ECONOMICS OF USING A GROOVED ROLLER FOR CONTROL OF GRASS GRUB IN SOUTHLAND

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SUMMARY

Results from three trials in Southland were used to construct a formula to estimate the density of actively feeding grass grub larvae at which control of grass grub by rolling becomes economic. The analysis suggests that sharing the cost of a tandem roller designed for optimum grass grub control amongst four farmers or contract rolling with a specialised roller would provide economic returns in the form of increased pasture yields in the following spring. These increases can be capitalised upon by raising the carrying capacity of the farm. Rolling appeared to give greater cost benefits than surface-broadcast fensulfothion insecticide granules (2kg/ha).

INTRODUCTION

Previous studies (Stewart and van Toor 1983, 1986; van Toor and Stewart 1986) have demonstrated the feasibility of rolling pasture for grass grub control using a 7.5 — 8 tonne tandem roller towed by a 53 kw tractor. The most effective roller designed for grass grub control was a grooved front roller of alternating 400 mm and 300 mm diameter bands 100 mm wide followed by a flat rear roller of 600 mm diameter. Both rollers were supported under a frame which could be loaded with weights as required.

Yield responses in spring and improvements in pasture composition have been recorded after rolling for grass grub control (Stewart and van Toor 1983, 1986). Best results were achieved when soil moisture was within 5% of field capacity (van Toor and Stewart 1986) and when grass grub were in the third instar. These conditions normally occur in Southland by late April or early May, by which time grub damage is usually apparent and paddocks which require treatment are easily identified. Provided no scuffing of the turf occurs, rolling itself does not damage the pasture or reduce yields. Although rolling slightly compacted the soil in the top 40 mm the soil density returned to normal after one year and there were no significant reductions in earthworm populations (Stewart *et al* 1988).

This paper reports on a model of data from three similar trials by Stewart and van Toor (1983 1986 and unpublished) from which an economic evaluation of the cost benefits of rolling was made.

METHODS

The formula for determining density of grass grub at which rolling becomes economic was calculated by comparing the cost of rolling with the value of the resulting improved gross margin.

The three trials in the model were on 3 to 5 year old pastures at Wendonside, Northern Southland. Treatments were applied between 4 and 14 May, during 1980, 1981 and 1982. The soil was a yellow grey earth, an Oreti stony silt loam, under an annual rainfall of 840 mm. The treatments compared pasture yield responses following a single pass of a grooved roller, fensulfothion (Dasanit 5G) insecticide surface-broadcast at 2 kg/ha and an untreated control. For full experimental details see Stewart and van Toor (1983, 1986).

RESULTS AND DISCUSSION

Grass grub mortality related to pasture returns

In May immature third instar larvae represented 63, 86 and 88% of the grub population at the three sites respectively, the rest being either two year life-cycle second instars or non-feeding mature third instars. These last two developmental stages contribute relatively little to spring pasture damage as the second instar larvae feed from mid-November to mid-January and the mature third instars are fully fed (Stewart and Stockdill 1972). Consequently increases in spring pasture production from rolling were related to the density of immature third instar larvae.

The proportion of these larvae killed by rolling in the three trials was similar regardless of initial grub density. The linear regression between immature third instar larval numbers before (x) and surviving 15 days after (y) rolling was linear: $Y = 0 + 0.465$ x, ($r^2 = 0.95$, $P < 0.01$) when forced through the orgin. Rolling therefore caused a 53% mortality of actively feeding grubs in the early autumn and winter. As a result of this, the early spring pasture production between 15 August and 30 October was increased by 2 kg DM/ha/day for every 100/m² reduction in these larvae. This occurred irrespective of pasture vigour with no significant differences in this relationship between sites ($P > 0.05$) Fig 1).

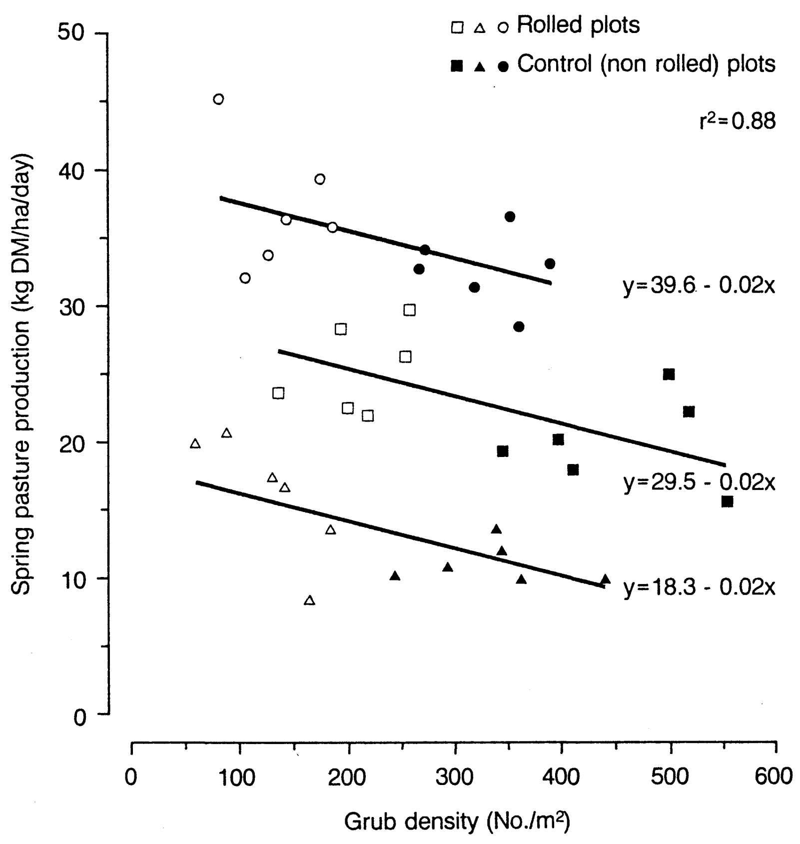

Fig. 1: Spring pasture production (15 August — 30 October) as affected by rolling and immature third instar grub density measured in May, 14 days after rolling, at three sites (■ ▲ ●) in Southland.

Spring pasture production was linearly related ($r^2 = 0.81$) to grub density in the spring (which allowed for a delay in grass grub mortality from fensulfothion) irrespective of rolling or insecticide treatments and the model was not significantly improved by allowing for differences in pasture production due to treatment type. This suggests pasture responses were directly related to reductions in grub density and not due to the effects of rolling itself. Mortality of larvae between autumn and spring is generally similar at all densities (ie is not density dependent).

Economic value of pasture increases

The increase in pasture yield resulting from autumn rolling occurred mainly in the following late August to late October period; thereafter differences between rolled and unrolled pasture declined. The value of this yield increase is high as it occurs at a time when the feed demand from lactating ewes is high (Drew and Fennessy 1980) but the supply of good quality pasture is deficient. The availability of pasture in the spring normally governs seasonal stock carrying capacity so that any increase in spring pasture production would allow a lift in stock carrying capacity for the year. Thus gross margins on a yearly basis can be used to determine the value of pasture saved.

In the spring, 1 kg DM/ha/day of mixed short-rank pasture provides 11.2 MJ ME/kg/day which will support 0.4, 50 kg ewes producing 115% lambing (Southland's average), requiring 21.2 MJ ME/day (Drew and Fennessy 1980) assuming 75% pasture utilisation. With a gross margin of of $23.47 per SU (net of interest on capital live stock at 8% in real terms) at March 1988, the potential value of the pasture saved in the spring is $9.39/kg DM/day.

Grass Grub Density Thresholds

Grass grub density thresholds at which rolling will provide an economic return can be calculated. Although costs and pasture value will vary from year to year, and thus so does the economic threshold, the basic formula remains true.

$$\text{Threshold of immature third instar larval density} = \frac{R}{V(.0107)}$$

Where R = Cost of rolling per ha

V = the $ value of 1 kg DM/ha/day

Constant (0.0107) = pasture DM saved/day by reducing grub populations (Fig 1) x proportion of third instar grubs killed = 0.02 x 0.535

ECONOMIC EVALUATION

Rolling Costs (R)

The cost of constructing an 11 tonne grooved roller is approximately $12,600 (GST not included), if the grooved wheel assembly is made by welding two thicknesses of 100 mm wide x 25 mm thick steel bands wrapped around a 2.4 m long, 700 mm diameter steel cylinder. In this design, both 800 mm diameter grooved wheels and 800 mm diameter smooth wheels are filled with concrete and protected by a reinforced webbing sandwiched between the concrete and steel skin. The unladen weight of the roller (8.8 tonne) can be increased by adding weights (eg, concrete posts) onto the platform.

This increase in the diameter of the rollers from that used in these trials is necessary due to the likelihood of the small diameter rollers becoming bogged in pasture severely damaged by grass grub. The larger diameters will not reduce the efficacy of the roller on grub mortality (Stewart *et al* 1988) provided the roller weight is increased from 8t to 11t to give the required pasture depression. With a write-off period for the roller of 10 years, the depreciation is $1,260 per year, the opportunity cost of interest foregone on captial which could otherwise be invested (5% in real terms) is $630 and maintenance allowed is $250, making the total cost of owning the roller $2140/year.

The capital cost can be reduced to about $7,000 by attaching a specially made grooved roller assembly to a modified existing smooth roller.

The roller can be towed at 6 km/hr by a 53 kw tractor with an approximate operating cost of $17/hour (Clark and Burt 1987). This excludes the cost of the farmer's labour which is regarded as an overhead. With 2.2m covered per pass which allows for a 20 mm overlap, and time allowed for turns, 1.25 ha can be rolled/hour, giving a rolling cost of $13.60/ha. The cost of rolling per hectare if 30 ha/year/farmer are rolled is $2,140 ÷ 30 + $13.60 = $84.93 (Table 1). Alternatively, rolling could be done by contractor.

If the cost of rolling was shared amongst four farmers it would be reduced to \$31.43/ha (Table 1). With the value of 1 kg of pasture saved being \$9.39, the density of third instar larvae required before rolling is economic, is: \$31.43/(\$9.39 x 0.0107) = 313 grubs/m^2

The grass grub density thresholds calculated by this formula for four control options are given in Table 1 and show that at a medium level of grass grub infestation, rolling by contract or cost sharing of the roller produces economic returns. An additional benefit is the possibility of minor increases in pasture yield (up to 11%) in the following autumn (van Toor unpubl.) The economic advantage of rolling compared very favourably with that from the insecticide application used (Table 1), which was the most expensive option.

TABLE 1: Costs and grass grub density thresholds for different methods of grass grub control.

Method	Capital cost /farmer \$	Increase in pasture production* (kg DM/ha)	Cost/30ha /farm/ /year (\$/ha)	Pasture return (kg/ha/\$ spent)	Grub third instar density threshold (n/m^2)
Grooved Roller					
Sole purchase	12,600	350	84.93	4.1	846
Shared amongst 4 farmers	3,150	350	31.43	11.1	313
Contract	—	350	27.00$^+$	13.0	269
Insecticide					
Fensulfothion in May at 2 kg ai/ha	—	700	191.00**	3.7	1272^{++}

* Derived from data from three trials (Stewart and van Toor 1983, 1986 and unpublished).
$^+$ Assumed charges similar for discing (MAF Economics Division 1987).
** Fensulfothion at \$184/ha and \$7/ha application cost (Clark and Burt 1987).
$^{++}$ Grub control at 80%

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