DEVELOPMENT OF SPECIAL PURPOSE FORAGE SYSTEMS FOR DEER PRODUCTION

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INTRODUCTION

Research at the Massey University Deer Unit since 1987 has concentrated on factors governing the efficiency of venison production from grazed forages Two major factors are involved in developing efficient systems of venison production. These are firstly, factors governing the growth of young deer and secondly marketing considerations.

Growth of young red deer is known to be highly seasonal (Barry *et al* 1991), with maximum growth and voluntary feed intake occurring in summer and minimum voluntary feed intake and growth occurring in winter. This system is driven by changes in photoperiod, and the rhythms in growth and voluntary feed intake are entrained to photoperiod by the hormone melatonin. All attempts to manipulate growth through improved feeding occur against this background of seasonal growth, which can be modified, but not eliminated by feeding

Although the New Zealand deer industry is seeking to promote a year-round consumption and supply of venison, in recent years there has been a strong seasonal demand from Northern Hemisphere markets for venison in the August to November period, leading to high export schedules in this period This has been reviewed by Wilson *et al* (1991), who showed that most efficient venison production occurs if young deer can attain a liveweight of 92 kg (50 kg carcass) by less than 12 months of age, with a slaughter date before the end of November These authors reviewed Massey University work during 1989 and 1990, and the present review will summarise results from 1991 to 1993

PASTURE HEIGHT AND MASS

Earlier work conducted in 1988 showed that venison production from young red deer, with slaughter at one year of age, was very sensitive to the height of perennial ryegrass/white clover pasture (hence referred to as pasture) being grazed (Ataja *et al.* 1992). Some 42% of young red deer stags grazing pasture which did not fall below 10 cm height during winter and spring attained 92 kg liveweight (50 kg carcass) by 12 months (30 November), whereas no similar stags grazing at 5 cm pasture height over the same time period achieved those weights Pastures of 10 cm surface height correspond to approximately 1500-2000 kg DM mass/ha, and under deer production the diet selected contains approximately 25-44 g N/kg DM, with an organic matter digestibility of 72-79% (10.5-11 6 MJ ME/kg DM) Since this time all our pastures have been managed to keep them in similar state to 10 cm pasture, including all the control pastures described in this review, either under continuous stocking management or as post-grazing residues under rotational grazing Although the term allowance (kg DM offered/deer/day) is used in this paper, different allowances were selected for each experiment such that the pasture grazed was of approximately 10 cm surface height.

LACTATION

Growth of red deer fawns and hinds when grazing perennial ryegrass/white clover pasture, red clover and chicory during the summer of 1991 is shown in Table 1 Relative to pasture, grazing on red clover or chicory increased fawn growth by approximately 50-80 g per day (15-24%), and increased weaning weight at the end of February by 3-4 kg Grazing on red clover also increased hind liveweight change Factors contributing to this increased response from red clover and chicory include a higher nitrogen content and higher organic matter digestibility in the diet selected Voluntary feed intake of the hinds was much greater on red clover than on pasture; to date we do not have voluntary food intake for hinds grazing chicory

Table 1 Diet composition, calf growth and hind liveweight change for red deer grazing on perennial ryegrass/white clover pasture, red clover and chicory during the summer lactation of 1991

	Pasture	Red clover	Chicory	SEM
Diet selected:				
Total N (% OM)	3.79	4 47	3.55	0.18
Organic matter digestibility (%)	78 2	80 4	84.8	0.63
ME (MJ/kg OM)	12 8	13.1	13.8	0.14
Deer performance·				
Calf weight change (g/d)	331	410	385	12 0
Calf weaning weight (kg)	46.7	50 5	49.3	0.59
Hind weight change (g/d)	27.2	69 6	6.7	13.17
Stocking rate (hind + fawn/ha)	6 0	7 0	8.6	

Niezen *et al.* (1993).

DM allowance was 12 kg/hind + fawn/day on all treatments.
Experiment commenced 7 January and concluded 25 February.

POST-WEANING GROWTH

The effects of red clover feeding upon the diet selected and growth of weaner deer during the autumn, winter and spring of 1991 is shown in Tables 2, 3 and 4. Because red clover is dormant during winter, both animal groups were joined and grazed on pasture over this period. The herbage allowances offered (Table 2) resulted in residual post-grazing dry matter mass of generally not less that 1200 kg DM/ha Both feed on offer and diet selected was generally higher in both total N and organic matter digestibility for red clover compared to pasture (Table 3).

Table 2 Pre- and post-grazing herbage mass (kg DM/ha ± SE) of red clover (RC) and perennial ryegrass/white clover (PRG/WC) forages grazed by weaner red deer (*Cervus elaphus*) during autumn, winter and spring of 1991.

	PRG/WC				RC			
	Pre-grazing		Post-grazing		Pre-grazing		Post-grazing	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Autumn	3706	219.7	1886	256 6	3569	215.1	1823	132 1
Winter[1]	1736	83 1	1170	41.4				
Spring	2150	63.9	1335	21 8	2726	43 2	1705	41.4

Soetrisno *et al* (1993) Experiment commenced on 13 March and concluded on 26 November.
DM allowance was 6 kg/head during autumn and 7 kg/head during spring
[1] Both groups joined and grazed on PRG/WC pasture during winter, when RC wss dormant.

Table 3. Nutritive value of feed on offer and diet selected for weaner red deer (*Cervus elaphus*) grazing either red clover (RC) or perennial ryegrass (PRG/WC) forages during autumn, winter and spring of 1991.

	Total Nitrogen (N, % DM)		Organic matter digestibility (OMD; %OM)	
	RC	**PRG/WC**	**RC**	**PRG/WC**
		Feed on offer		
AUTUMN	3.4	3 4	77 3	78.6
(SE)	(0 14)	(0.17)	(0 72)	(0.88)
WINTER	.	3 9	...	76.9
(SE)		(0.09)		(0 61)
SPRING	4.1	2.6	84 5	80.3
(SE)	(0 14)	(0.17)	(0.72)	(0.88)
		Diet selected		
AUTUMN	4.2	3 9	84.2	83.2
(SE)	(0.14)	(0 15)	(0 75)	(0.85)
WINTER		4 3	.. .	79.7
(SE)		(0 09)		(0 61)
SPRING	4.7	3 3	87.7	82 4
(SE)	(0.14)	(0.17)	(0.75)	(0 92)

Soetrisno *et al.* (1993)

Table 4 Liveweight gain (g/day ± SE) of weaner red deer (*Cervus elaphus*) grazing either red clover (RC) or perennial ryegrass/white clover (PRG/WC) pasture, during autumn, winter and spring of 1991.

Liveweight gain (g/day)	**STAGS**		**HINDS**		**SE**
	PRG/WC	RC	PRG/WC	RC	
Autumn	207	237	159	197	13 7
Winter[1]	95	94	40	38	8 5
Spring	281	346	188	260	13.2

Soetrisno *et al.* (1993).
[1] Both groups joined and grazed on PRG/WC pasture during winter, when RC was dormant.

Relative to pasture, feeding on red clover resulted in increased growth during both autumn and spring (Table 4) Table 5 shows that feeding upon red clover resulted in substantial increases in carcass weight, in both the 1990 and 1991 experiments This was achieved without any increase in carcass fatness, as indicated by the GR measurements when corrected to equal carcass weight, and resulted in all animals attaining target slaughter weight by 12 months

Another interesting result is that the proportion of animals attaining the desired slaughter weight from pasture progressively increased from 41% in 1989 to 90% in 1991, due to improved management. A contributing reason is that controlled grazing, with high pasture allowance, was conducted over winter and spring in 1989, but in 1990 and 1991 this was extended to include autumn, winter and spring

Table 5. Liveweight gain, total animals attaining target slaughter weight (92 kg by 30 Nov), and carcass production from red deer (*Cervus elaphus*) stags at the Massey University Deer Unit during 1989, 1990 and 1991. (RC, red clover; PRG/WC, perennial ryegrass/white clover pasture)

	STAGS		HINDS	
	RC	**PRG/WC**	**RC**	**PRG/WC**
Liveweight gain (g/day):				
AUTUMN 1990	263	197	200	173
AUTUMN 1991	237	207	197	159
WINTER 1989[1)]	-	140 (165)[4]	-	-
WINTER 1990[2)]	103	110	55	54
WINTER 1991[3)]	94	95	38	40
SPRING 1989	-	226 (235)[4]	-	-
SPRING 1990	366	343	238	218
SPRING 1991	346	281	260	188
Liveweight and slaughter criteria:				
Animals over 92 kg by 30 Nov (%)				
1989	-	41 (60)[4]		
1990	100	75		
1991	100	90		
Mean liveweight (kg) by 30 November				
1990	108	101	87	84
1991	105	99	83	77
Carcass production:				
Carcass weight (kg)				
1990	59 9	54 5		
1991	58 9	53 3		
Dressing out (%)				
1989	-	52 6 (53 8)[4)]		
1990	55 4	53 0		
1991	56 2	52 4		
GR (mm)				
1989	-	2 9 (3 6)[4)]		
1990	9 2 (8 6)[5]	6 3 (7 7)		
1991	6 4 (5 7)	4 9 (5 7)		

[1)] Ataja *et al.* (1992)
[2)] Semiadi *et al.* (1993)
[3)] Soetrisno *et al* (1993)
[4)] Annual ryegrass pastures.
[5)] After adjustment to equal carcass weight

During the autumn of 1993, we have been comparing the growth of weaner deer grazing either pasture or chicory (Table 6) In this case half the animals grazing each forage were pure red deer, whilst half were 0.25 elk; 0.75 red deer hybrids. In all cases, superior growth was obtained on chicory, but the biggest response was for hybrid males grazing chicory This probably indicates that the superior growth potential of the hybrid males can best be expressed when fed a high quality diet. Animals grazing chicory spent less time eating and much less time ruminating, than comparable deer grazing pasture The low ruminating times indicate that once chicory has been ingested, it may disintegrate very rapidly in the rumen. At the time of writing (June) these two animal groups have now been joined for winter, and will be split up again into the chicory and pasture groups in early September, when the measurements shown in Table 6 will be repeated.

Table 6. Growth of weaner red deer and weaner elk:red deer hybrids grazing pasture and chicory during autumn 1993.

Genotype		Number	Liveweight		Growth rate (g/day)	Eating time (hr)	Ruminating time (hr)
			1 March 1993	8 June 1993			
			Pasture				
Red	Male	6	52 0	68 4	179	10 8	3 4
	Female	6	45 2	60 8	158	11 0	3 6
Hybrid[1]	Male	8	47 5	67 6	203	10 7	3 3
	Female	4	49 3	65 5	164	11 2	3 6
			Chicory				
Red	Male	6	50 0	74 4	247	8 4	1 7
	Female	5	44 4	63 5	193	8 7	1 4
Hybrid[1]	Male	8	47 4	78 8	317	8 5	1 4
	Female	4	49 0	70 8	220	8 7	2 0

[1] 0.25 elk 0 75 red.
DM allowance was 6kg/head daily on both treatments.

PHYSIOLOGY OF DIGESTION

In addition to grazing experiments, we have also been conducting nutritional physiology research with castrate hand-reared male deer fed individually indoors in metabolism cages especially constructed for deer. These deer are also fistulated in the rumen, allowing us to make measurements of rumen metabolism.

One of our most interesting results has been to compare the rumen fractional outflow rate (FOR) of deer, goats and sheep fed the same diet. FOR measures the speed with which digesta leaves the rumen and flows into the intestines It is expressed as a percentage of the total quantity of material in the rumen that leaves per hour, and is usually measured separately for the liquid and particulate (ie solid) material in the rumen Table 7 shows that FOR of liquid from the rumen was approximately 60% greater for deer than for goats and sheep, and that this difference was present during both the summer and winter seasons As well as being scientifically interesting, this observation probably has great relevance to the aetiology of rumen frothy bloat Bloat is caused by a build-up of soluble protein in the rumen, developing into a stable foam Red clover is normally a very bad feed for causing bloat, but in three years of feeding red deer on red clover at Massey University, we have never encountered a single case of bloat. The most probable reason is that the liquid phase (containing the soluble protein) leaves the rumen so fast that there is not time for a stable foam to develop

Table 7 Rumen fractional outflow rate (%/hr) of liquid and particulate (solid) matter in red deer, goats and sheep fed lucerne chaff during summer (S) and winter (W).

Fractional outflow rate		Deer	Goats	Sheep	SEM
Liquid	S	15 8	10.8	10 4	0 54
	W	16 3	9 6	10.3	0 56
Particulate (ie solid) matter	S	2.8	3 7	3 3	0.16
	W	3.5	3 5	3.3	0.14

Domingue *et al.* (1991).

Another interesting observation is that FOR of particulate matter slows down from winter to summer in red deer, whereas there is no change with season in goats and sheep This probably indicates a seasonal cycle of digestion in deer, just the same as there is a seasonal cycle in voluntary feed intake It means that rumen retention time (1/FOR) is longer in deer in summer than in winter, thus allowing more time for rumen microbial fermentation in summer, and explaining why digestibility in deer does not decline during summer when voluntary feed intake increases.

DISCUSSION AND CONCLUSIONS

These studies have shown that early venison production by 12 months of age from grazed forages to meet specifications to achieve premium prices is possible with red deer. By grazing pastures to no less than 10 cm surface height, with residual dry matter generally around 1500 DM/ha, it is consistently possible to get about 75% of young stags to attain this target slaughter criteria, provided pastures are grazed at this level during autumn, winter and spring. An input of crops, such as red clover or chicory, has the potential to increase this to 100%. A critical factor in the profitability of these crops for deer production will be the length of time that a stand will last (ie persistency) Under our deer management, with no grazing during winter, a stand of red clover will last for three years. We do not have comparable information with chicory at this stage, but realise that persistency could be a problem with this crop, particularly in wet conditions In addition to animal measurements, our current measurements with chicory include persistency.

The very big responses to chicory in hybrid male deer could have significance for industry slaughter policy. This could mean that it may be possible to consistently attain carcass weights well in excess of 50 kg by one year of age, or alternatively provide the farmer with the flexibility to produce carcasses of 50 kg weight by well under one year of age.

Our plans are to continue studies on efficiency of particle breakdown in the rumen of deer consuming chicory. With its very low ruminating time, it may be that chicory disintegrates extremely rapidly in the rumen, and may be efficiently utilised by high producing deer.

Thus, these grazing trials, backed up by studies of the physiology of digestion of various feedstuffs in deer, have given a clear signal to the industry about the management and feeding of young deer if the industry is to achieve maximum productive efficiency.

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