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McGregor, B. A. 1987, The role of goats in complementary grazing systems in temperate and high rainfall regions of Australia, in Role of non-milch goats in agriculture production in Australia, Queensland Dept. of Primary Industries, Brisbane, Qld., pp.1-11.

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19. THE ROLE OF GOATS IN COMPLEMENTARY GRAZING SYSTEMS IN TEMPERATE AND HIGH RAINFALL REGIONS OF AUSTRALIA

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Introduction

Since 1971 fibre goats have been promoted in Australia as a way for wool growers to diversify farm enterprises to attain higher farm income. Australian farms in temperate and high rainfall zones are generally multi-enterprise with integration of crops, fallows, pastures and livestock. It is apparent that for goats to become a stable component on our farms goat enterprises must be economically comparable or superior to existing enterprises or provide equivalent benefits to management. In addition, management practices to obtain efficient production from goats and to integrate goats with other farm enterprises must be developed.

This paper briefly reviews observations on complementary grazing of livestock on annual pastures, with particular reference to my research at Werribee, very briefly comments on animal health aspects of mixed grazing and weed control programmes and suggests future directions for grazing management studies for goats.

Complementary grazing

Mixed grazing occurs when two or more species graze together. Mixed grazing may have no effect on production or may be complementary or competitive. Complementary grazing occurs when one or more species are better off and no species is worse off as a result of grazing together. Competitive grazing occurs when one or more species are worse off and no species is better off, or one species benefits at the cost of another. Competitive grazing may be beneficial in economic terms but in certain circumstances critical situations can develop where one species or class of stock is endangered.

Overseas research in arid and semiarid regions has shown benefits in mixed grazing of goats, sheep and cattle (briefly reviewed by McGregor 1985b, Downing 1987). In temperate Australia, two experiments examining complementary grazing of sheep and cattle have been reported. At Canberra (Bennett *et al.* 1970) on perennial pasture, mixed grazing led to increased productivity from spring-lambing ewes without any substantial effect on cattle production and both species could be grazed together.

At Rutherglen, on annual pastures (Hamilton 1975, Hamilton and Bath 1970), the wool production and lamb growth from autumn-lambing flocks were improved by 12% when sheep were grazed with cattle at comparable grazing pressure instead of separately. This was achieved without any reduction in the growth of cattle. However, it was more profitable to ignore

opportunities for better pasture utilisation provided by mixed grazing and instead graze sheep and cattle separately, each at its own most profitable stocking rate.

Grazing management and complementary grazing of goats on temperate pastures in Australia

If fibre goats are to offer diversification for wool growers then research is required in the wheat-sheep zone (300 to 650 mm annual rainfall) where 60% of Australia's sheep and wool producing properties are found. However, no published results are available for grazing experiments with goats in the wheat-sheep or high rainfall zones. Since 1980 I have been investigating the influence of stocking rate and mixed grazing of Angora goats with Merino sheep on animal growth, wool and mohair production, gastrointestinal parasitism, pasture availability and pasture composition on annual pastures at Werribee. Some progress results have been published (McGregor 1985b, 1987a). This paper is concerned only with the complementary grazing aspects of the experiment.

At Werribee the most economical stocking rate for dry Corriedale sheep on annual pasture is the set stocking of 10 dry sheep per hectare (10/ha) (Sharkey and Hedding 1964, Sharkey *et al.* 1964). This was used as the benchmark for the experimental stocking rates.

Potential for mixed grazing of goats and sheep in increasing utilisation of pasture

It is clear from analysis to date that potential exists for complementary grazing of pastures by goats and sheep.

Goat and mixed treatments had significantly greater subterranean clover seedling germination when measured in late autumn (May) than sheep plots. Pasture composition was also affected by grazing treatment with goat and mixed plots having significantly more clover DM available. For instance, mean green clover availability at the end of spring (November) during period 1981 to 1984 was 610 kg DM/ha (15% of total DM) for goat and mixed treatments compared with 115 kg DM/ha (4% of total DM) for sheep. Clover availability was greatly reduced in 12.5/ha sheep treatment (1% of total DM). Goats did consume dead clover residues and clover burr over summer. Thus grazing goats with sheep increased the availability of clover for sheep.

Visual observations showed clearly that during summer sheep at all stocking rates avoided dead grass in clumps while goats grazed much more evenly. This was confirmed when oesophageally fistulated sheep and goats were grazed on our experimental area (see Figure 1). Goats preferred dead herbage to clover in May and preferred grass to clover in August and October. The diets selected by goats and sheep had similar digestibilities except in May when sheep selected a diet of higher digestibility (68% vs 56% DOM) (Gurung *et al.* 1986, 1987). Studies of diet selection by goats and sheep on dry summer pastures are currently in progress at Werribee. It would appear that grazing goats with sheep increases the utilisation of dead pasture residues on annual temperate pastures.

Mixed grazing also altered pasture availability in favour of sheep. In all treatments as stocking rate increased pasture availability declined significantly (Table 1) but the absolute decline was much less in goat grazed plots. Thus when sheep were grazed with goats pasture availability at 10 and 12.5/ha was intermediate between sheep and goat plots at the same stocking rate.

Table 1. Mean availability of total pasture dry matter for stocking rates and grazing species (kg DM/ha) for period August 1981 to August 1984 (annual pastures at Werribee)

Stocking rate/ha	Grazing species			Mean ^B
	Sheep ^A	Mixed	Goats	
7.5	2995 ^{ab}	3490 ^a	3120 ^a	3200 ^X
10	1730 ^{de}	2370 ^{bcd}	2385 ^{bc}	2160 ^Y
12.5	1285 ^e	1575 ^e	2275 ^{cd}	1710 ^Z
Mean ^C	2005 ^q	2480 ^{pq}	2595 ^p	

A : Within body of table values with different superscripts are significantly different (P<0.05).

B : Stocking rate means with different superscripts are significantly different (P<0.05).

C : Grazing species means with different superscripts are significantly different (P<0.05).

Potential for mixed grazing of goats and sheep in increasing animal production

Complementary utilisation of pastures was reflected in differences in liveweight, fleece production and internal parasitism of separately and mixed grazed goats and sheep.

At 7.5/ha mixed grazed animals and at 10/ha mixed grazed goats had similar liveweight to separately grazed animals. However, at 10 and 12.5/ha mixed grazed sheep were heavier (P<0.05) than separately grazed sheep while at 12.5/ha mixed grazed goats were lighter (P<0.05) than separately grazed goats (Figure 2 and 3).

Mixed grazed goats grew significantly more mohair in summer than separately grazed goats but in winter at 12.5/ha mixed grazed goats grew significantly less mohair than separately grazed goats. Mixed grazed sheep grew significantly more wool than separately grazed sheep (mean increase was 10%). Value of fibre was affected by mixed grazing. In summer, fibre diameter of mohair from mixed grazed goats at 7.5 and 10/ha was stronger than mohair of separately grazed goats but at 12.5/ha mohair from mixed grazed goats was finer in summer and winter than mohair from separately

grazed goats. Clean mohair yield was also depressed in mixed grazed goats at 12.5/ha. Fibre diameter of wool of mixed grazed sheep was greater than of separately grazed sheep.

Significant health and internal parasitism effects were recorded. These subjects have been excluded from this review conference but brief progress reports are available (McGregor 1985c, McGregor and Presidente 1985, Halpin and McGregor 1987). Results are summarised in conclusions of this paper.

Some behavioural and physiological differences between goats and sheep

Differences in grazing preference affected pasture height and ground cover. While there were no significant differences between average pasture height, grazing species differences did occur at specific times of the year. In January, mean pasture height at 7.5/ha was the same for sheep and goats but in March goats had significantly shorter pasture, with this trend continuing until July, despite the fact that there was no difference in pasture availability. However, at 10 and 12.5/ha goat pastures were higher than sheep pastures. Mixed grazed plots were intermediate.

The incidence of exposed soil was greater in sheep treatments than goat or mixed treatments. Exposed soil increased as stocking rate of sheep increased but there was no change in incidence of exposed soil as stocking rate of goats increased. Mixed treatments were intermediate. These differences are related to both pasture availability and pasture height differences. However reduced soil exposure as a result of grazing goats could be a significant benefit in districts where soil erosion is a problem.

Observations of grazing behaviour measured using grazing clocks also indicate differences between species (McGregor, B. A. unpublished) and suggest that grazing preferences and behaviour are reflected in time spent grazing. In winter, goats spent 10.4 hours grazing compared with 9.6 hours for sheep; while in summer, goats spent 9.1 hours grazing compared with 9.9 hours for sheep. Goats tended to graze more uniformly throughout the day than sheep. Research with feral and crossbred goats (McGregor 1982) indicated that these goats preferred to spend little time grazing at night and almost no time at night when they had kids at foot.

I have also recorded differences in response of Angora goats and Merino sheep to exposure to full sun, with rectal temperatures of Angora goats being significantly higher ($P < 0.05$) than those of sheep. It is believed this difference is related to differences in fleece characteristics (McGregor 1985c). Smaller goats also had higher rectal temperatures than larger goats. Thus if shade was available, the need for shade was greatest with small goats and least with sheep.

Investigation of water consumption of Angora goats and Merino sheep revealed that goats consumed significantly more water than sheep when grazed on unshaded dry summer pastures (McGregor 1986). This difference was presumably related to increased heat stress as estimates of food consumption (Gurung *et al.* 1987) were the same for goats and sheep. In winter on green pasture no difference in water consumption was observed.

Goats have a greater ability to jump fences than Merino sheep. In my experience, removal of the odd rogue goat and selective use of electric fencing results in easily managed flocks of goats. When pastures become short, particularly in summer, large goats which have been contained all year may begin to jump fencing but use of an electric wire is an effective deterrent.

Grazing goats with cattle

No research has taken place on grazing goats with cattle on temperate pastures. Relevant observations from my research at Werribee would indicate that clover ungrazed by goats in late winter and spring is likely to be grazed by cattle. Goats will compete with cattle for green and dead grasses. Neither goats nor cattle do well when pastures are short and wet during winter. Goats harbour internal parasites of cattle as well as of sheep (Le Jambre 1978, McGregor and Presidente 1985) so introducing cattle onto goat properties to 'break' the internal parasite cycle will be ineffective and possibly counter productive. In high rainfall areas where white clover (*Trifolium repens*) is predominant, goats' avoidance of white clover is likely to provide additional pasture for cattle (McGregor, B. A. unpublished observations).

Complementary grazing of goats and weed control

While Mitchell (1987) gives a fuller discussion of controlling weeds by goats in temperate regions some comments are relevant here. Many grazing properties in temperate regions do not have major weed problems, weeds being more likely in high rainfall or monoculture cropping regions. Goats, however, can effect control where small areas of weeds occur. At Werribee goats have destroyed areas of variegated thistle and prevented hoary cress from flowering. In high rainfall areas they also stop ragwort invasion of pastures (McGregor, B. A. unpublished observations).

In the past, often the management practices used by producers to eliminate weeds involved heavy and prolonged grazing of 'unproductive, weed-infested' land. It is apparent from some of the reports that agronomic advantages have been evaluated, but the costs to the animals have been ignored (McGregor 1985b). Great care needs to be taken when elimination of weeds rather than control is the aim.

From my experiences with experiments to eliminate weeds (Couchman, R. C. and McGregor, B. A. unpublished), observations of other trials, and the grazing experiments at Werribee, it is obvious that there are potentially great dangers to goats used in these programmes. Problems of very high stocking leading to drastic liveweight loss, with animals in poor condition, vulnerable to heavy parasite infections and cold stress have been reported from numerous locations (East Gippsland, South Gippsland, Otways, Central Victoria). Animal welfare considerations must be properly appreciated. Use of breeding does and kids in these situations cannot be condoned. (In situations where some goats are introduced at low stocking rates to control weeds rather than eliminate weeds, then does and kids may be suitable.)

In addition, the nutritional value of many heavily grazed weedy areas and forests in high rainfall areas of south eastern Australia is very low (McGregor, B. A. unpublished data) and the productivity of this herbage in winter is almost zero. While seasonal liveweight loss is usual on pastures and can be tolerated in weed control enterprises, great care is required to prevent unnecessary animal suffering.

Discussion

Stocking rate of goats on annual pasture

In Australia, stocking rate is measured in dry sheep equivalents (DSE). One DSE is the feed required to maintain a 45 kg Merino wether for one year. As well-managed four to six year old wether Angora goats weigh 45 to 55 kg and mature Angora does 40 to 45 kg their DSE must be at least 1. Given that Angoras are shorn twice each year and so have longer periods subject to cold stress compared with sheep, their DSE could be as high as 1.15.

The DSE of breeding Merino ewes with 80% lambs is 1.3 DSE per ewe plus 0.7 DSE per ewe for each lamb kept until 18 months of age. Angora and cashmere does rear 120 to 140% kids. McGregor (1987a) recommends the DSE of breeding does as 1.5 DSE plus 1.4 DSE per doe if all kids are kept until 18 months of age.

At Werribee, goats grazed at the recommended stocking rate needed extra treatment to control internal parasitism compared with goats at low stocking rates. There was more available pasture for goats compared with sheep at the recommended stocking rate but when stocking rate of goats was increased to utilise this pasture, health and survival problems emerged for the goats. My research at Werribee indicates that adult wether goats should not be grazed at stocking rates above those recommended for dry sheep.

In addition, my research and observations of flocks in southern Victoria (McGregor and Presidente 1985, Adolph and Ross 1987) indicate that goats grazed at greater than 8 DSE/ha will face increased internal parasite challenge and potentially serious parasitism (including drench resistance if excessive anthelmintic treatment is used in attempts to suppress internal parasitism). It is therefore recommended that goats should not be grazed at intensities greater than 8 DSE/ha and any remaining grazing capacity be utilised by sheep or cattle.

Mixed grazing of goats with sheep

Grazing goats and sheep together at below the recommended stocking rate has little influence on liveweight or production. At the recommended stocking rate complementary grazing was observed. Goats had less internal parasitism than goats grazing separately and did not need extra treatment. They grew more fleece and their liveweight was unchanged. Sheep utilised the extra pasture and clover, were heavier and grew more wool. However, when stocking rate of mixed grazing plots was increased above the recommended rate a competitive situation resulted in which sheep outcompeted goats. Goats had greatly increased parasitism, were significantly lighter, grew significantly

less mohair in winter and had substantially increased death rates. Pastures were shorter with mixed grazing at 12.5/ha compared with 10/ha but longer than sheep only plots at 10 and 12.5/ha. Sheep utilised the extra pasture and clover, and were heavier and grew more wool than sheep alone at 12.5/ha.

Although complementary gains from grazing goats with sheep on pasture occurred, the small gains (about 10%) could easily be lost if overgrazing caused increased deaths of goats from cold stress or internal parasites. This implies that adding say one goat/ha to an already fully stocked sheep property (pasture land with no major weeds) without reducing sheep numbers by an equivalent amount will result in goats which are in poor condition and vulnerable to cold stress and parasitism.

Conclusion

It appears that if it is economic to graze goats on pastures then complementary grazing at the recommended stocking rate will provide added returns in wool and mohair production and reduce parasitism of goats.

Associated research on management of grazing goats and needs for future research in the temperate zone

Research is needed or in progress in the following areas.

- . Define the effects of goats' grazing preferences and habits on the productivity of annual pastures.
- . Define the effects of provision of shelter on the productivity of fibre goats.
- . Define the benefits, if any, of providing supplementary feed to fibre goats grazed on annual pastures.

Work in progress is examining the benefits of providing energy supplements and protected methionine in mohair production (McGregor, B. A. unpublished) during summer, examining the effects of energy supplements during summer on cashmere production (McGregor, B. A. unpublished), examining the benefits of providing energy or roughage supplements during winter in growth and compensatory gain of fibre goats during spring (McGregor, B. A. unpublished and McGregor 1984a,b).

- . Develop drought feeding recommendations for goats grazing annual pastures.

Two projects have been undertaken evaluating energy requirements and energy value of wheat diets for drought feeding Angora goats (McGregor 1987b and McGregor, B. A. unpublished). Preliminary recommendations have been published (McGregor 1983, 1985a) based on the cited work and other experiments including McGregor and Hodge (1987).

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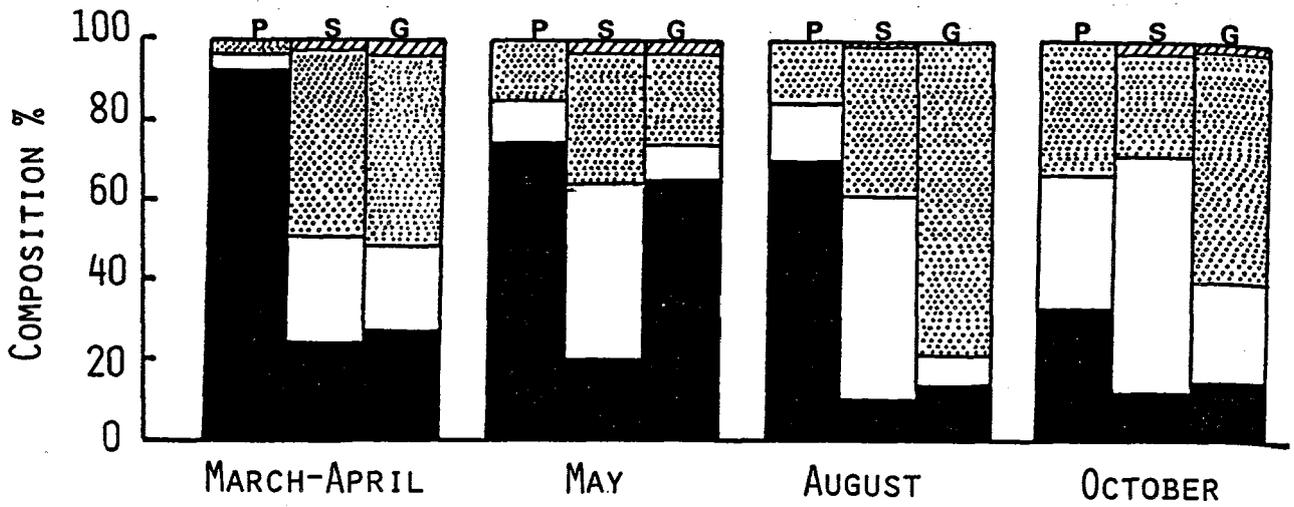


Figure 1. Botanical composition (% of DM) of pasture on offer (P) and of diets selected by Merino sheep (S) and Angora goats (G) grazing annual pastures at Werribee: ▨ unidentified; ▩ green grass; □ green clover; ■ dead herbage.

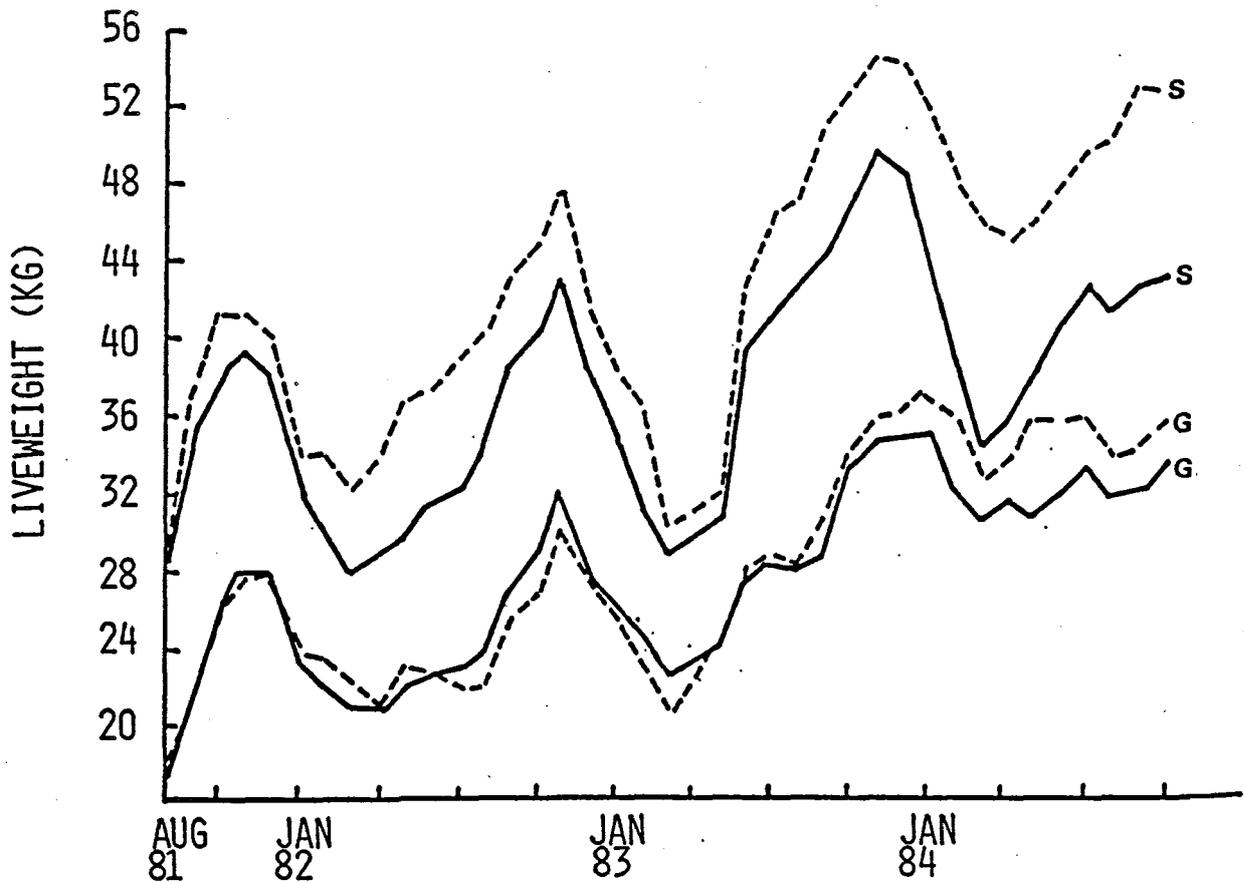


Figure 2. Fleece free liveweight of sheep (S) and Angora goats (G) when grazed alone (—) and when grazed together in equal numbers (mixed grazed) (----) at 10 animals/ha on annual pastures at Werribee.

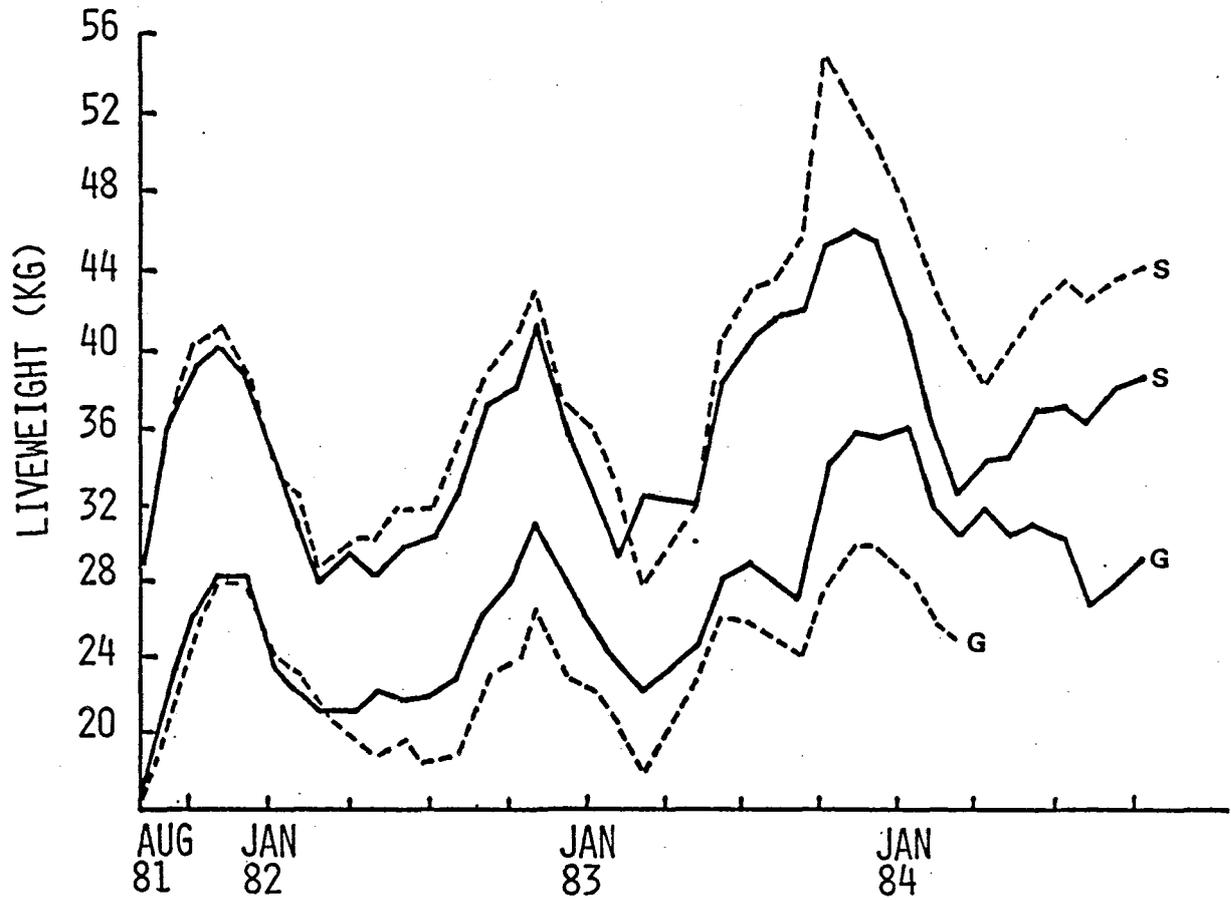


Figure 3. Seasonal variation in fleece free liveweight of sheep (S) and goats (G) when grazed alone (—) and when grazed together in equal numbers (mixed grazed) (----) at 12.5 animals/ha on annual pastures.