HIGH RETURNS FROM VELVET ANTLER

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SUMMARY

- Velvet antler production is a specialist operation. This paper covers aspects of performance, nutrition, breeding and harvesting of velvet antlers.
- Hard antler weight within red deer increases at a relatively faster rate than liveweight when comparisons are made across age groups and across strains. However within a strain of red deer velvet, antler weight increases at a rate of 0.1-0.2 kg/10 kg liveweight. Age has a major effect with velvet antler weight approximately doubling between two and five years of age. Early predictors of velvet antler producing potential are desirable: analyses show that two year old velvet antler weight is superior to yearling liveweight although some culling on yearling liveweight is clearly practicable.
- Effects of nutrition on antler weight are small but are of economic significance. This is particularly so in the period immediately post rut and during the antler growing stage in the spring. High protein diets during winter may also lead to increased antler growth but the effects are not consistent.
- Genetic progress through either within strain selection or hybridisation between strains is feasible. There are indications that the genetic variability within populations is of considerable economic significance particularly when cumulative production from two to five years of age is considered.
- Velvet antler is a high value product. Therefore care of the product at and after harvesting is critical. Harvesting itself is a critical time. Animal welfare concerns must be paramount so that adequate analgesia is an obligation.

INTRODUCTION

Velvet antler production is a specialist operation. There is the world of difference between velveting a few sire stags and running a specialist herd producing velvet antler. Developing a velveting herd is not an overnight operation - in fact it takes years. This paper will cover aspects of velvet antler production including looking at factors influencing performance, the influence of nutrition, the opportunities for breeding, and the harvesting of the product. The potential maximum size of antlers grown by a stag is a function of its genetics. Consequently the objective of the velvet producer must be to manage the stag so that he is given the opportunity to express his genetic potential in a profitable manner.

Performance

A number of studies over the years have shown that there is a general relationship between body weight and hard antler weight (Hyvarinen *et al.*, 1977; Huxley 1926, 1931; Schroder 1983; Fennessy and Suttie 1985). Of particular interest is the work of Schroder (1983) who showed that antler weight continued to increase even after body weight had plateaued at five to eight years of age. Table 1 shows the expected hard antler weight for stags (*Cervus elaphus*) of various body weights calculated from the data of Huxley (1931).

Table 1: Expected hard antler weight for stags according to weight based on the data of Huxley (1931).

Liveweight (kg)	Hard antler weight (kg)
100	1.6
150	3.1
200	4.9
300	9.4
400	14.9
500	21.3

Analyses of velvet antler production both within and across age groups have revealed similar patterns. For example, analyses within groups of red stags of the same age show increases of 0.1-0.2 kg velvet antler per 10 kg increase in liveweight (Moore *et al.*, 1988; Muir & Sykes 1988; Fennessy unpublished). Velvet antler production increases with age up to at least five years as is shown for three sets of data in Table 2. The proportion of such increases with age which can be accounted for by increases in body weight is unclear because data sets which include weights and various times of the year are not available except for Herd C. In fact, for this herd it appears that the major part of the increase from two to five years can be accounted for by changes in body weight (pre-rut liveweight).

From the practical point of view, early culling of low velvet antler producers is desirable and therefore early predictors of subsequent velvet antler production are necessary. In this respect,

Table 2: Velvet antler production (kg) by age in herds of red stags.

Age (years)	Herd A	Herd B	Herd C	Average CV%[2]
2	1.43	1.42	1.01	22.4
3	2.05	2.03	1.60	18.6
4	2.60	2.50	1.93	17.6
5	2.96	2.85	2.32	19.0
Number[1]	301	49	36	

[1] Approximately 30% of stags sold as yearlings or 2 year olds in herd A, no sales in herds B and C (Herd C: Moore, *et al.*, 1988).

[2] CV% = (100* standard deviation/mean)

Moore, *et al.*, (1988) examined a number of possibilities including spike antler weight and length, and weaning and yearling liveweights. Of these, yearling liveweight was the best predictor, being markedly superior to spike antler weight with the combination of the two being slightly superior to yearling liveweight alone. Two year old velvet antler weight had a strong relationship with subsequent velvet antler weight such that it would have been a very good predictor of subsequent velvet production. Analysis of a larger data set using yearling weight and two year old velvet antler revealed a similar picture. Analysis of this data set with cumulative velvet antler production from two to five years of age for a group of 90 stags categorised according to their two year old velvet antler weight is presented in Table 3.

Table 3: Velvet antler production (kg) by age for groups of stags categorised according to their two year old velvet antler production (n-90).

Rank on two year old velvet product	Velvet antler production (kg) by age 2	3	4	5	Cumulative (2-5 yrs)
Top 1/6	2.18	2.62	2.99	3.58	11.37
Next 1/3	1.55	2.22	2.46	3.12	9.35
Next 1/3	1.29	2.08	2.25	2.85	8.47
Bottom 1/6	1.02	1.89	2.11	2.67	7.69
Overall mean	1.48	2.18	2.42	3.03	9.11
±Std deviation (SD)	0.43	0.42	0.47	0.56	1.60

The top 1/6 of stags as two year olds were 0.70, 0.44, 0.57 and 0.55 kg above average at two, three, four and five year olds respectively, giving them an overall advantage of 2.26 kg (25%) over the four years.

Table 4: Velvet antler production (kg) by age for groups of stags categorised according to their yearling liveweight (N-90).

Rank on yearling liveweight	Yearling liveweight (kg)	Velvet antler production (kg) by age 2	3	4	5	Cumulative (2-5 yrs)
Top 1/6	119.6	1.75	2.29	2.73	3.30	10.06
Next 1/3	107.5	1.53	2.21	2.41	2.99	9.14
Next 1/3	101.6	1.38	2.18	2.35	2.98	8.88
Bottom 1/6	94.1	1.33	2.03	2.27	2.94	8.57
Overall mean	105.3	1.48	2.18	2.42	3.03	9.11
±SD	9.57	0.43	0.42	0.47	0.56	1.60

Table 4 shows the parallel analysis for the same group of stags categorised on their yearling liveweight. The top 1/6 on yearling liveweight were only 0.27 kg above the mean as three, four and five year olds respectively, giving them an overall advantage of 0.95 kg (10%) over the four years. Therefore it is clear that in this case two year old velvet antler weight was a much better predictor of subsequent velvet antler production than yearling liveweight. With two year olds, velvet antler is often harvested at variable stages of growth (for convenience or to meet particular market requirements). Consequently it is advisable to record both hard antler casting and velvet antler harvest dates for two year olds. The velvet antler weight can be adjusted for days of growth and consequently the predictive value of the two year old velvet antler weight will be improved. The usefulness of two year old velvet antler weight as a predictor notwithstanding, some culling based on yearling liveweight is still clearly practicable.

Nutrition

With respect to nutrition, the aim must be to feed stags well so that they have the opportunity to express their genetic potential. Nutrition can influence antler size and velvet antler weight. Over the last few years most work looking at the influence of nutrition on velvet antler production has been concerned with the level of feeding (ie. mainly energy) during the winter and early spring. The results of these trials are summarised in Table 5.

Table 5: Effect of level of nutrition at different stages of the antler cycle on velvet antler production of red stags[1].

Period (trials)	Post-rut May-June (1)[1]	Winter Jun-Sep (4)[2]	Late Winter July-Sep (2)[3]	Spring Casting-harvest (1)[4]
Days	50	80	50	65
Velvet antler yield (kg/stag)				
Restricted	2.45	1.66	1.94	1.87
Ad lib	2.70	1.80	2.06	2.20
Relative increase with ad lib feeding				
(%)	10	8	6	17
Approximate amount of extra feed required to feed ad lib[5]				
Grain (kg/day)	0.65	1.0	1.0	0.65

[1] Fennessy, Corson and Suttie, unpublished data from indoor trial.
[2] Fennessy, Drew and Moore, unpublished data; Muir and Sykes 1988; all field trials.
[3] Moore and Fennessy, unpublished data; Fennessy, unpublished data; both field trials.
[4] Fennessy and Suttie, 1985, indoor trial.
[5] 1 kg grain/head/day extra feed can be expected to result in a net liveweight gain of 1-2 kg/week.

The field trials involved feeding stags hay with concentrate supplements (a high quality pelleted diet or grain). The net result of offering more concentrate was an increase in metabolisable energy intake. Averaged overall the results were consistent with small increases in velvet antler weight. However there was considerable variability between the four winter feeding trials (Table 6), where the response to the better feeding ranged from nil (or negative) to about 25%. In all cases the additional supplements resulted in an extra liveweight gain of about 0.8 kg/week.

Table 6: Velvet antler production of groups of stags under different nutritional regimes during winter.

Farm[1]	*Velvet antler yield (kg)* A	B	C	D
Basal hay	1.22	1.37	1.77	2.28
Hay + 1/2 nuts	1.38	1.61	1.94	2.30
Hay + *ad lib* nuts	1.46	1.73	1.77	2.17

[1] Farms A and D, Muir and Sykes (1988); Farms B and C, Fennessy, Drew and Moore, unpublished.

Although the overall responses to improved nutrition were small, the increases are of considerable economic significance at the velvet antler prices of the last few years. In terms of cost effectiveness (Table 5) the most important periods to ensure good nutrition for velveting stags are during the immediate post-rut period. In this context, good feeding means ad libitum feeding with a high quality diet. In addition to any effects on velvet antler production, such good feeding is particularly important for stags from straight after the rut through the winter due to their vulnerability to adverse climatic changes. Good feeding helps compensate for their lack of body energy reserves and their relatively poor insulation. The importance of good feeding during the spring antler growth period cannot be overemphasised. This may mean continuing supplementation into early spring to compensate for lack of pasture growth.

With regard to specific nutrients, there have been claims that extra protein (Vogt 1936 cited by Drummond *et al.*, 1941; Wallace 1951) or certain minerals such as copper or vitamins such as Vitamin D, stimulate antler growth and hence could be expected to increase velvet antler production. While specific deficiencies of trace minerals could be expected to reduce antler growth, there is no evidence that luxury consumption of minerals will increase antler growth. However, the situation with protein is less clear. There have been three winter feeding trials and two spring feeding trials at Invermay where stags have been fed a high protein diet. In neither of the spring feeding trials was there any effect of large quantities of extra protein on antler growth. However, in one of the indoor winter feeding trials, but not in the other there was a very marked effect of high protein feeding on hard antler weight but not on velvet antler weight (one antler was cut for velvet antler and the other for hard; Table 7). In this respect it is possible that diets which cause changes in the amounts of certain natural growth-promoting hormones in the stag may influence antler growth. However, this aspect will require much more research. The variability between the experiments may be due to the actual type of protein used, and in particular, the amount of protected protein (ie. protein which by-passes the rumen and is digested post-ruminally).

Breeding

Genetic progress in any character is dependent on a number of factors:

- the character must be measurable
- the character being selected for must be heritable

- there must be variation for the desired character within the population.

Table 7: Effect of a high protein diet during winter on hard antler weight of red stags (n-16 stags per experiment); Fennessy, Corson and Suttie, unpublished.

	Hard antler weight (one antler only, kg)	
	Exp. 1 (2 year olds)	Exp. 2 (3 year olds)
Low	0.49	1.09
High	0.67*	0.98ns

* Significant at $P<0.05$; ns not significant.

There is evidence that velvet antler weight satisfies all of these criteria and therefore is amenable to genetic improvement within a population. However the situation is clearly different with velvet antler quality; quality is not readily definable and therefore measurable except perhaps with respect to the absence of the bez tine.

With regard to velvet antler weight, the stage of growth at the time of harvest is critical and consequently weight must be at a defined stage. Velvet antler weight is heritable with a heritability coefficient of 0.35 being reported for Chinese Meihualu (sika) deer. There is also considerable variability in velvet antler weight within groups of stags cut at the same stage of growth as evidenced by the coefficient of variation of about 20% (see Table 1).

Further evidence of the sort of genetic progress possible in velvet antler production is provided by progeny test data for five sire stags with 17 to 35 progeny each (Table 8).

Table 8: Progeny test of five red sire stags: comparison of the mean cumulative velvet antler production (two to five years of age) and the three year old winter lean liveweight for the progeny groups.

		Deviations from average (kg)	
Sire	Number of male progeny	Cumulative velvet antler weight	3 year old winter lean liveweight
A	29	-0.46	+4.6
B	32	-0.45	-1.4
C	22	-0.27	-0.7
D	17	+0.37	+4.6
E	35	+0.61	+2.0
Whole herd	301 Means:	9.11	126

In this progeny test, the progeny of the top sire (E) were 0.61 kg or about 7% above average over the 4 years production. Clearly there is considerable potential for selection and breeding for velvet antler weight, particularly when considering that there was little difference in liveweight (and hence estimated feed costs) between the different sire groups.

The other obvious breeding alternative for a deer farmer with a base herd of New Zealand red hinds is hybridisation with one of the larger antlered strains such as one of the selected European strains, Canadian wapiti, or a wapiti x red hybrid. While there are very little objective data currently available on the merits of such strains, the principles can be readily defined. Table 9 provides a comparison of three breeding strategies. The first involves selecting a top stag from within an average New Zealand red herd while the second involved selecting an average stag from within a genetically superior strain while the third involves selecting a superior stag from this genetically superior strain. Naturally the comparison predicts average responses.

The estimates in Table 9 clearly identify the benefits of hybridisation with a superior strain. However any such progress depends on identifying such a superior strain. While some of the European strains apparently fit this category, it may be that some of the New Zealand red strains also do. If the superior antlered strain is also a larger animal, there would also have to be some consideration of the effect of the increased size on feed requirements although in general terms larger strains can be expected to be more efficient velvet antler producers because antler weight increases at a faster rate than velvet antler weight (see Table 1).

Harvesting

There is an optimal stage for harvesting velvet antler for the Korean market. High returns to the farmer are dependent on harvesting at the appropriate stage and without damage. At velveting, animal welfare concerns are paramount. An adequate degree of analgesia (i.e. painkilling) is required by law (Animals Protection Act 1960) and restricted drugs should be used under the supervision of the farmer's veterinarian. In order to ensure that velveting is a straightforward procedure producing a high quality product, there are some simple guidelines. Stags should be familiarised with the yards well before velveting time.

Table 9: Comparison of various breeding options to improve velvet antler production (comparisons as 4 year olds).

Breeding option	*Velvet antler production (kg) as 4 year olds* Breeding animals stags X Red hinds		Genetic progress per generation	Yield of progeny
Selection within strain				
Top 3% of stags	3.6[1]	2.5[2]	0.22	2.72
Hybridisation between strains				
a) Average stags	3.6	2.5	0.55	3.05
b) Top 3% of stags	5.2	2.5	0.87	3.37

[1] Assuming a standard deviation 0.5 kg (a coefficient of variation of 20%) and a heritability of 0.40.

[2] The hinds are average red hinds in that their male progeny from mating with average red stags would be expected to produce 2.5 kg of velvet antler.

The yards must be designed to have good flow with few opportunities for animal or velvet damage. Adequate analgesia, while required by law, is also good management. It means that there is much less likelihood of damage to the product. Velvet antler is a perishable product and therefore careful post harvest handling is also vital.

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REFERENCES

Animals Protection Act 1960. New Zealand Government, reprinted with amendments, October 1, 1980.

Drummond, J.C., Greenwood, A.W., Ridgway, R.R. & Williams, P.C. (1941) Sesame cake and antler growth. *Nature* **147** : 26-27.

Fennessy, P.F. (1987) Genetic selection and recording. *Proceedings of a Deer Course for Veterinarians* 4 : 81-93.

Fennessy, P.F. & Milligan, K.E. (1987) Grazing management of deer. In: Livestock Feeding on Pasture. *NZ Society of Animal Production Ocassional Publication* **10** : 111-118.

Fennessy, P.F. & Suttie, J.M. (1985) Antler growth: nutritional and endocrine factors. In: Biology of Deer Production, ed. P.F. Fennessy & K.R. Drew. *Royal Society of NZ Bulletin 22* Wellington, p 239-250.

Huxley, J.S. (1926) The annual increments of the antlers of the red deer (*Cervus elaphus*). *Proceedings of the Zoological Society London,* p 1021-1035.

Huxley, J.S. (1931) The relative size of the antlers of the red deer (*Cervus elaphus*). *Proceedings of Zoological Society London,* p 819-864.

Hyvarinen, H., Kay, R.N.B. & Hamilton, W.J. (1977) Variation in the weight, specific gravity and composition of the antlers of red deer (*Cervus elaphus*). *British Journal of Nutrition* **38** : 301-311.

Moore, G.H. (1984) Removal of antler in velvet: time, method, grades. *9th Annual Conference NZ Deer Farmers' Association, Technical Addresses,* p 21-33.

Moore, G.H., Littlejohn, R.P. & Cowie, C.M. (1988) Liveweights, growth rates, and antler measurements of farmed red deer stags and their usefulness as predictors of performance. *NZ Journal Agricultural Research* **31** : 145-150.

Schroder, J. (1983) Antler and body weight allometry in red deer: a comparison of statistical estimates. *Biometrical Journal* **25** : 669-680.

Wallace, F. (1951) Experiments in feeding red deer. *Country Life* **110** : 889 (21 September).