DEER GROWTH AND NUTRITION

J M Suttie
Invermay Agricultural Centre
Private Bag
MOSGIEL

INTRODUCTION

The topic of deer growth and nutrition has been the subject of 2 previous contributions to the Deer Branch. Fennessy (1981) covered the cylic pattern of growth and feed intake by stags, the relationship between liveweight and reproductive performance in hinds (also covered by Fennessy et al 1986) and the energy requirements for maintenance and growth in both sexes. In 1986 Adam and Asher using data from the northern region of New Zealand discussed the growth from weaning to slaughter of pasture fed red and fallow deer on farm. They considered the effect of stocking rate and pasture allowance on growth in different seasons, concluding with a discussion on the effects of stocking rate on venison and weaner production. It is neither my intention to fully review nor repeat any of the above but rather to update subjects where new research has taken place and to introduce a few new concepts. This paper will deal with the following topics: An up-to-date assessment of hind energy requirements compared with stags; Effects of melatonin on growth; The latest data from the Invermay red v wapiti growth comparisons; Individual sire effects on weaner growth; Inwintering of weaners; Lactation.

1. **Hind Growth and energy Requirements - A Comparison with stags**

Although estimates of the energy requirements for hinds based on stag data are available (Fennessy et al 1981) no actual measurements have been made. As hinds grow more slowly than stags (Suttie 1981) and have lower amplitude seasonal fluctuations in growth (Suttie and Simpson 1985), it was felt that the actual energy requirements for maintenance and production should be calculated.

9 red deer hinds were handreared and then penned indoors in 2 groups from May (5 months old) until May 2 years later (29 months old). They were non-pregnant throughout the study. The hinds were fed to appetite a pelleted barley based diet which supplied 11 MJ ME/kg DM. Group food intake and individual hind liveweights were recorded weekly. 4 stags were naturally reared by their dams and placed in individual pens from weaning at four months of age until 27 months of age. Weekly food intake and liveweight was recorded.

Food intake. Both hinds and stags ate about 10 kg/week during their first winter of life but during spring this increased to about 16 kg/week (Figure 1). The hinds food intake dropped sharply in late summer, but that of the stags remained high at over 17 kg/week. Food intake of both sexes dropped in autumn and remained low throughout the winter but that of the stags was higher than the hinds. Although both sexes were maintaining their weight over this period, the stags were larger (Figure 2) and the differences in intake probably reflects the stags higher value for maintenance of body weight. During the second spring of life both sexes increased their food intake but whereas the hinds intake plateaued from November-February, at about 16 kg/week, the stags rose to a peak of over 23 kg/week in January. The food intake of both sexes fell during autumn in the case of the stags precipitously.

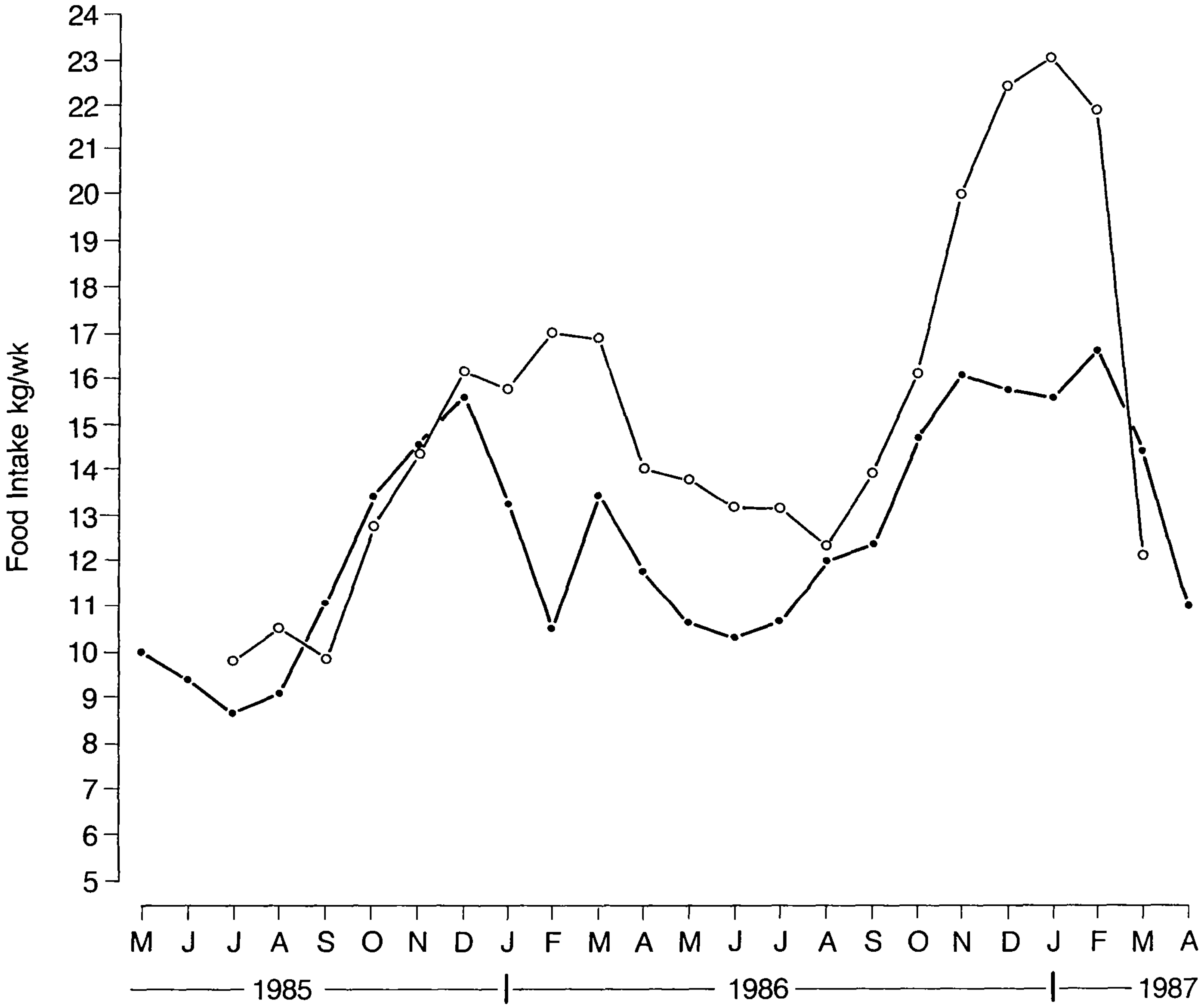

Figure 1. Dry Matter Intake (kg/week) for a group of 9 red deer hinds (●) and 4 red deer stags (o). The stags were fed the same diet as the hinds (Suttie et al 1987).

Growth rate. The hinds grew rapidly from birth to six months of age (May 1985) gaining about 220 g/d (Figure 2). This period was followed by one of slower growth (80 g/d) during the months of June-August (the first winter of life). Growth rate then increased so that in spring from September-November it was 141 g/d, during summer (December-February) it was slightly less at 123 g/d. From autumn until the following spring (March-September) the hinds grew very slowly at 38 g/d. During their second spring-summer from September - 1986 February 1987, they grew at 110 g/d. Thus although the hinds grew faster during spring-summer they did not entirely stop growing during the winter. Thus although a seasonal weight gain pattern was shown this was of low amplitude.

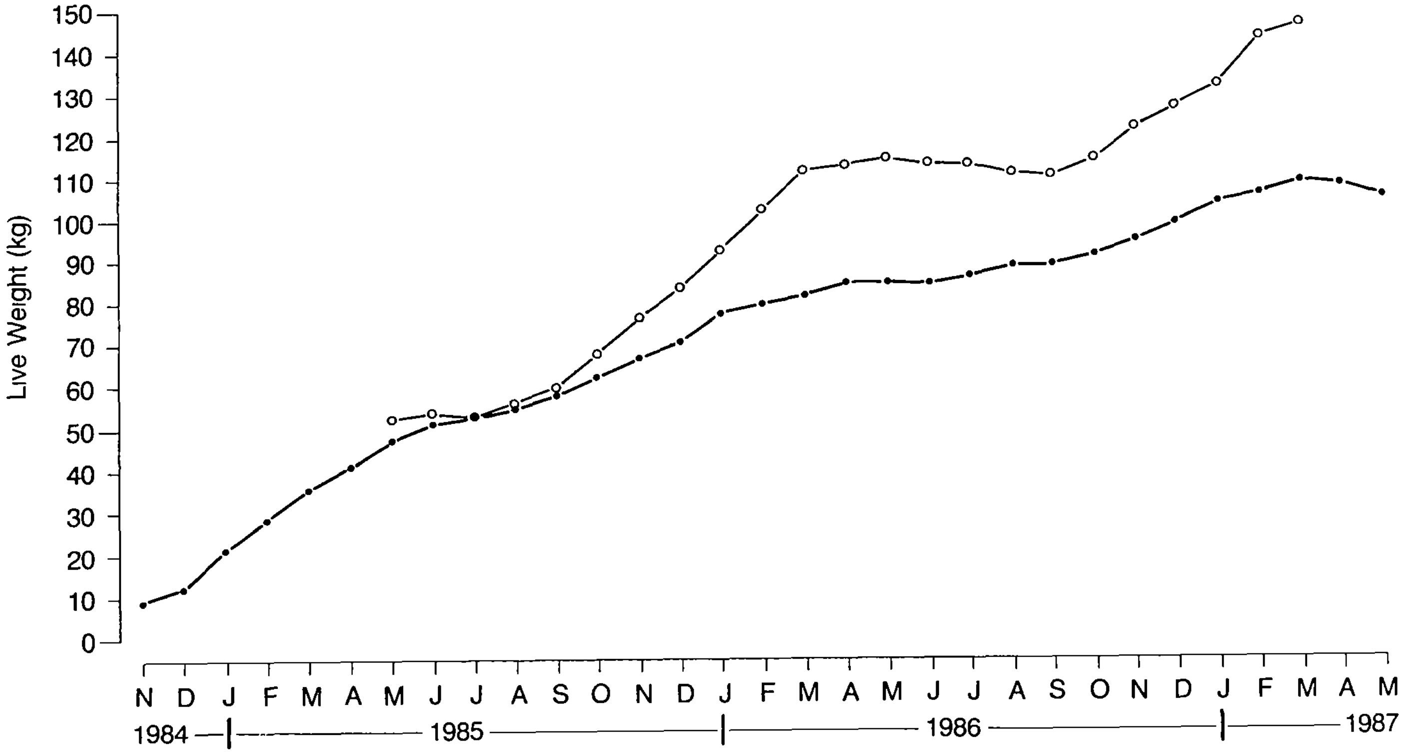

Figure 2. Liveweight for a group of 9 red deer hinds (●) and 4 red deer stags (o). (Suttie et al 1987).

In contrast the stags in Figure 1, although the same weight during winter 1985, grew more rapidly (285 g/d) than the hinds from September-March (spring-summer) so that there was a 30 kg difference in weight at 15 months. The stags did not grow at all from March-September (autumn-winter) although they did not show a conspicuous weight loss during the rut in April 1986 at 15 months of age. From September 1986 until March 1987 (spring-summer) the stags gained 203 g/d. Thus the stags showed more strongly, a seasonal influence on growth.

Energy Requirement. The ME intake for each hind from May 1985-May 1986 i.e. 6-18 months of age was taken as the mean intake for the group for each 4 week period. The common (pooled across animals) regression relationship between ME intake (MEI) ($MJ/kg^{0.75}/d$) and liveweight gain (LWG) ($g/kg^{0.75}/d$) was

LWG = 18.34 MEI - 9.56

r^2 = 0.423 RSD ± 3.15 (n = 117)

This means the hinds required 0.52 M J M E/kg$^{0.75}$/d for maintenance and 55 MJ ME/kg LWG for production. By comparison Fennessy et al (1981) found energy requirements for stags were 0.57 MJ ME/kg$^{0.75}$/d for maintenance 37 MJ ME/kg LWG (Figure 3).

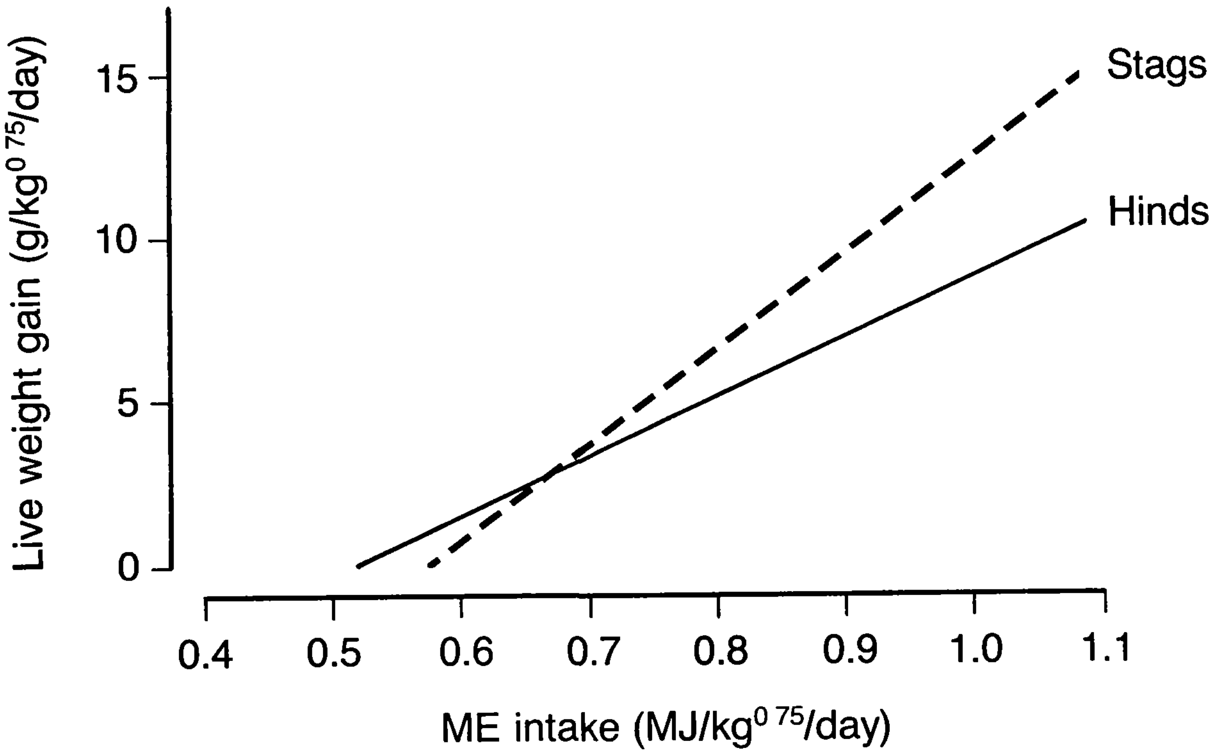

Figure 3. Relationship between ME intake and liveweight gain for hinds and stags. Hind data from Suttie et al 1987 stag data from Fennessy et al., (1981).

The calculated energy requirement for maintenance for the hinds is based on animals kept indoors, and thus sheltered from outdoor environmental conditions. Previous research on stags (Fennessy et al 1981) indicated that the maintenance energy requirement of animals kept outdoors was 0.85 MJ ME/kg$^{0.75}$/d in contrast to 0.57 MJ ME/kg$^{0.75}$/d for indoor deer. Although no data are available for hinds kept outdoors it seems reasonable to accept that a similar increase for maintenance would be required for hinds kept outdoors particularly during winter.

Fennessy et al., (1981) estimated that the maintenance requirements for deer kept outdoors were 30, 50, 20 and 10% higher than those kept indoors during autumn, winter, spring and summer respectively. Using these percentages and the calculated requirements from the present study along with the actual growth rates achieved, the daily ME requirements for hinds would be 18, 19, 23, 22 MJ ME/day during autumn, winter, spring and summer respectively. These values are 5 to 16% higher than previously estimated, reflecting the higher energy requirement for liveweight gain. It is critical that red hinds reach a liveweight greater than 70 kg at 15 months of age (Fennessy et al. 1986) in order to breed and it is desirable for the herd average to be over 80 kg to achieve a herd fertility above 90%. The average weight of hinds in the present study was 89 kg; they thus exceeded the minimum requirements.

The cycles of food intake and liveweight gain shown by hinds are of lower amplitude than those of stags. Hind's require slightly less ME for maintenance than stags, but require about half as much again for liveweight gain. This means that current estimates of hind energy requirements which have been based on stag data, underestimate these and should be increased.

2. Melatonin

Melatonin is a hormone secreted by the pineal gland which controls many seasonal physiological rhythms such as breeding and coat replacement. Its use for advancing the breeding season in deer in New Zealand has recently received a great deal of attention (Fennessy et al 1986) but its effects on growth have been less well studied.

Webster et al (1986) compared melatonin feeding with melatonin implants (Regulin, Genelink Australia - not currently licensed for use in New Zealand) to test their efficacy to advance seasonal reproductive activity. From 10 December until 6 March at 1500 hrs each day 20 yearling red deer hinds were fed 5 mg/head/day melatonin incorporated in a ration of 0.5 kg/head deer nuts. During the same period 16 hinds were each given two subcutaneous constant melatonin releasing implants replaced twice at about 28 day intervals. A further 10 hinds were untreated as controls. Melatonin implanted and control hinds were offered the same quantity of untreated nuts daily as those fed melatonin. The hinds were weighed at the start of the trial, on January 30th and on the 24th of March. Of the 20 hinds offered the melatonin incorporated nuts, only 11 readily and repeatedly ate them; data from these have been analysed separately from the remaining 9.

Table 1 Weight gain from December-March in yearling red deer hinds treated with melatonin. Webster et al 1986).

	CONTROL	MELATONIN IMPLANT	FED MELATONIN		SED
			ATE	DID NOT EAT	
Weight gain (kg)	10.8	9.1	8.6	10.8	0.9
n	10	16	9	11	

Untreated control hinds gained 10.8 kg over the summer-autumn period, as did hinds which rejected the melatonin incorporated feed (Table 1). However hinds which ate the feed and hinds which were implanted with melatonin had lower liveweight gains of 9.1 kg and 8.6 kg respectively.

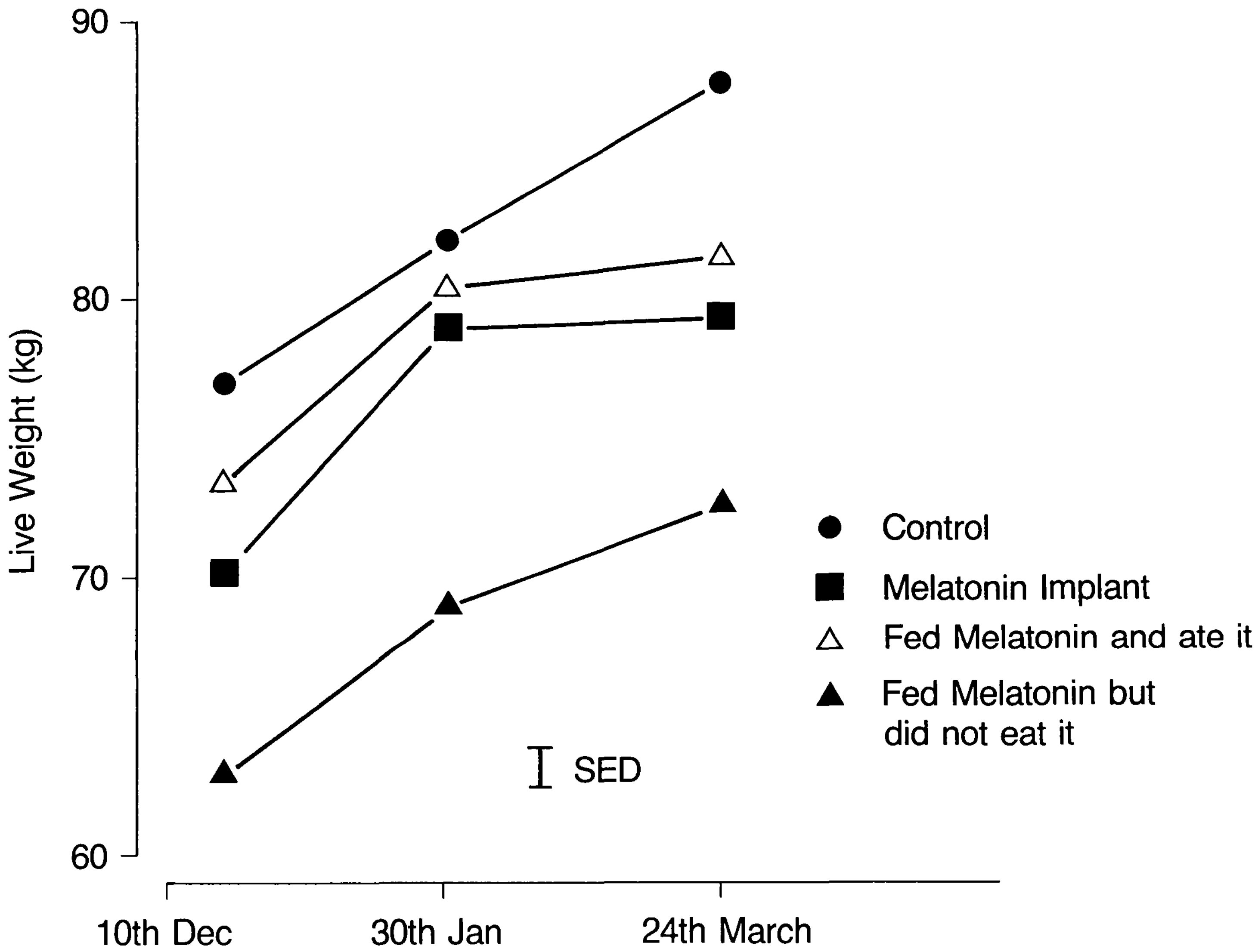

Figure 4. Influence of melatonin treatment during late summer on liveweight of yearling hinds. (Webster et al 1986).

Neither was the pattern of liveweight gain the same. Control and non melatonin feeders gained weight steadily throughout the study, but implanted hinds and melatonin feeders gained weight rapidly until January but either did not gain weight or gained weight only slowly from January-March (Figure 4).

Thus melatonin not only slightly limited growth, but altered the pattern of liveweight gain. It is tempting to conclude that melatonin has limited the summer growth and advanced the seasonal winter low weight gain phase.

In a separate study Webster et al (1987) studied the influences of melatonin implants on advancing seasonal reproductive activity in adult red deer stags. They implanted 12 stags with 3 Regulin implants per month, 6 stags from November-February (early melatonin, EM) and 6 stags from December-February (late melatonin, LM). Of the remaining 12 stags 6 were kept with the melatonin treated animals (close control, CC) and 6 were kept far apart (> 1 km) (remote control, RC).

All stags were kept at pasture, the remote control stags were offered pasture at the same rate as the other animals. The stags were weighed monthly.

Table 2: Weight change during summer and early autumn for melatonin treated and control (untreated) adult red deer stags. (Webster et al 1987).

WEIGHT CHANGE	EARLY MELATONIN	LATE MELATONIN	CLOSE CONTROL	REMOTE CONTROL	SED •
Nov-Jan	30	17.4	23.7	19	3.11
Jan-Mar	-38.6	-36.5	-14.3	-5.6	4.91
Jan-Apr	-39.8	-35.7	-37.3	-40.0	5.34

From November until January the EM group gained significantly more weight than the LM group or either of the control groups (Table 2). The LM group in contrast grew less than the control stags, particularly the CC animals. Between January and March both melatonin treated groups lost more weight than the controls, but overall by April all groups had lost about the same amount of weight. This means that melatonin treatment of stags in November advanced the seasonal weight increase, but also the autumn weight decrease. December treatment resulted in failure to achieve the expected annual peak weight and also advanced the autumn weight decrease.

In the same way as for the hinds (Webster et al 1986) the pattern of liveweight gain was also altered by melatonin treatment (Figure 5). The EM group achieved their peak annual weight one month ahead of the controls and underwent their seasonal period of weight loss one month earlier. The LM group reached their peak weight one month ahead of controls but at significantly smaller body size; weight loss occurred earlier than in the controls. There was little difference in liveweight pattern or extent of liveweight gain between the controls.

The finding that November treatment with melatonin advanced weight gain and loss is consistent with the tentative conclusion from the hind experiment, namely that melatonin advances all aspects of seasonality. The fact that weight gain was slightly reduced in the LM group indicates that care should be exercised with melatonin treatment particularly if melatonin treated stags are due for eventual slaughter as meat animals.

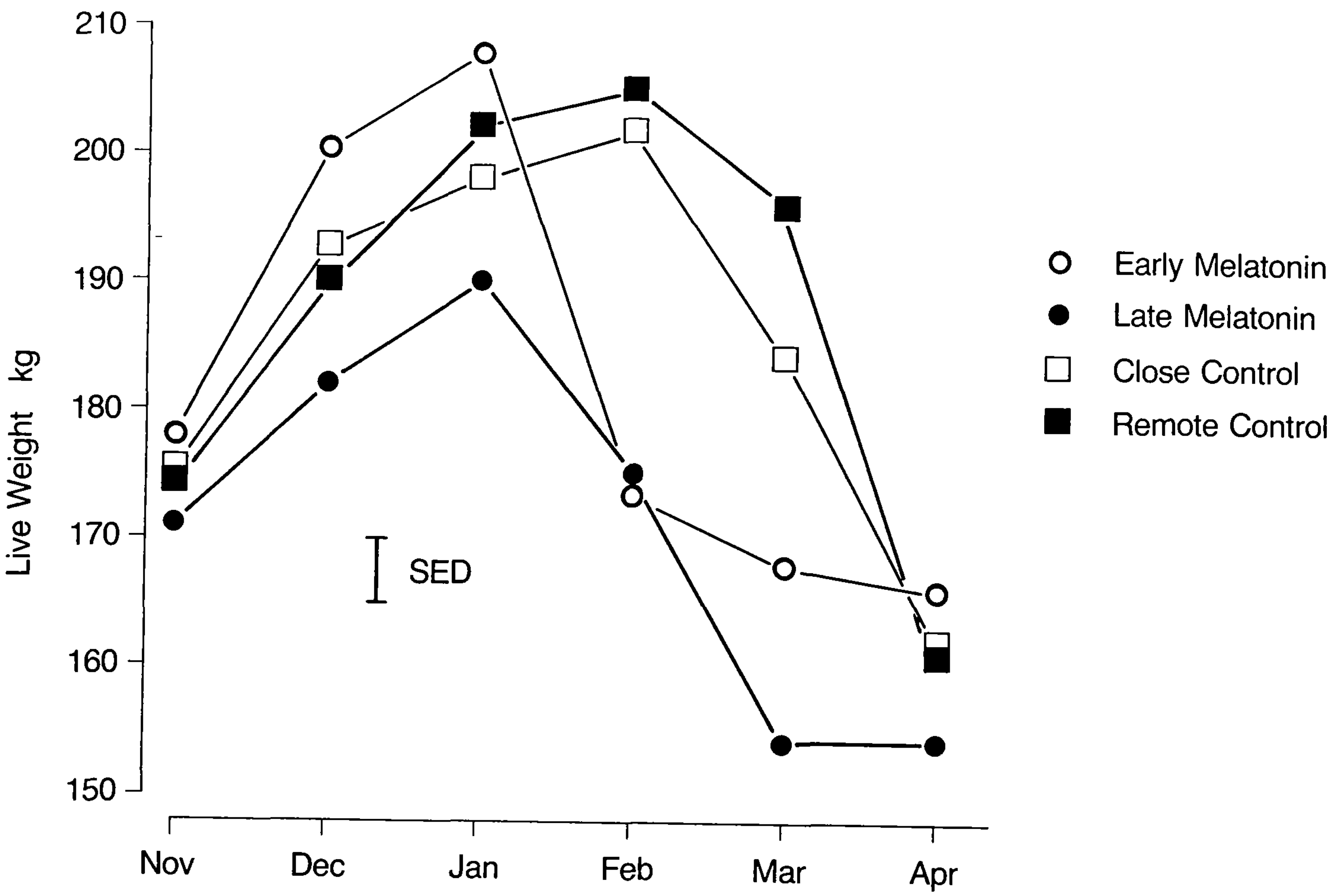

Figure 5. Influence of melatonin treatment in summer on pattern of liveweight gain and loss in adult red deer stags, n = 6 per group. (Webster et al 1987).

The above result is hardly surprising in view of the known effects of daylength on growth in deer (Suttie and Simpson 1985). Whether this factor could be positively manipulated to enhance growth will be discussed below, see Section 5.

Conclusion

Melatonin administration, by feeding or implant, in stags or hinds, limited liveweight gain and altered the pattern of liveweight gain. Melatonin use should be limited to well grown hinds to permit attainment of the critical weight for puberty of around 70kg. Melatonin should not be given to stags destined for eventual slaughter as growth potential may be retarded.

3. Wapiti-Red Comparison

Genotype clearly plays a major role in determining body size and liveweight gain (Table 3). Summer growth rates of wapiti type yearling stags were 50% higher than pure red deer of the same age, with wapiti-type hybrids being almost exactly intermediate (Table 3).

Whether the pattern of liveweight gain and the relationship between weight and fatness is the same for each genotype remains to be established, but it would be expected that fatness would be the same at the same proportion of mature weight.

Table 3: Liveweight measurements in 3 'breed' types of young male deer from weaning to 14 months of age. (mean of 4 seasons ± s.d.) (G H Moore unpublished)

	RED x RED	WAPITI TYPE BULL X RED HIND	WAPITI TYPE x WAPITI TYPE
Liveweight (kg)			
Weaning (March)	47 ± 6	55 ± 7	67 ± 14
14 months	99 ± 8	115 ± 11	140 ± 15
Liveweight gain (October-February)			
- g/day	234	297	362
- relative gain	100	127	155

4. **Red Deer Sire Effects**

The analysis of on-farm performance data has provided evidence of sire effects on the growth rate of their progeny. For example from Table 4 it is clear that stag A was consistently a better sire than B over a period of 3 years. Likewise he also consistently out performed C. This finding underlines the importance of the choice of stag in producing quality weaner deer for venison production (stags) or live sale (hinds).

Table 4: Comparison of the weaning weight of the progeny of a superior stag A with those of 2 other stags for 3 successive years. The data are adjusted for calf sex, hind age and calf rearing rank. (P F Fennessy and J Cowie unpublished data).

A compared with B			A compared with C		
YEAR	WEIGHT ADVANTAGE	N	YEAR	WEIGHT ADVANTAGE	N
1980	+3.94	55	1982	+1.24	34
1981	+5.37	72	1983	+1.87	102
1982	+5.08	49	1984	+3.01	102

5. **Inwintering**

Within the last few years farmers particularly in Southland and Otago have begun to keep weaner deer indoors during the winter. No data are yet available on the effectiveness of this novel husbandry procedure but intuitively, if maintenance energy requirements are reduced by housing, then production should be increased, if intake is consistent.

In the UK inwintering is a standard procedure for young deer and some data are available particularly on the influence of plane of winter nutrition on winter growth and subsequent growth on summer pasture.

Table 5: Effect of diet quality on live weight gain (g/day) in inwintered hind and stag calves, during winter (January-April) and subsequent summer compensating growth. (Note: Northern Hemisphere) (Adam and Moir, 1985)

	WINTER FEED TREATMENT			
PERIOD OF LIVEWEIGHT GAIN	AMMONIA-TREATED STRAIN	CONCENTRATE	POTATOES	SED
Jan-Feb	-35	+5	-23	13.7
Feb-April	-18	+273	+162	13.7
May-Sept	+215	+156	+170	10.8

Adam and Moir (1985) fed 3 groups of stag and hind calves, which all weighed about 40 kg at weaning, different diets namely ammonia treated straw, a pelleted concentrate diet with a restricted amount of hay and whole potatoes with restricted hay between January-April. All animals were turned out to pasture in May and each group was grazed separately, but on similar quantity and quality of feed until September. The results are shown in Table 5. During the early part of the winter (Northern Hemisphere) only the concentrate group gained weight, but between February and April both the concentrate and potato fed deer gained weight. At turnout in May the straw concentrate and potato fed groups weighed 35, 60 and 50 kg respectively. During the summer the deer who were fed straw during winter grew much faster than either of the other groups in an effort to compensate for the slow winter growth. However the average liveweight of the 3 groups was 76, 94 and 85 kg in September at the end of the summer, largely reflecting the influences of plane of winter nutrition. In Scotland naturally reared stag calves kept outdoors all winter would be around 49 kg at the end of the winter and 70 kg at the end of summer, aged 15 months (Hamilton and Blaxter 1981). Clearly in that environment there are advantages of inwintering for peak growth efficiency.

Suttie and Hamilton (1983) allocated 20 weaner stags to either a high (n=9) or low (n=11) plane of winter nutrition indoors from December-May and then turned them out on hill pasture for the summer until September. The winter high plane group received 1.1 kg/head/day of a mixed diet containing 90% whole loose barley and 10% pelleted fish meal protein and vitamins. The winter low group received 0.25 kg/head/day of the same diet. Second cut meadow hay and water were available to appetite.

Table 6: Liveweight gain during winter and during the summer compensating phase in weaner red deer stag calves in Scotland (Suttie and Hamilton 1983)

(Ed. Note: North Hemisphere dates)	LIVEWEIGHT GAIN (G/DAY)	
	DECEMBER-MAY	MAY-SEPTEMBER
Winter High (n = 9)	141	5
Winter Low (n = 11)	33	77
SED	13	15

The calves fed the high plane of nutrition grew much faster during winter than the low fed deer (Table 6). Although both groups weighed about 37 kg before the trial, they weighed 60 and 43 kg (winter high and low respectively) after the winter. After the summer the winter high group only weighed 61 kg but the winter low group had caught up appreciably to 55 kg, but were clearly still smaller. Thus restricting feed quantity during winter restricted body size. In Scotland the spring-summer conditions were too severe to permit further body growth in the winter high group.

Although there is some information about feeding different quantities and qualities of winter feed indoors, there is as yet no convincing data on the actual growth advantages of inwintering. This is currently under investigation at Invermay.

As has been mentioned previously young deer grow slowly during their first winter of life. There would be production advantages if some of this growth inhibition were prevented. The rhythm of intake and growth is controlled by daylength - short days limit growth. If deer are housed in winter then there may be an opportunity to increase growth by keeping the lights on artificially and thus deluding the deer that spring has arrived. In support of this Darroch (1980) found that weaner red deer given supplemental lighting during the winter did grow faster, but this effect was lost after turnout onto pasture in spring. In a "natural experiment" weaner red deer in Queensland were wintered outside at 25-30° latitude - with much less seasonal distinction than in New Zealand (14 hrs of light : 10 hrs dark on the longest day compared with 16 light : 8 dark). (Ritchie et al 1986). The stag calves gained weight at 248 g/day from May-August whereas deer outwintered in NZ gained only 34-93 g/day (Adam and Asher 1986) over the same period. Although the winter weather might have been less harsh in Queensland than in the Waikato, the Australian deer could be of a different genotype or could have been fed better there seems to be an advantage of increased winter daylength on weight gain.

There is potential for increasing growth efficiency of young deer by feeding them indoors during the winter. Both quantity and quality of diet can be manipulated to suit individual requirements. If deer are fed poor quality diets during winter some compensatory growth will be shown in spring. As daylength influences weight gain pattern then it should be possible to prevent the winter growth check in young deer, which are housed indoors, with supplemental light.

6. Lactation

Hind milk production is likely to have a big influence on early calf growth. However no studies have been carried out on the lactational performance of deer in NZ. Several good studies have been carried out on deer lactation overseas, and this section of the article reviews relevant portions of these.

Arman, et al (1974) measured the composition and yield of milk in penned red deer hinds throughout a lactation. They estimated milk yield, using the calf-weighing technique, as about 2.0 kg/day at the peak at about 40-50 days post partum. Lactation continued for up to 280 days and total yield for the first 150 days varied from 140-180 kg. The composition of the milk varied during the course of the lactation (Table 7). Total

Table 7: Composition of deer milk. All values are the mean of 5 hinds. (Arman et al 1974).

	COMPOSITION %					
STAGE OF LACTATION	TOTAL SOLIDS	FAT	CASEIN	WHEY PROTEIN	LACTOSE	GROSS ENERGY (KJ/100g milk)
3-30 days	21.1	8.5	5.71	1.13	4.45	543
31-100 days	23.5	10.3	6.16	1.23	4.45	652
100+ days	27.1	13.1	7.03	1.34	4.46	773

solids increased as did fat and protein content but lactose remained about the same. The gross energy supplied by the milk increased considerably, presumably mainly due to the increase in fat content.

In comparison with other species (Table 8),

Table 8: Percentage composition of milk of 4 different species (McDonald et al 1966, Arman et al 1974).

	TOTAL SOLIDS	FAT	PROTEIN	LACTOSE
Cow	12.3	3.6	3.3	4.7
Goat	13.2	4.5	3.3	4.1
Ewe	19.3	7.4	6.1	4.8
Sow	20.1	8.5	5.8	4.8
Hind (day 31-100)	23.5	10.3	7.6	4.4

red deer produce milk of much higher total solid content (i.e. more concentrated). Fat and protein content are higher but lactose is lower than all but the goat. Thus no other milk resembles deer milk even remotely in composition - perhaps sows milk would be the best substitute for young deer calves.

Elk cows produced, about 4.0 kg/day of milk at peak lactation (25 days post partum) (Robbins et al 1981). During the first 3 months of lactation elk milk was composed of 19.8% total solids 6.2% protein 7.5% fat and 4.1% lactose. This makes it slightly more dilute than red deer milk. The elk cow produced about her own weight of milk after about 150 days - contrast that with the red hind who produced nearly twice her own weight during the same period. At peak lactation the red hind produces about 10 MJ/day energy while the elk cow produces 18.4 MJ/day. These values agree closely with the interspecific regression relationship between the log of body weight and the log of energy output in milk. (Linzell, 1972).

Loudon et al (1984) compared the lactational performance of red deer on the Scot's hill with red deer on improved pasture.

Table 9: Milk consumption by calves (kg/day) on 2 swards using the calf-sucking technique. Loudon et al (1984).

	MILK CONSUMPTION kg/day	
STAGE OF LACTATION (days)	HILL PASTURE	PERMANENT RYEGRASS PASTURE
0-20	1.56	1.95
20-40	1.44	2.18
40-60	1.34	1.88
60-80	1.02	1.43
80-100	0.68	1.21

Table 9 shows that hinds grazing poor hill pastures produced less milk than comparable hinds grazing permanent ryegrass swards. The calves from the hill grazed hinds gained 279 g/day during the 100 day grazing period and the hinds themselves gained 40 g/day. In contrast the calves from the improved pasture grazed hinds gained 368 g/day and the hinds themselves 100 g/day. There was a significant correlation between milk yield and calf growth rate.

This quite clearly illustrates the effect of poor summer feeding on lactational performance in red deer. The precise energy requirements for lactation in red deer hinds remains to be established. Such studies are planned at Invermay for the near future.

CONCLUSIONS

Red deer hinds produce a large volume of concentrated milk. Milk production and hence calf growth is very closely linked to hind nutrition. It appears that hinds fed poorly attempt to make up for the deficiency by limiting their own growth in favour of milk production.

SUMMARY

This contribution considers topics new to the Deer Vet literature in New Zealand and updates others in the light of recent research findings.

The importance of adequate feeding of young and lactating hinds is stressed. Growth of young hinds requires more energy than previously thought and energy budgets should be adjusted upwards as a consequence.

Care should be exercised in the use of melatonin to control seasonal breeding of hinds and stags, because melatonin may act to limit growth.

The wintering of young deer indoors, particularly in the Southern parts of New Zealand, may prove a useful husbandry procedure. This technique permits the manipulation of weaner deer growth with supplemental light, providing the possibility of earlier achievement of slaughter weight. The effects on reproduction are unknown.

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