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A review of forage grazing systems to produce venison according to market signals

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ABSTRACT

Grazing systems are described for producing venison carcasses weighing 50-65 kg (92-120 kg liveweight) in the spring by one ear of age (30 November), using red and hybrid (0.25 elk: 0.75 red) deer stags. Grazing perennial ryegrass/white clover pasture at 10cm surface height during autumn, winter and spring resulted in 73% of young stags attaining the desired slaughter target, but variation between years was large (range 25-100%), with a contributing cause being variation between years in winter growth rate. When red clover and chicory were grazed during autumn and spring, with pasture grazing during winter, the proportion of young stags attaining the desired slaughter target was consistently increased to 90-100% and mean carcass weights were increased by 11 & 17% respectively. Largest responses in deer growth to red clover (26%) and chicory (47%) over perennial ryegrass – based pastures were seen during autumn. Both voluntary feed intake (VFI) and digestibility of the diet selected were higher for deer grazing chicory and red clover than perennial ryegrass-based pasture, with the largest effects seen during summer and autumn, when perennial ryegrass was of lowest nutritive value. In indoor studies, both the rates of ruminal degradation and outflow of chicory were greater than for perennial ryegrass, with similar results found for red clover. It was concluded that the faster breakdown and clearance of red clover and chicory from the rumen than perennial ryegrass explained their higher digestibility and VFI by grazing deer. Management of red clover and chicory to increase persistence on commercial deer farms and grazing systems to support year round supply of venison in a branded market strategy are also discussed. For successful venison production by 12 months of age, target growth rates during winter of 100g/day for red deer and 150g/day for hybrids are suggested.

Keywords: Grazing systems, Deer, Forages, Nutritive Value

INTRODUCTION

The farmed deer population in New Zealand (NZ) has now risen to 1.8 million animals, with the number of deer estimated to be slaughtered in 1999 being 0.45 million (Game Industry Board (GIB) personal communication). Like sheep and cattle production, farmed deer production in NZ occurs largely from the 12 month grazing of perennial ryegrass (0.80): white clover (0.20) pastures, supplemented with hay, silage and cereal grains at times of low pasture availability and/or low pasture nutritive value (Barry & Wilson 1994).

There are three major market signals for venison production in NZ. The first is higher prices/kg for carcasses in the range 50-65 kg (92-120 kg liveweight), the second is an additional premium if these can be produced in the spring months (Aug-Nov) and the third is a price penalty for over fatness, often associated with heavier carcasses. The first premium is to attract carcasses of preferred size for the restaurant trade, whilst the second is to attract carcasses for the seasonal N. Hemisphere chilled venison market, which is mainly for Europe and is dominated by Germany. The third signal is to encourage production of tender low fat venison, to enhance the perception of venison as a healthy red meat. Some 98% of NZ farm produced venison is exported. It is most economic if carcasses to these specifications can be produced by one year of age. The objective of this paper is to review the development of grazing systems to produce carcasses to meet the above criteria. In all experiments one year of age was defined by slaughter on 30 November or shortly thereafter.

GRASS-BASED PASTURES

Early research developed grazing systems based on perennial ryegrass/white clover and annual ryegrass/white clover pastures (Ataja *et al.,* 1992; Table 1) and showed lower growth rates in set stocked young red deer grazed at 5cm than 10cm surface heights. However, even when grazing 10cm grass-based pastures during winter and spring, only 42-50% of young stags attained the desired slaughter criteria. A follow up investigation using rotational grazing (initial height 10cm; final height 8cm) produced similar results, with 41 and 60% of young red stags grazing perennial ryegrass/white clover and annual ryegrass/white clover pastures during winter and spring attaining 92 kg liveweight by 12 months of age (Ataja *et al.,* 1992). This compares with 0 – 42% (mean 8%) of young stags attaining the same criteria on commercial deer farms (Audige' 1995). Hamilton *et al.,* (1995) obtained similar results in the UK with weaned red deer grazing N fertilised grass-based pastures during spring; growth rates were lowest at 4 cm surface height, maximal at 8-10 cm and intermediate at 6 cm.

Based upon the above results, it was evident that inputs of higher nutritive value forages were needed if most stags were to attain 92 kg liveweight (50 kg carcass) by one year of age.

Table 1: Growth of young red deer during their first winter (W) and spring (S) when grazing ryegrass-based pastures maintained at 5 and 10 cm sward surface heights

		10 cm		5 cm		SEM
Ryegrass		Perennial	Annual	Perennial	Annual	
Herbage Mass	W	1840	1694	1236	1148	
(kg DM/ha)	S	2251	2022	1731	1690	
LWG (g/d)	W	153	131	74	79	9.0
	S	234	209	147	211	10.1
Stags attaining 92 kg LW (%)		42	50	0	21	

From Ataja *et al*., 1992. Initial liveweight was 59.4 kg.

RED CLOVER AND CHICORY AS SPECIALIST FORAGES FOR VENISON PRODUCTION

Red clover and chicory were selected for evaluation with deer because both have good summer/autumn growth and therefore better match the feed requirements of deer than do perennial ryegrass/white clover pastures, both have deep tap roots to resist summer drought and both are of high nutritive value and are highly preferred by deer (Hunt & Hay (1990). In the experiments reviewed here, deer grazing these forages were compared with similar deer grazing perennial ryegrass/white clover pasture, when both were grazed under optimum conditions as described below. Rotational grazing was used in all instances, with rotation length being 3-5 weeks.

Deer were offered all three forages at the same DM allowance/animal in each season. These corresponded to mean pre- and post- grazing forage masses of 3,500 & 2,100 kg DM/ha for chicory and 2655 and 1770 kg DM/ha for perennial ryegrass/white clover pasture. This corresponded to red clover and chicory being grazed from an initial height of approx. 30 cm to a final height of approx. 10 cm, with the corresponding values for perennial ryegrass/white clover pasture being 10 cm and 8cm. Further details of forage management are given by Barry (1998) and Barry *et al.,* (1998).

The experiments were divided into a lactation phase (January & February) and a post weaning to slaughter phase (early March to 30 November of the same year). Because red clover and chicory are dormant during winter, animals allocated to these were grazed on pasture during winter. Red deer and hybrid (0.25 elk : 0.75 red) deer were used as specified in each experiment. All were regularly drenched with anthelmintic from weaning (end Fed) to the end of winter.

During lactation, growth of deer calves grazing perennial ryegrass/white clover pasture was 331-399g/d (Table 2). Grazing red clover, chicory or *Lotus corniculatus* further increased calf growth by approx. 20%, with the response being similar for all forages.

From weaning to slaughter, growth of young deer grazing perennial ryegrass/white clover pasture was approx. 200g/day during autumn and 300 g/day during spring (Tables 3&4). Grazing red clover increased growth by an average of 26% during autumn and 14% during spring. Corresponding increases for chicory were 47% in autumn and

TABLE 2: Growth of deer calves during lactation (g/day) in summer (January & February). Values in brackets are % increase relative to grazing perennial ryegrass/white clover pasture.

Author	Initial Liveweight (kg)	Perennial ryegrass/ white clover pasture	Red Clover	Chicory	*Lotus corni-culatus*	SEM
Niezen *et al*.,	23.5	333	433 (30)			15.1
(1993)[1]	30.4	331	410 (24)	385 (16)		12.0
Kusmartono *et al*., (1996)[2]	31.0	351		404 (16)		18.0
Adu *et al*., (1997)[2]	28.3	399			485 (22)	12.1
Mean % increase			(27)	(16)	(22)	

[1]Calves all red deer.
[2]Half calves were red deer & half were 0.25 elk : 0.75 red deer hybrid.

TABLE 3: Growth of red stags (g/d) from weaning to one year of age on red clover, compared with perennial ryegrass/white clover pasture. Values in brackets are % increases relative to grazing perennial ryegrass/ white clover pasture.

Author	Initial Liveweight (kg)	Perennial ryegrass/ white clover pasture	Red Clover	SEM
			AUTUMN	
Semiadi *et al*., (1993)	48	192	263 (37)	11.8
Soetrisno *et al*., (1994)	54	207	237 (14)	13.7
Mean % increase			(26)	
			WINTER[1]	
Semiadi *et al*., (1993)		106	101	6.7
Soetrisno *et al*., (1994)		95	94	8.5
			SPRING	
Semiadi *et al*., (1993)		341	354 (4)	16.8
Soetrisno *et al*., (1994)		281	346 (23)	13.2
Mean % increase			(14)	

[1] all animals joined together and grazed on perennial ryegrass/white clover pasture during winter.

Table 4: Growth of weaner red (R) and hybrid (H) stags (g/d) to one year of age on chicory, compared with perennial ryegrass/white clover pasture. Values in brackets are % increases relative to grazing perennial ryegrass/white clover pasture.

Author	Perennial ryegrass/ white clover pasture		Chicory		SEM
	R	H	R	H	
			AUTUMN		
Kusmartono *et al*., (1996)[1]	178	203	246 (38)	318 (57)	17.2
Min *et al*., (1997)[2]	152	199	235 (55)	271 (36)	11.4
Mean % increase			(47)		
			WINTER[3]		
Kusmartono *et al*., (1996)	171	146	127	193	13.6
Min *et al*., (1997)	72	89	53	86	12.2
			SPRING		
Kusmartono *et al*., (1996)	260	271	255 (-2)	310 (14)	21.1
Min *et al*., (1997)	285	298	335 (18)	331 (11)	18.6
Mean % increase			(10)		

[1] Initial liveweight 50.4 and 47.4 kg for red and hybrid stags respectively.
[2] Initial liveweight 45.7 and 51.1 kg for red and hybrid stags respectively.
[3]All groups joined together and grazed on perennial ryegrass/white clover pasture during winter.

Table 5: Percentage of red (R) and hybrid (H) stags reaching 92 kg liveweight (50 kg carcass) by one year of age when grazing red clover, chicory or perennial ryegrass/white clover pasture.

Author	Perennial ryegrass/ white clover pasture		Red Clover	Chicory	
	R		R		
Semiadi *et al*., (1993)	75		100		
Soetrisno *et al*., (1994)	90		100		
	R	H		R	H
Kusmartono *et al*., (1996)	100	88		100	100
Min *et al*., (1997)	25	75		80	80
Mean Values	73	82	100	90	90

10% in spring (Table 4). During winter, when the groups were joined and grazed on pasture, average growth rate over the four experiments was 110g/day, but this varied from a minimum of 75g/day in one year to a maximum of 160g/day in another year.

The proportion of young red stags grazing perennial ryegrass/white clover pasture which reached 92 kg liveweight (50 kg carcass) by one year of age averaged 73%, but showed great variation between years (Table 5). One of the main causes of this variation was low winter animal growth rates in some years, associated with long periods of wet weather. When red clover or chicory were grazed this was consistently increased to 90-100%, with little variation between years. Relative to deer grazing perennial ryegrass/white clover pastures, grazing red clover increased carcass weight by an average of 11% whilst grazing chicory increased carcass weight by 17%.

Carcass weight responses were particularly high for hybrid stags grazing chicory. Grazing red clover or chicory did not affect carcass fatness, as measured indirectly by GR.

TABLE 6: Carcass weight (kg) of red (R) and hybrid (H) stags at one year of age from grazing red clover, chicory or perennial ryegrass/white clover pasture. Values in brackets are % increases relative to grazing perennial ryegrass/white clover pasture.

Author	Perennial ryegrass/ white clover pasture		Red Clover	Chicory	
	R		R		
Semiadi *et al*., (1993)	54.5		59.9 (10)		
Soetrisno *et al*., (1994)	53.3		58.9 (11)		
	R	H		R	H
Kusmartono *et al*., (1996)	56.6	57.0		63.2 (12)	73.0 (28)
Min *et al*., (1997)	48.6	53.3		56.0 (15)	59.3 (12)
Mean % increase			(11)	(17)	

NUTRITIONAL REASONS FOR DIFFERENCES BETWEEN FORAGES

The chemical composition of vegetative perennial ryegrass, red clover and chicory is shown in Table 7. Chicory contains a higher concentration of ash than either perennial ryegrass or red clover. Relative to perennial ryegrass, both red clover and chicory contain higher concentrations of readily fermentable carbohydrate (soluble sugars and pectin) and lower concentrations of structural carbohydrate (cellulose and hemicellulose). Hence the ratio readily fermentable carbohydrate: structural carbohydrate is higher for red clover and chicory than for perennial ryegrass. The consequences of this are that both rate of ruminal particle breakdown and rate of rumen outflow are faster for chicory than for perennial ryegrass (Table 8), whilst ruminating time is much lower for chicory. As a result of this, both apparent digestibility (Table 8) and metabolisable energy (ME) concentration (Table 7) are considerably greater for chicory than for perennial ryegrass. The higher ash content of chicory probably also contributes to the very high fractional outflow rate (FOR) of rumen liquid in deer fed this forage. Similar measurements of digestion kinetics show that red clover is also broken down faster in the rumen than perennial ryegrass (Freudenberger *et al.,* 1994).

In grazing studies, both voluntary feed intake (VFI) and apparent digestibility of the diet selected have been consistently higher for young deer grazing red clover and chicory than for deer grazing perennial ryegrass/white clover pasture (Semiadi *et al.,* 1993; Soetrisno *et al.,* 1994; Kusmartono *et al.,* 1996; Min *et al.,* 1997). These differences have generally been largest at the time when the nutritive value of perennial ryegrass/white clover pasture is lowest (summer) and least when the nutritive value of pasture is highest (spring).

Kusmartono *et al.,* (1996) found that VFI of deer grazing chicory was 55%, 25% and 15% greater than that of deer grazing pasture during summer, autumn and spring respectively. These increases in VFI and apparent digestibility can be explained by the faster clearance of red clover and chicory from the rumen (Table 8).

TABLE 7: The chemical composition (g/kg DM) of vegetative perennial ryegrass, red clover and chicory.

	Perennial ryegrass	Red Clover	Chicory
Ash	105	104	149
Total N	45.2	46.9	19.7
Soluble sugar (a)	74	95	111
Pectin (a)	10	39	98
Cellulose (b)	184	115	104
Hemicellulose (b)	212	54	44
Ratio (a:b)	0.21	0.79	1.41
Lignin	10	12	20
Metabolizable energy (MJ/kg OM)	12.3	13.4	13.7

From Jackson *et al.,* (1996), Scales *et al.,* (1995).

CONCLUSIONS

By increasing grazing height of perennial ryegrass/white clover pasture to 10 cm, during autumn, winter and spring, these experiments have shown that the growth of young deer can be increased, such that an average of 73% of animals reach the target of liveweight of 92 kg (50 kg carcass) by one year of age. This is a considerable improvement over the figure of 42% found in the best commercial farms recorded by Audige' (1995). However the mean percentage varied between years (range 25-100%) in the Massey University studies and one of the causes identi

Table 8: Kinetics of feed breakdown and outflow from the rumen in red deer fed chicory and perennial ryegrass under indoor conditions.

	Perennial ryegrass	Chicory	SE
Composition:			
Dry matter (g/kg)	247	161	
Total N (g/kg DM)	30.4	26.9	
Ash (g/kg DM)	102	180	
Apparent digestibility			
Organic matter	0.744	0.820	0.0311
NDF	0.755	0.679	0.0231
Rumen pH	6.44	5.63	
Particle breakdown efficiency			
Eating[1]	0.37	0.27	0.038
Ruminating[2]	0.47	0.65	0.038
Chewing time (min/24 h):			
Eating	221	209	49.2
Ruminating	257	30	54.6
Rumen fractional outflow rate (%/h)			
Liquid	13.6	18.9	2.18
Particulate (Lignin)	2.78	4.08	0.551
Particulate (ADF)	2.02	4.30	0.506
Rumen mean retention time (h)			
Liquid	8.9	6.4	0.01
Particulate (Lignin)	49.0	37.7	9.61
Particulate (ADF)	52.5	27.9	4.66

From Dryden *et al*., (1995); Kusmartono *et al*., (1996a, 1996b, 1997).
[1]Efficiency of chewing during eating in breaking down particles to the critical particle size (1mm) to allow passage from the rumen of red deer.
[2] Efficiency of the rumination process in breaking down particles to the critical particle size (1mm or less) to allow passage from the rumen of red deer.

fied was variation between years in winter growth rate of weaner deer. For successful venison production from grazed pastures only, winter growth rate needs to be at least 100g/day and preferably 150g/day if hybrids are used.. To ensure a consistent supply of top quality carcasses to venison processors, it seems that some input of higher nutritive value feeds will be required. This could be achieved from either strategic supplementation with cereal grains or by the use of high nutritive value specialist forages as reviewed in this paper.

Inputs of red clover nd chicory consistently increased venison production through increasing the proportion of stags attaining the target liveweight to 90-100% and increasing carcass weight by 11-17%. With such superior feeding value, the key to these specialist forages being adopted by deer farmers is devising grazing management practices which will result in maximum persistence of these plants with 4-6 years being the goal. Key recommendations are rotational grazing at 3-5 week intervals, with initial and final heights of 30 and 10 cm, if necessary mechanically topping reproductive growth during summer and not grazing during prolonged wet weather (Li *et al.,* 1997). It is also recommended that chicory be sown as a mixture with white clover ; the legume will fix atmospheric nitrogen and also spread to fill gaps as chicory plant density decreases with age, so reducing invasion by weeds.

The downside of these crops is that they are winter dormant; we therefore recommend that no more than 20% of a deer farm be sown in these crops and that they be managed as "special purpose forages" as described above, rather than using the normal management system for perennial ryegrass/white clover pasture.

Another potential advantage of chicory may be that use of anthelmintic drenches can be reducing during autumn without producing sub-clinical parasitism and without depressing weaner deer growth rate, as shown in the one study of this type conducted to date with deer (Hoskin *et al* 1999). Scales *et al.,* (1995) similarly found low parasite burdens in lambs grazing chicory. These effects are probably due to the different plant morphology of chicory compared to perennial ryegrass, with reduced numbers of infective larvae getting into the stratum that is eaten by grazing animals (Moss & Vlassoff 1993).

These studies have shown that hybrid (0.25 elk : 0.75 red) deer show greater responses on chicory than pure red deer, suggesting that the genetic potential of the hybrids for superior growth can best be expressed when grazing high nutritive value forages.

The grazing systems described here were designed to produce carcasses for the chilled venison trade, which is a commodity market and is seasonal, to supply venison for Germany during their late autumn and Xmas. Strategies of the NZGIB are to market venison as a branded top quality product, which is available in markets all year round. Examples of this are CERVENA™ for the N. American market and a similar product to be launched on the European market in late 1999. As demand for these branded venison products grows, there will be a need to develop grazing systems, which will produce 50-65 kg carcasses in all months of the year. Collectively, these data show a clear future for the input of specialist forages into efficient venison productions systems under grazing.

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