SOIL MANAGEMENT STRATEGIES FOR INCREASED WINTER PASTURE PRODUCTION ON DRYLAND DAIRY FARMS

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Summary. This project researched the use of sub-surface drainage (conventional mole and gravel mole drainage) and the strategic use of nitrogen fertiliser to alleviate the impact of waterlogging on pasture production. Research conducted in the Kiewa Valley demonstrated large production gains over the winter period. Drainage was able to increase pasture production by 1.45 t DM/ha ($P<0.05$), and nitrogen fertiliser was able to increase pasture production by 0.75 t DM/ha ($P<0.05$). There was no significant interaction between the drainage and nitrogen treatments. Pasture utilisation was 66% for the drainage treatment compared to 52% for the undrained treatment. The implementation of these strategies is economical, with payback periods of less than three years needed to recoup the initial capital investment.

INTRODUCTION

The dryland dairy industry in north-east Victoria is based on dairy farms located in high rainfall (>700 mm) river valleys. Heavy winter rainfall combined with poor natural drainage results in extensive areas of waterlogged soils in winter. The effects of waterlogging are seen as nitrogen deficient pastures, poor pasture quality, growth and utilisation, and difficulties with pasture establishment. In terms of sustainable production, waterlogging causes pugging, soil compaction, reduced trafficability and soil degradation.

Previous overseas research (1, 3) and preliminary work at the Rutherglen Research Institute (2, 4) demonstrated that overcoming waterlogging by draining the soil could give spectacular yield increases in a range of crops and pastures. This paper describes the results of an experiment conducted in the Kiewa Valley (Latitude 36^{o} 20'S, Longitude 147^{o} 05'E). This experiment was conducted on four separate farms, on sites which suffered from waterlogging. To alleviate the waterlogging on each site slotted, subsurface pipe drains were used in conjunction with either conventional mole drains (6) or gravel mole drains (5).

MATERIALS AND METHODS

Drainage was installed at four farms and plots were set out for the measurement of pasture growth and utilisation, soil damage, drain flows and water quality. All plots were renovated during autumn 1991 with *Phalaris aquatica* cv. Sirosa, *Trifolium repens* L. cv. Haifa, *Trifolium subterraneum* L. ssp. *yanninium* cv. Trikkala and *Trifolium subterraneum* L. ssp. *subterraneum* cv. Karridale.

On each farm four treatments were imposed. These treatments were:

1. a control, to which the only treatment was to improve the pasture on undrained land with phalaris and clover;

2. pasture improvement on undrained land, along with the treatment of two 30 kg applications of nitrogen per hectare, during the autumn/winter period;

3. pasture improvement on land which was drained, with no applications of nitrogen;

4. pasture improvement on land which was drained, along with the treatment of two 30 kg applications of nitrogen per hectare, during the autumn/winter period.

The approach taken in setting up the sites was that each site could be considered a replicate of the treatments imposed provided that an assumption that no interaction between treatment and site occurred. This creates a randomised complete block with a split plot nitrogen treatment.

The measurement of pasture harvested from plots rotationally grazed by cattle was difficult, due to selective grazing leaving a plot with highly variable pasture heights after grazing. This problem was compounded by pugging damage by the cattle, creating extremely uneven soil surface conditions on the undrained plots. Initial pasture measurements (taken early in the project) made use of a rising plate meter. This method proved unsatisfactory due to the poor calibration of the meter on undrained plots. This method was quickly changed to the cutting of 20 random quadrants (0.25 cm^2) per plot, prior to and after grazing. Once taken, each quadrant sample was washed (to remove traces of soil) and oven dried (70^oC to constant weight), to enable the calculation of drymatter consumed (t/ha).

RESULTS AND DISCUSSION

Pasture production

Total dry matter production and consumption during the growing season from all sites are presented in Fig. 1. The relationship between the drainage and nitrogen treatments was consistent throughout the measured period, thus each site can be used as a replicate. Analysis of variance was therefore carried out treating each site as a replicate of a randomised complete block design with a split plot nitrogen treatment for the pasture production results obtained. The results were transformed using natural logarithm to correct for heterogeneity of variance. Mean

Figure 1. Total dry matter production and consumption by cattle during the 1992, 1993 and 1994 growing seasons.

yield dry matter increases were significant with differences of 1.45 t DM/ha ($P<0.05$) for the drainage treatment and 0.75 t DM/ha ($P<0.05$) for the nitrogen treatment. There was no significant interaction between the drainage and nitrogen treatments.

The largest difference in daily pasture growth rates due to treatment differences was found to be in spring where the drained pastures grew at a rate of 55 kg DM/ha/day compared to 42 kg DM/ha/day on the undrained pastures. During the autumn/winter period the daily growth rates were measured at 43 kg DM/ha/day for the drained pastures and 38 kg DM/ha/day for the undrained pastures. The seasonal variation of daily pasture growth rates can be very large, dependant on the timing of rainfall and temperature. This variation was exhibited through the growth period of 1993 where above average winter temperatures produced a similar growth rate to the wet mild spring.

The quantity of dry matter consumed by the cattle at each site indicates that the cattle harvested 66% of the available pasture on the drained land compared to 52% on the undrained land (Fig. 1). This result agrees with the common perception that cattle utilise pasture better if the pasture is not waterlogged. The benefits of drainage are therefore twofold as pasture production is increased by 23%, but more importantly cattle consumed a much greater proportion of the grass available on land which is drained.

The increase in dry matter production due to the application of nitrogen fertiliser indicated that for every kilogram of nitrogen applied an extra 15 kg of dry matter was produced on the drained sites. This compares with 10 kilograms of dry matter per kilogram of nitrogen applied on the undrained sites. More importantly however is that the extra dry matter produced on the undrained site was poorly utilised, wasting the production gains due to nitrogen on the undrained land.

Economic analysis

The profitability and return to additional capital invested for the different treatments used in this project and the payback period for their implementation was determined using partial budgeting. Partial budgeting simply means that the extra income and extra costs for the various treatments were calculated. The net profits were then expressed as an annual percentage of the average capital invested in the

various drainage systems. The payback period was calculated by dividing the extra capital required for drainage by the extra net cash flow generated.

Application of nitrogen fertiliser to boost winter pasture growth and hence annual milk production is a highly economic strategy providing an estimated $150 per ha return for an expenditure of $85/ ha in the undrained situation, and $250/ha when accompanied by a drainage system.

The implementation of a drainage program is also a highly economical investment. Coupled with the use of nitrogen fertiliser, percentage returns to extra capital invested of between 98% and 146% were calculated depending on the drainage system used. Translating the results of the pasture improvement project to a farm business, the period for recouping the capital investment for the different types of drainage systems coupled with the use of nitrogen, would be from 2 to 3 years.

CONCLUSIONS

1. Well fertilised improved pasture species continue to provide the base for winter milk production.

2. Waterlogging reduces winter growth significantly, and has an even greater impact on pasture utilisation.

3. Drainage can economically decrease winter waterlogging providing improved management flexibility.

4. Application of nitrogen fertiliser in autumn and early winter yielded between 10-15 kilograms of drymatter per kilogram of nitrogen applied.

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