RECENT ADVANCES IN GOAT NUTRITION IN AUSTRALIA

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Summary

Feral goats in Australia are a new potential source of export earnings from meat and fibre (cashmere and mohair). The following paper reports some recent Australian research on the effects of doe nutrition on kid growth, milk production and skin follicle development in cashmere bearing goats. The potential for increasing post weaning growth and manipulating carcass composition is described in relation to nutritional treatment and daylength effects. The effects of daylength and improved nutrition on cashmere growthare presented, and some aspects of selective grazing and comparative productivity of sheep and goats at pasture have been discussed.

I. INTRODUCTION

Goats from Europe, Asia and Africa were probably first introducted to the north and west coasts of Australia by mariners in the 17th century and together with escapees from flocks established by English settlers in eastern Australia have spread throughout the continent to form a feral herd estimated to be between 1 to 3 million animals. The goat industry in Australia is small compared with other animal industries and until recently was concerned with milk production for local consumption and with Angora goats for mohair production. In the early seventies an export market for goat carcasses developed, and feral goats were trapped and still are being trapped in large numbers to supply this market. At the same time it was recognised that a significant number of our feral goats were growing cashmere (Smith et al. 1973). Since then an export market for cashmere has been developed and this potential new grazing industry has created a demand for management and nutritional information on goats raised for cashmere and meat in the Australian grazing environment.

Despite the lack of recommendations by the Agricultural Research Council (UK) the nutrient requirements of the milking goat have been comprehensively studied in Europe. The requirements of the Angora goat have been reported by workers in USA and South Africa and together with a large amount of fragmented knowledge from studies with different goat breeds in the tropics (Devendra and Burns 1983), the National Research Council (USA) has recently (1981) compiled a set of nutritional requirements for goats. There is presently no information available on the nutrient requirements of goats for cashmere growth nor is it clear whether the NRC recommendations are useful for feral goats of mixed breeding raised under Australian conditions. A collaborative research program between the University of Queensland and the Wollongbar Research Centre (NSW Department of Agriculture) was initiated in 1980 to study the biology of Australian goats bearing cashmere, and the following review presents some of the recent nutritional findings from these studies.

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II. NUTRITION OF THE DOE DURING PREGNANCY

Fertility

Mature feral does are fertile and fecund producing on average 150 - 180% kids per lifetime. Maiden does (18 months) seldom produce twins and it is not known whether early joining (8 months) affects the lifetime performance of a doe. There have been no studies yet of the effects of nutrition on fertility, but it is well known that they are seasonal breeders with low fertility in Spring. It is also known that ovulation in the doe can be induced by the presence of the buck (Restall, personal communication) and by improved nutritional conditions (e.g. after rain). Because there are a wide range of environments in Australia in which goats can be raised there is an urgent need to define more clearly the determinants of fertility in goats.

Kid birth weight and growth to weaning

A study of the effects of doe nutrition on kid growth has been conducted at Wollongbar Research Centre. Does were diagnosed as single or twin bearing at 60 days after conception by the use of ultra-sound scanning (Fowler and Wilkinson 1982), and groups of 32 does (one half twin-bearing) allocated to the following periods when pelleted rations were fed in pens: 60 - 90, 90 - 120, 120 - 150, 120 - 180 days post conception. A group of single and twin bearing does were maintained at pasture continuously as a control group and all does after their feeding period were returned to the same pastures. Within each feeding period, two diets (high and low protein content) were offered either ad libitum or at restricted levels (70% ad libitum). Since it is beyond the scope of the present review to present all treatment interactions only the main effects of feeding period on the birth weight and growth of kids to weaning are shown in Table 1,

Table 1. The effects of feeding period of does on kid weight at birth and subsequent growth to shearing

Feeding period (days post conception)	Age of kid (days)			
	Birth	57	107	301
	Liveweight (kg)			
Pasture only	2.78	8.74	11.95	15.60
60 to 90 days	2.89	9.82	13.48	17.85
60 to 120 days	2.49	7.03	9.84	13.61
120 to 150 days	3.23	10.88	15.36	19.18

Does fed the rations in the last month of pregnancy produced heavier kids at birth than any other does. The kids from these does were also significantly heavier than other kids at weaning (29%) and at shearing at 10 months (23%). Energy rather than protein intake was found to be the major determinant of this response. This study is continuing to determine whether these early effects on growth ultimately affect mature body weight and life time productivity. Since kinds born with birth weights less than 1.5 kg have low survivability, it is clear that the adequacy of doe nutrition in the last month of pregnancy should be a major priority in goat management programs.

The quantity and quality (protein) of feed available to does in the first month after kidding also significantly affects milk production and kid growth at this time but does not appear to affect the persistence of lactation (Norton et al. 1984). Feeding in the month prior to kidding does not affect the subsequent level of milk production. Does with twins did not produce significantly more milk than does with singles indicating that selective feeding of twin bearing does may result in higher growth rates and survivability of twins between birth and weaning.

Doe nutrition and skin follicle development in kids

In sheep, primary hair follicles in the skin are initiated between 60 and 90 days after conception, and secondary follicle development occurs between 90 and 150 days (Ryder and Stephenson 1968). The studies of Schinckel and Short (1961) demonstrated that both pre-natal and post-natal nutrition can severely retard follicle maturation, fibre production and fibre number in Merino sheep. In Angora goats Wentzel and Vosloo (1975) found that whilst secondary follicles are largely initiated by 120 days post conception, maturation (fibre bearing) was not complete until 4 months after birth. Preliminary results from a study of the effects of doe nutrition on follicle development in cashmere bearing goats have been reported by Lambert et al. (1984) and a summary of these findings is shown in Table 2.

Table 2. The changes of primary (P) follicle density (no./mm 2) , secondary (S) follicle density (no./mm 2), S/P ratios and liveweight (kg) of kids from birth to shearing (301 d)

	Age at sampling (days)			
	Birth	57	107	301
Liveweight	2.75	8.3	11.7	15.7
Primary follicles	14.9	7.1	3.9	2.7
Secondary follicles	11.2	28.4	26.5	15.8
S/P ratio	0.75	4.00	6.79	5.85

These results suggest that primary follicle development is largely complete by birth and that secondary follicle maturation (appearance of fibre) starts just before birth and is complete by three months of age. Although the interactions between sex, birth type, energy level, protein level, time of doe feeding and age of kid are still being analysed it would seem that moderate restrictions in either energy or protein intake of does during pregnancy did not have a major affect on the pattern or extent of follicle development in their kids, nor did birth type (twin or single) or sex appear to affect the final secondary follicle density. It is not known whether more severe restrictions of pre-natal and/or post-natal nutrition would affect follicle development in these kids.

NUTRITION AND POST WEANING GROWTH

Post-weaning growth

Weaning is a time of stress for the goat and it is essential that kids maintain good growth rates following weaning so that they may enter the breeding flock or reach a marketable slaughter weight at an early age. Increasing emphasis is being placed on goat meat and it appears likely that there will be a demand for kid carcasses of 10-12 kg (Holst et al. 1982). Post-weaning growth rates of kids are usually lower than those prior to weaning (Singh and Singh 1974) and this observation is confirmed by the results shown in Table 3 from kinds grazing improved pastures at two sites in a sub-tropical Australian environment (Mt. Cotton, S.E. Qld and Wollongbar, Nthn NSW).

Table 3. Growth rates of kids (g/day) grazing improved pastures at two sites in a sub-tropical environment (Ash, unpublished)

	Wollongbar*		Mt. Cotton*		Mt. Cotton°			
	F	M	F	M	F		M	
Birth-Weaning (Jan)	93	120	88	113	74		87	
Post-wean (Jan-Mar)	39	45	51	54	38		46	
					C	S	C	S
Mar-Jun	-32	-28	-15	-32	0	20	-5	12
Jun-Sep	42	137	33	67				
Sep-Dec	63	102	40	57				

*Mean of two years' kiddings from breeding flock
°Supplementation trial, C = control, S = supplement (60 g protein/d)

Growth rates to weaning were high but post-weaning growth was poor at both sites, particularly in the autumn, even though pasture quantity and quality appeared adequate. Supplementation with protein during autumn prevented weight loss but still did not permit any significant growth despite regular drenching for intestinal parasites and provision of cobalt.

However when fed high quality concentrate diets in pens (free of parasites) the growth rate of kids was improved and comparable with other breeds of goats (Table 4).

Digestive efficiency

Comparative digestion studies have generally shown that goats digest low quality roughage feeds better than sheep (Devendra 1978). Goats offered mature Pangola grass hay maintain higher rumen ammonia levels and have longer rumen fluid retention times than sheep given the same diet (Watson and Norton 1982). These results suggest that goats may have either higher rates of proteolysis or higher rates of urea recycling to the rumen than do sheep on low quality diets. On high quality roughage diets similar efficiencies of nutrient consumption and utilisation have been recorded between goats and sheep (Brown and Johnson 1984). However when fed concentrate (low roughage) diets sheep have been found to convert food to liveweight gain some 30 to 40% more efficiently than goats (Trockmorton et al. 1982, El Hag et al. 1984, Gallagher and Shelton 1972).

There is little information available in the literature for goats on the amounts of protein and organic matter absorbed from the small intestine. Table 5 shows some results collected in this laboratory using the pelleted diets reported in Table 4 and compars them with values recorded for sheep for both forages and other pelleted rations. When given low protein diets sheep and goats absorbed

Table 4. Dry matter intakes, growth rates and feed conversion efficiencies of goats fed ad lib concentrate rations

Goat	Sex	%Conc.	N%	Mean LW	DMI (g/d)	Growth (g/d)	FCR*	Source
Aust.	M	69	2.6	19.5	683	104	7.0	Ash and Norton (1984)
Cashmere	F	69	2.6	17.7	568	53	9.0	
Angora x	W	71	2.4	22.5	788	90	8.8	McGregor (1984)
Feral	F	71	2.4	21.1	703	40	17.6	
Angora	W	65	–	23.5	604	68	8.9	Throckmorton et al. (1982)
Damascus	M&F	90	2.3	23.9	913	147	6.2	Louca and Hancock (1977)
W.African Dwarf	M	90	2.9	14.6	593	87	6.8	Zemmelink et al. (1985)
Sudan Desert	M	65	2.4	32.0	947	87	11.0	El Hag et al. (1984)

*Food conversion ratio - g dry matter eaten/g gain

similar amounts of protein per unit digestible organic matter intake suggesting that the uptake of nutrients is very similar between goats and sheep. The high protein diet (43% cottonseed meal) fed to goats in our experiment was degraded in the rumen to such an extent that protein flows to the small intestine were in fact greater on the low protein diet. It is not known whether higher levels of protein/energy absorbed would increase the growth rates of goats. Evidence presently available suggests that goats and sheep digest and absorb protein and energy from concentrate rations with similar efficiencies and that the better feed conversion ratios observed with sheep on concentrate diets (El Hag et al. 1984; Throckmorton et al. 1982) may simply relate to the higher intakes of' feed consumed by sheep when compared with goats. Indeed when net feed conversion efficiencies were compared using intakes above maintenance there was no difference between sheep and goats.

Body composition

Most body composition studies have found goats to be leaner than sheep (Kirton 1970; McGregor 1982), however most of these results are based on goats grazing low to medium quality pastures. The composition of sheep can be affected by nutritional regime (Black 1974) with fatter carcasses being produced when high intakes of grain occur (Soeparno and Lloyd Davies 1982). Table 6 shows results of carcass composition for cashmere bearing goats fed the diets previously described in Tables 4 and 5 and compares them with New Zealand feral goats and 'bred' lambs at the same carcass weight.

Within our study females produced fatter carcasses than males and ad lib diets produced significantly more fat in the carcass than restricted feeding as has also been observed in cattle (Tudor and Utting 1978).

Table 5. A comparison between goats and sheep of organic matter and protein digested in the small intestine

Species	Diet	N%	OMD%a	OMIb	NAN/DOMIc	Source
Feral	Pelleted					
goat	10%CSM*, 59% sorghum	1.9	67.9	532	19.5	Ash (Unpubl)
	43%CSM, 26% sorghum	3.4	64.8	528	17.4	
Sheep	Pelleted					
	50% maize	1.9	67.9	1070	19.1	Weston (1971)
	45% maize, 10% FMT#	3.2	72.0	1074	36.6	
Sheep	Forage					
	Ryegrass	1.8	65.5	865	17.9	Egan (1974)
	Strawberry clover	5.1	75.0	1120	28.1	

a Organic matter digestibility
b Organic matter intake (g/day)
c Non-ammonia N absorbed/kg digestible organic matter intake
* Cotton Seed Meal
# Formaldehyde treated casein

Table 6. Carcass chemical composition of N.Z. feral goats, Australian cashmere goats and N.Z. lambs

Animal	Sex	Diet	Carcass wt (kg)	%Protein	%Fat	%Water	Source
Goats							
Aust.	M	Ad lib-conc.	11.6	17.5	15.0	61.3	Ash (unpub)
Cashmere	M	Restr.-conc.	10.6	17.8	11.9	65.4	
	F	Ad lib-conc.	11.1	16.5	24.2	55.8	
	F	Restr.-conc.	11.1	17.4	18.1	59.5	
N.Z.	M	Native past.	10	18.5	6.0	69.8	Kirton (1970)
Feral	F	Native past.	10	17.5	10.6	66.5	
Lambs							
Merino	W	Hill country	10	16.7	15.8	61.9	Kirton et al.
Corriedale	W	Hill country	10	15.4	18.8	60.4	(1974)
N.Z. Export	W	Rye/Lucerne	10	17.1	16.7	62.5	Jagusche et al. (1970)

Goats fed the pelleted diets produced carcasses with very similar composition to N.Z. wether lambs and with twice as much fat as the feral goats in Kirton's study. These results show that by nutritional manipulation goats can produce relatively fat carcasses at young age (1 year) and at low body weights (25 - 27 kg). It is not clear from market information whether these small fat carcasses would be more or less acceptable than the present lean carcass trade.

Seasonality of Growth

As reported earlier (Table 3) poor growth rates of grazing goats have been recorded in late summer and autumn following weaning, however growth was increased in July and August, a time of low and irregular rainfall and with pastures often at their lowest quality. In addition, in the pen studies of Ash (Table 4) which ran from April to October, it was noted that kids, particularly males, had depressed food intakes and growth rates between May and June, a time when grazing goats were losing weight. Morand-Fehr (1981) has also recorded a weight loss of male kids at this time and attributed it to a marked reduction in feed intake and not sexual activity associated with the breeding season.

Deer and unimproved Soay sheep exhibit a photoperiodic seasonal pattern of growth (Milne et al. 1978; Forbes 1982) and it seems possible that cashmere bearing goats, of feral origin and free of imposed selection for over 200 years, behave similarly. Table 7 shows some initial results from an experiment with weaner does and bucks which have been maintained on lucerne pellets (2.8%N) for an eight month period under either daylight or continuous light regimes. There was a clear depression in growth and intake in May-June with these effects being more marked in bucks than does. The light regime (continuous or normal daylength) did not affect growth rate or feed intake and it would seem that the response was not to photoperiod. However studies by McDonald (1985) have shown that cashmere growth, which is photoperiodic, was also not significantly affected by continuous light in the first six months of the cashmere growth cycle but thereafter differences in the cycle of cashmere growth were clearly being manifested. These studies will continue for a period of two years to determine whether the liveweight growth cycles have a similar pattern to the cashmere growth patterns in these goats.

Table 7. Effect of season and light regime on intake and growth rate of goats

Month	Light	Mean LW (kg)	Intake (g/kg/d)	Growth Rate (g/kg/d)	FCR
Jan-Feb	Cont.	17.5	47.7	3.9	12.1
	Day	17.5	49.4	3.8	13.1
Mar-Apr	Cont.	22.0	42.6	3.5	12.3
	Day	21.7	45.3	3.5	13.1
May-Jun	Cont.	25.7	35.6	1.9	19.1
	Day	25.5	37.6	1.9	20.0
Jul-Aug	Cont.	30.2	40.6	3.5	11.7
	Day	29.2	44.6	3.1	14.3

III. NUTRITION AND CASHMERE GROWTH

The cycle of cashmere growth in Australian goats has only recently been described (McDonald 1985). Under natural daylength cashmere growth in commences at the time of the summer solstice (December) and reaches maximum length between June and August. Fleece composition (cashmere: hair number) reaches a maximum between May and June. Does which have been pregnant in the previous year appear to reach maximum length growth and fleece composition about one month later than non pregnant does and male goats. There is presently some evidence that suggests that if late pregnancy and early lactation coincide with the cashmere growth period fleece production is significantly depressed, but these observations need further confirmation. Throughout this growth cycle fibre diameter varies between 15 and 16 microns and only increases significantly during the shedding phase indicating that the finest fibres are probably shed first. Hair appears to be continuously shed from the fleece. Under continuous light the growth and shedding patterns are condensed to more than two cycles per year.

These studies have important implications for the optimization of cashmere production from goats, firstly under normal daylight conditions shearing date must be at the time of maximum fleece composition and longest fibre length, secondly manipulation of the light regime can markedly increase annual yield of cashmere and thirdly any attempts to increase cashmere yield by nutrition must be carried out during the time of active fibre growth (December to May).

In sheep the provision of additional protein or sulphur amino acids for absorption at the intestines significantly increases wool growth (Reis 1979). Similar responses to additional protein have been reported in Angora goats growing mohair (Throckmortonet al. 1982). Since white cashmere currently sells for $110/kg, similar nutritional responses in cashmere growth would justify the feeding of additional protein. Ash and Norton (1984) fed weanling goats diets containing different protein contents and reported that total fibre growth increased as the level of protein in the diet increased. Johnson and Rowe (1984) have reported similar findings but could find no significant response in cashmere growth. We have since carried out many similar trials with grazing goats supplemented with a range of protected and unprotected protein sources and have been unable to demonstrate a significant response of cashmere growth to additional protein. Similarly trials with methionine supplements have also produced equivocal results. Table 8 shows results from an experiment where male and female weanling goats in pens were offered high quality (lucerne pellets) and low quality (Pangola grass hay) diets ad libitum from 10 December 1984 to 21 June 1985 (193 days).

Table 8. Cashmere, hair and liveweight growth in male and female goats given ad libitum intakes of high (lucerne pellets) and low (Pangola grass hay) quality diets between December and June

	Lucerne pellets		Pangola grass		+ SE
	Males	Females	Males	Females	mean
Initial Wt (kg)	16.0a*	13.0b	16.1a	13.0b	0.96
Final Wt (kg)	32.1a	22.3b	17.5c	14.7d	1.05
Feed Intake (g/kg LW)	46.2a	48.3a	28.3b	29.4b	0.20
Hair growth (g)	256a	127b	127b	84c	11.2
Cashmere growth (g)	35	27	47	37	4.4
Cashmere length (mm)	38	41	55	44	6.4
Cashmere diameter (μm)	15.6	15.0	15.0	14.8	0.3

*Values within a line with different subscripts differ significantly ($P < 0.05$)

Despite large differences in voluntary feed intakes and liveweight growth there were no significant effects of either diet or sex on the growth of cashmere, cashmere length or diameter. The nutritional regime did not affect either the length of the cashmere growth cycle or the patterns of fleece shedding. However hair growth was significantly greater in males than in females and in both sexes more growth occurred on the high quality diets. The goats used have not been selected for cashmere production and the responses obtained are those which might be expected from goats in our feral flock.

The refractory nature of the secondary cashmere follicle to nutrition needs further study. Because the goat only produces small amounts of cashmere (50 - 500 g) it is possible that the maximum protein requirements are met in all but the severest nutritional crisis. It may be calculated that less than 1% of dietary protein intake is required to grow a cashmere fleece whereas for sheep 6 - 9% of the dietary protein is converted to wool. Since cashmere growth cycles can be manipulated by changing daylength (McDonald 1985), the primary control of growth is probably hormonal rather than nutritional. There is an urgent need for study of the hormones responsible for the initiation of fibre growth in the telegenic follicle, for the control of fibre growth (diameter and length) during anagen and for the shedding of these fibres during catagen. There is presently no evidence that improved nutrition applied during the active phase of fibre growth will significantly increase cashmere production.

IV. NUTRITION OF THE GRAZING GOAT

Selective grazing

It is well known that goats will select a wider range of plants from their grazing environment than will sheep (Wilson et al. 1975) and therefore survive better than sheep under the same harsh conditions. The reputation of the goat for causing irrepairable damage to rangelands probably comes from the observation that they are the last animals to survive in an environment previously overgrazed by sheep and cattle. In pastoral areas where woody weed invasion is causing major losses of production, goats are now being recognised as an effective means of weed control (Mitchell 1985). Introduced woody weeds such as blackberries, briar and gorse are readily controlled by goats (Campbell et al. 1979) as are some native weeds Narrow-leaf Hopbush and Mulga regrowth. Wattle and eucalyptus regrowth as well as groundsel (Baccharis halimfolia) have also been effectively controlled by goats in coastal areas of Queensland (Norton and Deery 1985). Grass weeds like serrated and poa tussock and many different thistles (variegated, slender, black and saffron) are also readily eaten by goats.

McGregor (1985) has recently reported that Angora goats grazed on rye grass and subterranean clover pastures in a mediterranean environment preferentially consumed grass to clover. Where sheep and goats were grazed together the clover content of the pastures in November was higher (38%) than that of pastures grazed only by sheep (14%). Sheep grazed with goats (12.5/ha) produced more wool than sheep grazed alone. This aversion by goats for clover appears only to be restricted to the growing plants since dead clover and burr were readily consumed. New Zealand workers have found similar preferences for grass by goats grazing white clover pastures. Table 9 shows results from studies with oesophageally fistulated cattle, sheep and goats grazing tropical grass/legume pastures in different seasons (Kennedy 1982).

Table 9. The selective grazing by cattle, sheep and goats of two tropical grass pastures [Brachiaria decumbens (BD) and Paspalum plicatulum (PP)] containing tropical legumes

Species	Component	Summer		Autumn	
		BD	PP	BD	PP
Cattle	Grass	27*	71	40	35
	Legume	64	13	50	51
Sheep	Grass	79	82	66	66
	Legume	11	6	25	20
Goats	Grass	11	51	34	7
	Legume	80	37	58	78

*Percentage of diet selected

In this study a selection of different legumes were available from each pasture, ranging from prostrate species (Trifolium semipilosum) to twining types (Siratro). In summer, both cattle and goats selected legume in preference to Brachiaria (grass) but selected Paspalum (grass) in preference to legume. During autumn, cattle and goats again showed similar preferences, and selected legume rather than grass. Unlike sheep grazing clover pastures in other environments, sheep grazing these tropical pastures preferred grass to legume in both seasons irrespective of the grass species. Despite this preference of goats for tropical legume, at no time did they select Kenya White clover (Trifolium ssp). These results indicate that goats are more like cattle than sheep in their grazing preferences from tropical pastures and that when grazing together goats would compete with cattle for available pasture. Preference for particular grass and legume species also varies with season and further studies are needed in other environments to define the extent to which cattle, sheep and goats compete for plants in improved pastures.

Pastures and goat productivity

There is presently little information available for different Australian environments on pasture types, stocking rates or the productivity of goats at pasture. McGregor (1985) has reported some results from a grazing trial with Angora wethers and Merino sheep in southern Victoria and concluded that despite the fact that goats were lighter than sheep (16 vs 28 kg), goats should not be stocked at levels greater than those recommended for sheep on annual pastures. Where sheep were grazed with goats at low stocking rates (7.5/ha), wool production was increased above that when sheep were grazed alone, but at high stocking rates (12.5/ha) these complementary gains were lost because goats deteriorated in body condition and became more susceptible to environmental stress.

Table 10 shows results from an experiment where sheep and goats were grazed for 9 weeks at different stocking rates either together or separately on oats/rye grass pastures in southern Queensland (O'Grady 1982). These studies were conducted at a time (September-October) when goats had a high potential for growth (see Table 3). As total stocking rate increased liveweight gain per head in both sheep and goats decreased at a similar rate irrespective of whether the

Table 10. The effects of grazing sheep and goats together or alone on oats-rye grass pastures at three stocking rates

Stocking Rate No./ha	Sheep alone	Goats alone	Sheep with goats	Goats with sheep
Initial Wt (kg)	26.6	19.5	26.9	19.2
		Liveweight gain (g/d)		
20	158	111	161	100
40	136	85	125	85
60	112	65	109	61
Mean Wt Gain (g/d)	135	87	132	82
Wt Gain/Kg LW/d	4.4	4.0	4.3	3.8

the species were grazed alone or together. The sheep used were initially heavier than the goats and grew faster (g/d) than goats at all stocking rates. However when weight differences were removed, sheep appeared to be only marginally superior (10713%) in growth to these unselected goats. Goats had a higher preference for green leaf than for green stem when compared with sheep. Goats also had higher parasite burdens than sheep when grazed alone or together with sheep. These studies support the conclusions of McGregor (1985) that despite a 36% difference in liveweight, the stocking rates appropriate for maximum gain of sheep and goats on the same pasture were similar. It is clear from these observations that the production of meat and fibre from goats in Australia may not only be a viable alternative for grazing enterprises seeking new markets, but goats may also contribute to the productivity of traditional grazing systems by controlling weed growth and renovating improved pastures overgrazed by sheep.

V. CONCLUSIONS

The Australian feral goat herd represents an international gene pool of goats that have survived in our harsh environment for at least 200 years. There is presently an export demand for both goat meat and fibre and Australian scientists and producers face the exciting prospect of being able to select from this population goats with the desirable production traits and adapted to a range of Australian environments. This is the beginning of a new grazing industry for Australia. In this review particular attention has been paid to developments in our understanding of the biology of cashmere growth and to the potential of these feral goats to grow under improved management conditions. By the application of our present knowledge of ruminant physiology, biochemistry and nutrition and from our understanding of grazing management systems in different environments, information on the limitations and potential for goat production in Australia are being rapidly accumulated. Goats have previously been maligned as the final destructor of the ecology of grazing systems, and yet it is man who is ultimately responsible for this catastrophe. We have proposed in this review that by appropriate management this 'pariah' of the grazing community, the goat, can be managed not only for economic gain but also for the preservation of an environment conducive to long term production. At this time when Bill McClymonts contribution to animal production in Australia is being honoured, it is relevant to comment that it only by our understanding of how the unmanaged goat affects the ecology of our rangelands that we have been able to design management systems which will minimize the detrimental effects and maximize the beneficial effects of these animals in our productive grazing systems.

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