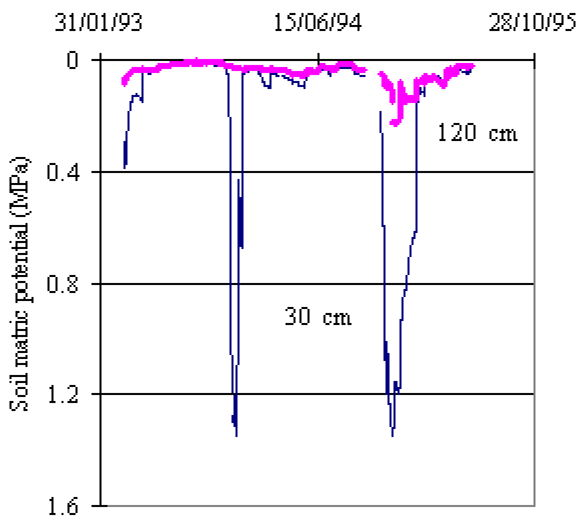

Figure 1. Soil profile matric potential under productive pasture at Vasey, south-west Victoria.

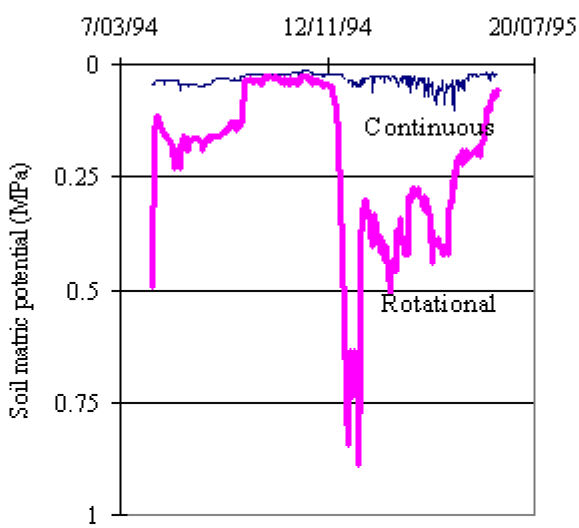

Figure 2. Soil matric potential at 120 cm depth, under rotational and continuous grazing, Cavendish, south-west Victoria.

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