Revegetation of erosion scars in Wairarapa hill country

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Abstract

In a trial to determine means of increasing rate of revegetation of erosion scars, 3 fertiliser and 3 seeding treatments were applied to plots on 8 recent scars in the Wairarapa, half each on northerly or southerly aspects. Four scars were grazed, and 4 were not grazed for the first 2½ years. Fertiliser treatments were no fertiliser, superphosphate, and superphosphate plus nitrogen. Seeding treatments were no seed, a slow-establishing mixture, and a fast-establishing mixture. Changes in vegetative cover were monitored during years 0 to 2½, and pasture production during years 3½ to 5½. Conclusions include: rate of recovery of pastures can be greatly increased by not grazing for 2-3 years and sowing white clover and *Lotus pedunculatus;* space-planting hill slopes with suitable tree species could be accomplished at the same time; if slips are not spelled from grazing, rate of slip revegetation and subsequent productivity from oversowing white clover can be reduced.

Keywords: erosion, fencing, fertiliser, hill pastures, oversowing, production, revegetation, slips

Introduction

In previous work (Lambert et *al.* 1984) Wairarapa slip sites of varying age were identified and pasture production and botanical composition measured. Pasture production on erosion scars took 20 years to reach a level 70-80% of that on uneroded sites, and subsequently levelled off at 80-85%.

The present work investigated ways of increasing the rate of recovery of pasture on erosion scars. Limited detailed experimentation on this topic has been published in New Zealand, most of it being summarised in a NWASCO (1980) report.

Experimental

Site

The trial was conducted on Te Whanga Station, 15 km east of Masterton. The Kourarau steepland soils were derived from fossiliferous siltstone, and have a moderate to severe erosion limitation to pastoral use (Noble 1979). Average annual rainfall was 1075 mm, and the native vegetation (podocarp-hardwood forest) was felled, burnt and the land sown to pasture during 1860 to 1890.

Eight recent (Winter 1981) erosion scars were selected, half each on northerly and southerly faces, Their skeletal soils were thin (O-34 cm) and there was little visual evidence of accumulated organic matter in the subsoil. Organic C content was 0.33%, total N content 0.03%, Olsen P status <6 mg/kg, and pH 6.4.

Treatments

Four of the slip sites (two each on northerly and southerly aspects) were fenced to exclude grazing animals ("fenced" sites). The remaining four were grazed by sheep and cattle as part of station grazing management ("no fence" sites). The fenced sites were opened to grazing in spring 1985, after 2½ years.

Within each site a factorial arrangement of 3 fertiliser x 3 seeding treatments was applied to nine 2 m^2 plots in May 1983.

Fertiliser treatments were:

1. No fertiliser.
2. 16 kg/ha phosphorus (P), 40 kg/ha sulphur (S) as S-fortified superphosphate annually ("P/S" treatment).
3. As for the P/S treatment, plus 100 kg/ha nitrogen (N) annually as dried blood in split autumn/spring dressings ("P/S+N" treatment).

Molybdenum was applied with P/S and P/S+N in 1983, and fertiliser application was discontinued after 3 years, i.e., after the autumn 1986 dressing.

Seeding treatments, applied after removal of scattered volunteer plants, were:

1. No seed applied ("no seed" treatment).

2. Slow-establishing seed mixture ("slow seed" treatment).

	kg/ha
Phalaris (Grasslands Maru)	15
Cocksfoot (Grasslands Wana/Grasslands Kara)	6
Smooth brome grass (Grasslands selection)	2

Crested dogstail (Grasslands selection)	2
Browntop/dryland browntop (Grasslands selections)	2
Red fescue (Grasslands selection)	2
Tall fescue (Grasslands Roa)	10
White clover (Grasslands Tahora)	3
Red clover (Grasslands Pawera)	7
Subterranean clover (Mt. Barker)	8
Suckling clover (commercial line)	2
Crown vetch (Grasslands selection)	2
Lotus (Grasslands Maku)	2
Yarrow	0.5

3. Fast-establishing seed mixture ("fast seed" treatment):

	kg/ha
Perennial ryegrass (Grasslands Nui, selections)	30
Prairie grass (Grasslands Matua)	15
Yorkshire fog (Massey Basyn, Grasslands selection)	10
White clover (Grasslands Tahora)	3
Red clover (Grasslands Pawera)	7
Subterranean clover (Mt. Barker)	8
Chicory (Grasslands selection)	1

Slow and fast seed mixtures were differentiated, as it was felt that vigorous seedlings of species such as ryegrass might out-compete slower-establishing but promising other species.

Measurements

Vegetation cover (percentage of the ground surface covered) was assessed by first-hit point analysis in spring 1983, and autumn and spring of 1984 and 1985. Botanical composition of the establishing vegetation was estimated by recording species encountered.

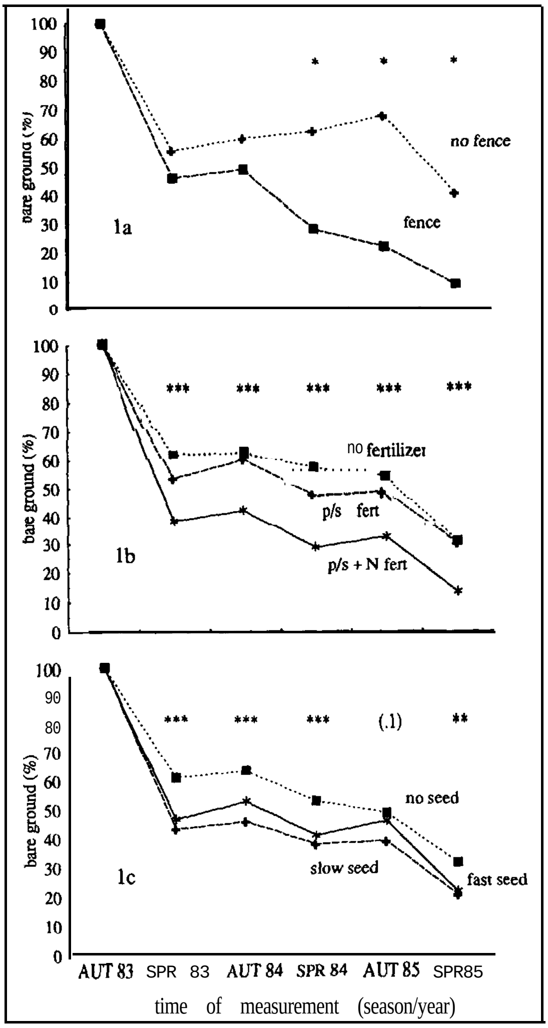
From October 1986 to October 1988 (3½-5½ years after treatment imposition) pasture production measurements (using a standard trim technique involving one 0.5 m^2 grazing exclusion frame on each plot, relocated after each harvest) were made 8 times. In spring 1986 and autumn 1988 herbage subsamples were dissected to obtain an estimate of relative contribution of grasses, legumes and other species to DM production.

Results and discussion

1. ***Establishment phase (first 2½ years)***

Bare ground percentage decreased more rapidly on fenced than unfenced slips (Figure la), because plants

Figure 1 Bare ground percentages. Changes over the 2 years after imposition of fencing (la), fertiliser (lb) and seed (lc) treatments. Asterisks show statistical significance.



established more successfully, and biomass accumulated in the absence of grazing. Application of fertiliser N hastened the formation of a plant/litter cover (Figure lb); and both seed treatments promoted the rate of decrease of bare ground (Figure lc).

Botanical composition of the vegetative cover was influenced by the various treatments (Figure 2). "Other species", which included weeds and the sown species yarrow and chicory, were not an important pasture component at any time during the trial.

The legume component was greater (at the expense of grasses) for fenced sites (Figure 2), where fertiliser N was not applied (i.e., no fertiliser and P/S treatments),

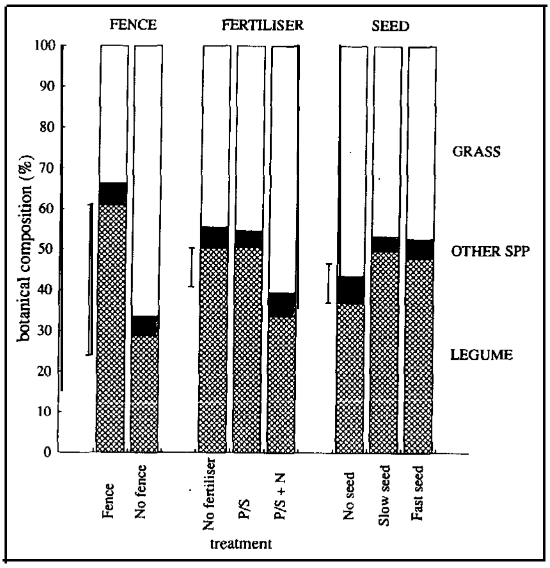
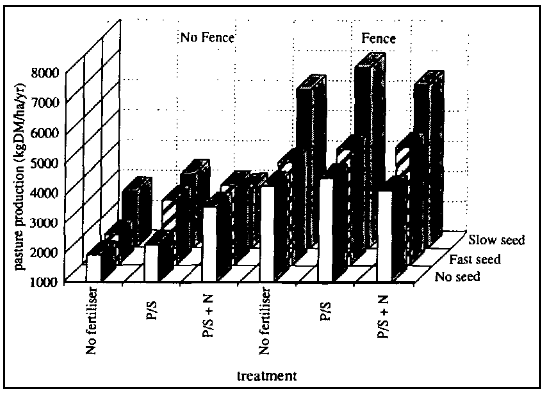


Figure 2 Average (mean of 5 seasonal assessments) botanical composition (grass, legume, other species) during the first 2 years of the trial. Bars indicate lsd.05 **values to** be used in comparing grass or legume contributions (use the same bars for legumes **and** grasses).

Figure 3 Average annual pasture production for fence* **fertiliser*** seed treatment combinations, for years 3%5%.



and where either seed mixture was sown. There were no consistent and significant interactions among the fence, fertiliser and seed treatments.

White clover (average 25% of "green" hits) and lotus were the most effective sown legumes. Lotus was slow to establish and sensitive to grazing, but was a dominant component of some treatment combinations, e.g., 24% on fenced, slow-seed plots after 2 years. In contrast red clover was fast establishing, but after 2 years was a minor component (3%) on fenced, sown plots where its contribution had been most significant. Other sown legumes did not make significant contributions.

Ryegrass content was little affected by seed and fertiliser treatments, but was decreased by exclusion of stock (on average from 30 to 12%). -Yorkshire fog (average 8% where sown) and cocksfoot (average 6% where sown) were the most prominent of the other sown grasses. Both these species, and particularly fog, responded to N application. Other sown grass species did not make significant contributions, other than **browntop** which was as common on unsown plots (9%) as on sown (10%).

2. Pasture production phase (years 3½-5½)

Pasture production over the two years was 8 1% greater (5220 and 2890 kg DM/ha/year respectively, $P<.10$) on previously fenced versus unfenced sites (Figure 3). P/S and **P/S+N** treatments during the establishment phase did not have a significant effect on subsequent level of pasture production (3640, 4230, and 4300 kg DM/ha/year for no fertiliser, P/S and P/S+N treatments respectively, $P>0.10$). Oversowing with slow seed increased production on average 41% ($P<0.001$) compared with no seed, but there was not a significant increase with fast seed (4860, 3440 and 3860 kg DM/ha/year for slow seed, no seed and fast seed respectively).

There was a significant ($P<0.05$) fence*seed treatment interaction: increase in production from slow seed was proportionately much greater for the previously fenced compared with the no fence treatment (Figure 3).

Effects of treatments on **botanical composition** of pastures during years 3½-5½ (Figure 4) were similar to those during the establishment phase (Figure 2). Legume contribution was higher (and grass lower) on fenced sites, and plots where N had not been applied (i.e., no fertiliser and P/S plots). The effect of seed was different, however: there was a significant ($P<0.001$) fence*seed interaction. Slow seed increased ($P<0.10$) legume content on previously fenced slips only, and fast seed tended to decrease ($P<0.15$) legume content on both fenced and no fence sites.

As in the establishment years, white clover and lotus were the most important legume components. White clover made a contribution (13%) even on plots where it had not been oversown, presumably resulting from seed ingress from surrounding pasture.

Lotus occurred only where sown (slow seed), and was a minor contributor (<2%) on previously unfenced sites. However, on previously fenced sites where it had been sown it constituted >50% of pasture produced during years 3% to 5%. In this situation it was so dominant as to reduce the contribution from white clover. This level of performance by lotus is exceptionally high for drought-prone hill country. The impoverished soil conditions of the slips probably contributed to its good performance, as it has high tolerance of low soil fertility (e.g., Lowther 1980). Lotus performed well on northerly as well as southerly aspects, despite its reputation for poor performance on dry sites (Levy 1970). The cultivar sown (Maku) is a tetraploid, and has superior performance in seasonally dry conditions (Hopkins et al. 1993).

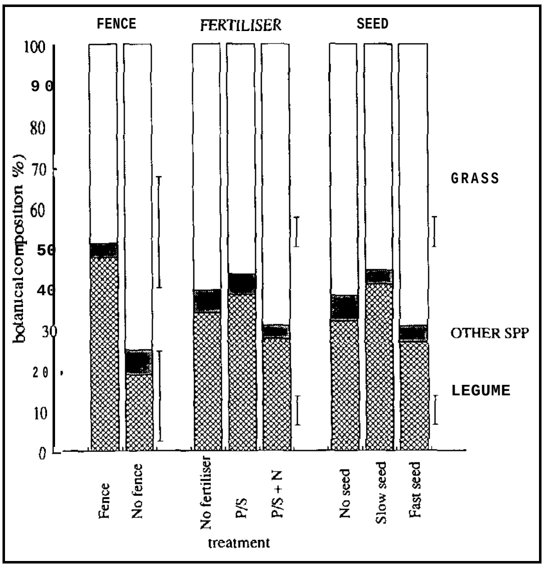
Pasture production appears to have been strongly influenced by legume growth, and its influence on N fixation. Treatments that had high legume content (Figure 4) would have had increased soil N availability for use by associated grasses. Although N availability assays were not conducted to test this hypothesis, it is supported by legume production and total pasture production being highly correlated (r = 0.90**).

Dependence of pasture production on legume performance could explain the superiority of sites which had been fenced and sown with slow seed. Lower production with fast as opposed to slow seed could be linked with lowered legume performance, resulting from increased competition from companion grasses (ryegrass and Yorkshire fog in particular).

The lack of a measured significant influence of fertiliser application on pasture production appears to have resulted from the lack of a P/S effect on legume growth. Possible reasons for this include the fact that low fertiliser application rates used might have made detection of a response difficult; and the fact that in N-deficient environments competition for available P and S by N-starved companion grasses is low, hence legumes requirements are low. Quilter *et al.* (1993) did not detect a white clover response to fertiliser application at slip sowing.

Average annual DM production of the no fence, no seed (control) plots was 2270 kg DM/ha, compared with predicted production from Lambert *et* al. (1984) of 2910 kg DM/ha. Production from the best (fenced, slow seed) treatments of about 6600 kg DM/ha, measured during years 5-7 after slips occurred, was similar to predicted production following unaided revegetation of slip scars 20-50 years after slipping.

Figure 4 Contribution (%) of grasses, legumes and other species to pasture production during years 3½-5½. Bars indicate lsd.05 values for comparing grass (upper) or legume (lower) contributions.



Conclusions

Rapid establishment of productive pastures on erosion scars in Wairarapa and similar hill country can be achieved by retiring areas from grazing for 2-3 years, and oversowing with white clover and lotus.

Deferred grazing (McCallum et al. 1991), or pastoral or sabbatical fallow (Mackay *et al.* 1991) techniques involve not grazing areas for part or all of a growth season. Objectives include stimulating pasture reseeding, improving the efficiency of nutrient cycles, increasing soil biological activity, and boosting pasture vigour. This philosophy could be extended to include the short-term retirement policy proposed here. Trees can play a major role in slope stabilisation (O'Loughlin & Owens 1987), and hill slopes could be space-planted with suitable tree species at the same time. Establishing trees while grazing animals are excluded would enhance establishment success.

Where spelling from grazing is not an option, significant (but reduced) improvements in rate of slip revegetation and subsequent productivity can be made through oversowing white clover seed.

By adopting the approach outlined here, time for recovery of pastures on erosion scars can be shortened dramatically.

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