TEMPERATE PASTURE AND SHEEP PERFORMANCE UNDER RADIATA PINE AND IN OPEN PASTURE

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ABSTRACT

Forage production from years 4 to 6 of an agroforestry system at 400-600 trees per ha and pasture alone were compared for a temperate sub-humid environment. Forage production was best for lucerne pasture followed by phalaris/clover and cocksfoot/clover, and least for ryegrass/clover and the ryegrass only pastures. Total pasture production in the agroforest relative to the open pasture was from 10% more for phalaris to 20% less for lucerne. Sheep carrying capacity over all pastures was 14.6 sheep/ha in the open and 11.8 sheep/ha in the agroforest and varied by ±15% according to the pasture types.

KEYWORDS

Agroforestry, carrying capacity, clover, cocksfoot, liveweight, phalaris, production, radiata pine, ryegrass, sheep, temperate pasture.

INTRODUCTION

Radiata pine planted with improved pasture has become common in New Zealand. Grazing is possible from year two or three when trees are large enough to resist grazing damage. Low tree densities of 100-400 stems/ha prolong useful pasture production to 10-15 years (Hawke, 1991). New Zealand studies have used mainly ryegrass and white clover as the introduced species in the understorey. Subterranean clover was used by Anderson and Moore (1987) in Australia.

At Lincoln University an agroforestry experiment was established in 1990 to study production and competitive processes between pine trees and improved pastures in a temperate sub-humid environment (Mead *et al.*, 1993). Pollock *et al.* (1994) described the forage production during the first three years prior to introducing sheep.

The pastures in this region are subject to summer drought stress and winter mean temperatures of 6°C, so five pasture types were chosen which had different seasonal growth patterns, competitiveness and persistence. The pasture productivity and sheep carrying capacity in the open and under radiata pine were compared.

MATERIALS AND METHODS

The site was on a Templeton silt-loam on the Canterbury Plains. Establishment details are given by Mead *et al.* (1993) and pasture details by Pollock *et al.* (1994).

The trees in the agroforest were thinned to 800 trees/ha in December 1992, 600 in December 1993 (year 4) and 400 in August 1994, and pruned to 3.5-4 m crown lengths in December 1994 (year 5) and again in December 1995 (year 6). All thinned and pruned material was removed. The open pasture was located beside the agroforest but exposed to the prevailing winds.

The open pasture and agroforest experiments were randomised block designs with 3 replications. The five pasture types were: 1. perennial ryegrass (*Lolium perenne*) + clovers [red (*Trifolium pratence*), white (*T. repens*) and subterranean (*T. subterranium*)]; 2. cocksfoot (*Dactylis glomerata*) + clovers; 3. phalaris (*Phalaris aquatica*) + clovers; 4. perennial ryegrass without legume and 5. lucerne (*Medicago sativa*). The ryegrass was a high endophyte (*Acremonium lolii*) type.

Sheep grazed the site from September 1993 to May 1996. Sheep were removed during summer dry periods for up to 10 weeks and during winter, June - August. Ten uniform flocks were assigned, one to each pasture type in the open and in the agroforest, and rotated across replicates. Marked sheep from each flock were weighed before and after each grazing period. Extra sheep were added or removed from each flock, and length of each rotation varied, to maintain feed intake near 1.5 times maintenance requirement in spring and near maintenance in summer and autumn. The total number of sheep x the number of days on each pasture were used to calculate the carrying capacity.

Pasture mass was measured before and after each grazing using visual and capacitance probe estimates calibrated for each pasture and current conditions.

RESULTS AND DISCUSSION

The total herbage accumulation between grazing periods was greatest for lucerne in the open and least for ryegrass only (Table 1). Pasture production in the agroforest relative to the open was about 10% less, a similar result to the cut forage production in the first three years (Pollock *et al.*, 1994). The variation between years was due largely to growing season rainfall which was 15% above normal in year 4, 42% below in year 5 and 18% below in year 6. Phalaris grew particularly well in the agroforest in all years. It grew vigorously in the late winter and spring and again in autumn thus was least affected by the dry summer of year 5. Lucerne on the other hand was dependent on good soil moisture reserves in summer and appeared to be suffering the effect of increased competition for soil moisture from the trees in year 6. Lucerne and phalaris have caused the greatest depression of tree growth to date (Mead, pers. comm.). The relatively low production from ryegrass pastures was mainly from lack of clover in the ryegrass only pasture and from weed invasion in the ryegrass/clover pastures after an earlier infestation of grass grub (*Costelytra zealandica*). Cocksfoot pasture produced consistently well.

Studies in humid temperate environments (reviewed by Knowles, 1991) have shown that agroforest pasture production is inversely related to the pruned crown length of radiata pine.

The sheep carrying capacity per annum was 14.6 sheep/ha in the open and 11.8 sheep/ha in the agroforest, a 20% reduction which varied according to the pasture types (Table 2). Knowles (1991) showed a 60% decrease after 5-8 years under 350 trees/ha where slash had not been removed, and Anderson and Moore (1987) reported a 27% reduction in carrying capacity under seven year old trees at 225 trees/ha without slash removal. In the present study the relationship between carrying capacity and annual pasture production was not strong (regression R^2= .72 in open and .68 in agroforest) indicating that other factors such as feed quality were important. Sheep liveweight gains during spring were near 100g/day in the open and about 80 g/day in the agroforest. The pasture became rank at times which reduced its feed value. Problems with ryegrass staggers during late summer and severe staggers in sheep grazing the phalaris in autumn meant that grazing these pastures had to be reduced or stopped at times.

During the first six years of the agroforest, herbage and animal production have been maintained at acceptable levels. With further thinning to 200 trees/ha, continued pruning for another five years and the absence of nutrient deficiencies, the current production can be expected to continue. Opportunities also exist to improve pasture utilisation by reducing the rotation time to maintain optimal green leaf production.

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Table 1
Annual herbage production (t DM/ha) between grazing periods in open pasture and in agroforest pasture.

	In open				In agroforest			
Pasture	Year4	Year5	Year6	Total	Year4	Year5	Year6	Total
Ryegrass/clover	7.0	6.3	5.7	19.0	7.7	5.0	5.1	17.8
Cocksfoot/clover	9.6	5.8	6.5	21.9	8.4	5.4	7.5	21.3
Phalaris/clover	8.3	4.6	6.3	19.1	7.8	7.4	7.6	22.8
Ryegrass only	5.6	5.1	5.6	16.3	6.0	4.2	6.0	16.2
Lucerne	14.1	4.1	12.3	30.6	12.1	4.7	7.8	24.6
Significance	<.001	NS	<0.001		<0.001	<0.001	0.003	
s.e.m.	0.6	0.5	0.4		0.6	0.2	0.4	

Table 2
Annual sheep carrying capacity (sheep/ha) from open and agroforest pasture.

	In open				In agroforest			
	Year4	Year5	Year6	Average	Year4	Year5	Year6	Average
Ryegrass/clover	19.7	11.9	10.3	13.9	17.3	7.9	8.6	11.3
Cocksfoot/clover	25.2	11.6	13.7	16.8	18.1	8.3	11.9	12.7
Phalaris/clover	19.6	8.0	9.1	12.2	17.9	7.5	9.2	11.5
Ryegrass only	15.8	9.6	11.9	12.4	15.0	6.2	9.6	10.3
Lucerne	25.5	6.6	20.2	17.4	21.4	4.7	12.8	13.0