THE ROLE OF GRAZING ANIMALS IN WEED CONTROL

E.D. Carter
The University of Adelaide, Waite Agricultural Research Institute
Glen Osmond 5064, South Australia.

INTRODUCTION

Australia has some 40 million ha of crop and sown pasture lands that rely on introduced legumes to maintain or improve levels of soil nitrogen and to guarantee the quality and quantity of livestock feed. These legumes, mainly the annual self-regenerating medics (*Medicago* spp.) and clovers (*Trifolium* spp.) are worth at least US$2,500 million each year to the crop and livestock industries (6). In the integrated crop-pasture-livestock farming systems sheep and cattle, and to a lesser-extent goats, play a vital role in weed control - through timely grazing.

A weed is a plant growing where it is not desired. What is considered an undesirable weed by some landholders may not be considered a problem by others. These differing viewpoints are reflected in regional common names. For example, *Echium plantagineum* is referred to as Paterson's Curse in New South Wales but Salvation Jane in South Australia.

The Shorter Oxford Dictionary defines a weed as a "herbaceous plant not valued for use or beauty, growing wild and rank, and regarded as cumbering the ground or hindering the growth of superior vegetation". But, in Australia, many weeds at flowering time in rural areas are regarded by urban populations as things of beauty. Such weeds include soursob (*Oxalis pes-caprae*), capeweed (*Arctotheca calendula*) and Salvation Jane.

Grazing livestock are not concerned about the desirability or beauty of weeds, but livestock are concerned with palatability and availability of feed supply. As a general rule, if plants are green and not poisonous, these are a suitable diet for grazing animals.

Many weeds are valuable grazing plants in the early part of the season, e.g. barley grass (*Hordeum leporinum*) and the nutritive value of many well-known weeds does not differ greatly from cultivated pasture plants, e.g. comparison of *Reseda lutea* and *Medicago sativa* (14). However, palatability and nutritive value of plants including weeds declines with increasing maturity which is associated with declining digestibility. There may also be decreased palatability and intake of many weeds associated with troublesome seed heads, e.g. barley grass and storksbill (*Erodium spp.*).

Palatability and availability of pasture including weeds are directly related to short-term stocking density or longer-term stocking rate. At low grazing pressures, pasture availability increases and grazing animals can be more selective. At high grazing pressures, livestock must eat what is available and the ability to select declines markedly. This is the basis of weed control.

PRODUCTION, MANAGEMENT AND UTILIZATION OF PASTURES

The establishment and management of annual pastures has been reviewed by Carter (8), while the establishment and management of perennial pastures has been reviewed by Campbell *et al* (2). In all sown pasture situations the potential livestock production depends on the product of YxUxE where Y is yield, U is percentage utilization and E is the efficiency of conversion of the pasture into animal products (meat, milk, wool, etc.) Pasture plant density is of crucial importance to production of sown species and has a significant influence on exclusion of weeds. Stocking rate determines the percentage utilization of pastures.

Grazing animals have direct and indirect effects on pasture yield and botanical composition which may well influence invasion by weeds. However, while grazing animals have a direct role in controlling many weeds they also contribute to the spread of weeds.

The main effects of the grazing animal on pastures are: treading, defoliation, recycling of nutrients and dispersal of seeds and these four effects may have positive or negative influences on pasture yield, botanical composition and weed invasion or weed control.

Treading. Cattle have been used extensively for controlling bracken (*Pteridium* spp.) by treading resulting in bruising and breaking of plants. Treading by sheep has been used to advantage in burying surface-sown pasture seeds to improve establishment. On the other hand, treading by sheep and cattle can damage pasture by causing pugging of the soil and poaching of useful pasture plants leading to reduced density and productivity (10), increased percentage bareground and consequent invasion by such species as toad rush (*Juncus bufonius*), a useless weed, or winter grass (*Poa annua*) which is far less productive than sown grasses.

Defoliation. In perennial pastures, lax grazing favours the taller-growing species (grasses or weeds) and heavier grazing favours the more prostrate species e.g. sown legumes. In annual pastures, the same general responses occur but there is a most important additional factor i.e. seed production which is very sensitive to grazing pressure. Stocking density (short-term) or stocking rate (longer-term) may have a dramatic impact on yield, botanical composition and also seed production (3,4). Furthermore, grazing of the dry pasture residues in summer and autumn may have a dramatic impact on seed survival and regeneration (5,6).

On farmlands where there is adequate fencing to control grazing, then livestock can, and do, play a major role in controlling weeds. Examples of the impact of grazing pressure on survival and productivity of weeds are very common in southern Australia during spring: a very obvious example is the comparative productivity of Salvation Jane under horse/cattle grazing and sheep grazing. This weed can be almost eliminated by high grazing pressure with sheep. Similarly, barley grass and other grasses can be greatly reduced by high grazing pressure. The abnormal decline in density of both sub clover and grass plants with increasing stocking rate recorded in July 1967 (Table 1) reflected the fact that prior to this date there were six germinating rains with subsequent dry weather and loss of seedlings i.e. six "false breaks" to the season.

Table 1. Some examples of the effects of continuous grazing by sheep on Salvation Jane, mixed grasses, barley grass and subterranean clover at the Waite Institute.
Source: Carter (1968); Carter and Lake (1985).

	December 1963		April 1965				July 1967	
Stocking rate	Salvation Jane Plants	Yield DM	Sub clover Plants	Grass Plants	Barley grass Yield DM	Seeds	Sub clover Plants	Grass Plants
(Sheep/ha)	(#/m^2)	(kg/ha)	(#/m^2)	(#/m^2)	(kg/ha)	(kg/ha)	(#/m^2)	(#/m^2)
7.4	72	3890	1967	20812	2466	735	2190	4107
12.4	60	2620	2368	9442	-	-	1109	915
14.8	44	1270	2229	10950	1323	413	985	1096
17.3	15	200	2348	6928	-	-	846	753
22.2	4	20	1843	2089	312	68	164	3

The special role of goats in eliminating weeds that are completely or partially avoided by sheep and cattle is well known (13). Such species include gorse (*Ulex europaeus*) and horehound (*Marrubium vulgare*).

Recycling of nutrients. Most of the readily-available nitrogen and potassium is in the urine, while most of the readily-available calcium and phosphorus is in the dung of grazing animals.

Thus, areas of the farm where there are large concentrations of livestock excreta, e.g. the "night paddock" of a dairy farm, tend to encourage nitrophilous weeds including barley grass.

Dispersion of seeds. Seeds may be dispersed in two ways by grazing animals: firstly by attachment to the wool or hair and secondly by surviving passage through the digestive tract (1,5,11,12). Both methods are important in the spread of weed seeds. However, ingestion of the seed of many species by livestock has a dramatic impact on survival of that seed. Two processes are involved, viz. chewing and digestion. The small, hard-seeded species can most successfully avoid both chewing damage and digestion (9). Tests on the seed survival of dozens of species of pasture legume have been conducted in the Animal House at the Waite Institute in the past 15 years. These have shown seed survival values ranging from 0% for a genotype of *Medicago murex* to 55% for Kyambro Persian clover (*Trifolium resupinatum*) (5,9). Our methods have been adopted by other researchers, e.g. J. Heap (pers. comm., 1989) showing potential spread of cutleaf mignonette (*Reseda lutea*) by sheep and St. John-Sweeting and Morris (pers.comm.,1989) demonstrating passage of a range of weed species through the horse.

SPECIES DYNAMICS OF GRAZED PASTURES

In a closed system, the separate effects of the grazing animal may all contribute to yield and botanical composition. For example, in a grazing experiment involving five stocking rates at the Waite Institute, capeweed, cluster clover (*Trifolium glomeratum*) and winter grass gradually increased during the five-year period partly because some viable seed of each of these species passed through the digestive tract of the sheep. In the case of cluster clover, some 60% of the seed may survive passage through the sheep, so under heavy grazing pressure cluster clover increases (Table 2). On the other hand, the grazing pressure was so low at the lowest stocking rate that there was little need for the sheep to eat any barley grass seed, hence barley grass dominance (Table 3).

Table 2. The effects of stocking rate on seed production of cluster clover, the quantity of sheep faeces, total seed content and the amount of cluster clover and winter grass seed present in faeces during early autumn (March) after five growing seasons at Waite Agricultural Research Institute. Source: Carter (1977); Carter and Lake (1985).

Stocking rate	Cluster clover seed	Faecal[a] pellets	Total faecal seeds	Seed numbers and germination percentage of seeds in 40 g samples of faecal pellets			
				Cluster clover		Winter grass	
(Sheep/ha)	(kg/ha)	(kg/ha)	(#/m^2)	(#)	(%)	(#)	(%)
7.4	<1	306	1	1	0	0	-
12.4	<1	634	20	11	82	0	-
14.8	1	754	22	14	93	0	-
17.3	16	948	321	127	96	0	-
22.2	439	1334	14451	4171	95	1006	15

[a]Faecal pellets that accumulated during the previous summer

It is contended that this phenomenon of botanical composition reflecting the relative intake and excretion of viable seeds has direct relevance to all grazed ecosystems. Grazing pressure has far more impact on botanical composition than does the initial seeds mixture. In a closed system each stocking rate will evolve, quite rapidly, its own mini-ecosystem comprising pasture plants and weeds.

Certainly grazing livestock can be used as a cheap and effective means of changing botanical composition and controlling most weeds: each year our livestock save the cropping enterprises

millions of dollars by grazing weeds that would otherwise have to be treated with herbicides. Furthermore, there are clear indications that the more widespread use of grazing livestock would prevent or delay the onset of severe herbicide resistance in sown pasture species and weeds. Colour slides will show the vital role of grazing animals in weed control which is often more effective, more sustainable and far cheaper than herbicides.

Table 3 The effects of stocking rate on the patterns of seedling emergence from sheep droppings collected in March and the subsequent botanical composition in May after 5 years continuous grazing at the Waite Institute.Source: Carter (1987).

Seedlings emerging from 10 g sheep faeces covered with sand							
Stocking rate (Sheep/ha)	Sub clover	Barley grass	Sour sob	Cape weed	Cluster clover	Winter grass	Total plants
7.4	1	2	-	2	1	0	6
14.8	0	0	-	12	3	0	15
22.2	2	0	-	0	217	48	267
Percentage botanical composition in May							
Stocking rate (Sheep/ha)	Sub clover	Barley grass	Sour sob	Cape weed	Cluster clover	Winter grass	Wimmera ryegrass
7.4	23.4	74.1	0.8	1.4	0.0	0.0	0.3
14.8	5.8	6.1	trace	88.0	0.0	0.0	0.1
22.2	12.2	0.0	16.6	20.8	24.6	25.8	0.0

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