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New perspectives on deer reproduction, growth and production efficiency

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ABSTRACT

Reproduction and growth intersect during lactation. Lactation is the period when the initial productivity of the calf is expressed and much of the potential production efficiency is set. Examples of recent advances in our understanding of productivity systems in deer farming are summarised. Experimentation in lactation has highlighted new information that can improve on-farm production. Recent research has given an understanding of the lactational outputs of the hind rearing either a red or F1 wapiti crossbred calf. Further experimentation has examined the role of protein and energy in determining calf growth. Other research has quantified both hind and calf intake and live weight change during late lactation. The impacts of these developments are discussed.

Keywords: calf, energy, feed intake, forage, hind, lactation, milk production, protein.

INTRODUCTION

The reproductive and growth processes intersect during lactation. The efficiency of production of venison is, in no small part, governed by the growth performance of young deer within the first 3-4 months of life, when they are dependant on their dam for the majority of their nutrition.

Weaning weight is largely driven by nutrition and the lactational outputs of the hind contribute significantly to calf weaning weight. However, we know very little about the effects of variable maternal nutrition on the quality of lactational outputs in red deer hinds.

Summer lactation of red deer often coincides with deteriorating pasture quality in the New Zealand pastoral environment (Nicol & Stevens, 1999) due largely to the effects of drought conditions in some regions and the general process of seasonal pasture senescence (Asher *et al.,* 1996). In line with nutritional practices for traditional ruminant domesticants (sheep and cattle), farmers strive to provide pastures and supplementary feeds of high energetic value (*i.e.* >11 MJ ME/kg DM) in sufficient quantities to promote optimum lactational yields of hinds (Nicol *et al.,* 2000). This is indirectly measured by calf growth rates up to weaning at three to four months of age. However there is also a contribution of direct pasture intake by the calf from about six weeks of age and this may interact with lactational output.

A series of studies to examine the separate roles of lactational output of the hind and forage intake of the calf have been conducted at AgResearch's Invermay Agricultural Research Centre over the past 6 years and some findings are summarized here.

WHAT IS DRIVING THE LACTATIONAL OUTPUT OF THE HIND?

How much milk a hind will produce and for how long was one of the questions that have been addressed at Invermay. The lactational output of red deer hinds rearing either red deer calves (n=8) or F1 wapiti x red deer calves (single and twin calves (n=11) reared by red hinds (n=9)) was measured during 2003-04 (Archer, J.A. pers. Comm.). The use of F1 crossbred calves provided the opportunity to investigate the possible upper limits of lactational output.

Red deer hinds were synchronized and artificially inseminated with red deer or wapiti semen in the autumn of 2003. Calving date and birth weights of calves was recorded as well as post-parturition hind weight. The lactational output of the hind using the double isotope dilution technique (Dove, 1988), the feed intake of hind and calf using the alkane dilution technique (Dove & Mayes, 1991), and the live weights of both were recorded at regular intervals over the following 12 months.

General results showed that lactation ceased after approximately 9 months, though milk yields were very low 6 months after parturition. Hinds rearing an F1 crossbred calf produced nearly 50% more milk than those rearing a red calf , even though suckling time was not different (Ward *et al.,* 2007). Calves did not have different forage intakes over the first three months of lactation , representing a standard pre-rut weaning time. However, hinds rearing an F1 crossbred calf had a feed intake of approximately 30% more than those rearing a red calf over that period . Hinds rearing red deer male calves produced more milk than those rearing red deer female calves, but this difference was not evident in hinds rearing F1 crossbred calves, indicating that the upper limits of the lactational output of red deer hinds were being reached .

ENERGY OR PROTEIN FOR LACTATION?

Another limitation to hind lactational output may be the quality of the diet that she eats. On standard perennial ryegrass/white clover pastures managed optimally to provide the desired energetic level, growth rates of red deer calves approach 450 g/day over the first 12 weeks of life, resulting in calf weights of about 47-50 kg in early autumn. However, some on-farm observations, in which novel crop and forage species have been incorporated into the nutritional regimen over lactation, report growth rates in red deer calves up to 700 g/day (Beatson *et al.*, 2000). This raises questions about the optimal nutritional requirements of lactating red deer hinds to express their true genetic potential for lactation and calf growth outputs. Do non-conventional crops and forages provide additional nutrients that support calf growth rates 30-40% higher than on standard pastures?

Protein concentrations in the diet of 14 to 18% CP are required to maximise lactational output in both sheep and cattle (ARC, 1980). Often summer pastures fall below this level. Red deer milk also has a higher content of protein (12-13%) than is the case for sheep (5.5%) and cattle (3-4%) (Arman *et al*., 1974; Krzywinski *et al*., 1980), and so the hypothesis that protein may be the nutrient limiting red deer lactational output was tested at Invermay in the 2005-06 summer autumn period.

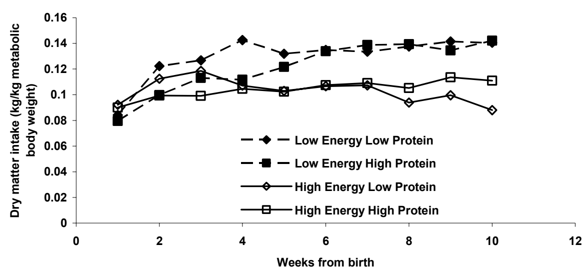
The experiment was a two by two factorial design with four replicates. The factors were energy and protein. Diet energy densities were approximately 10.3 and 12.4 MJ ME/kg DM for low and high energy diets respectively. Diet protein densities were approximately 120 and 230 g CP/kg DM for low and high protein diets respectively. The diet was presented in a pelletised form (Asher *et al.,* 2006)

Sixteen parous hinds (>4years old) were individually housed and calved indoors after a period of habituation and assigned to the four treatments. The assignment was balanced for calf sex. Measurements of daily intake, and weekly live weight were taken for ten weeks after parturition. For the complete methodology refer to Asher *et al.* (2006). The system was set up to exclude the calf from feeding to assess milk only live weight gain and hind intake. However, some cross feeding was observed and so each pen was considered as a hind/calf intake pair.

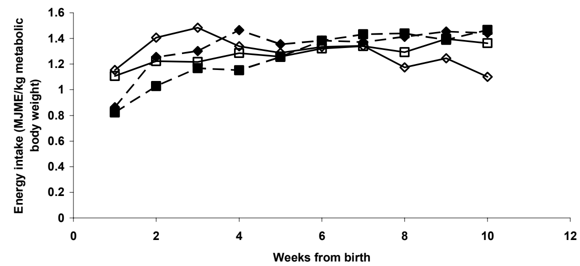
Mean dry matter intakes for treatment groups generally increased from around 2.2-2.4 kg DM/d around calving to a plateau of 3.5-5.0 kg DM/d 20-40 days later. Overall mean dry matter intake (Figure 1a), adjusted to metabolic body weight, was significantly higher (by about 35-40%) for hinds receiving low energy rations than those receiving high energy rations, irrespective of crude protein level (P<0.05). Average energy intake expressed per kg of metabolic body weight (Figure 1b) was similar across all treatment groups (P>0.1). Consequently, average crude protein intake (Figure 1c) varied enormously across treatment groups (P>0.001), with a range at mid-late lactation of <400g to >1000 g/d from High Energy/Low Protein and Low Energy/High Protein, respectively.

Figure 1: Mean daily dry matter, energy and crude protein intakes of hinds on diets of differing energy and crude protein concentrations expressed on a metabolic body weight basis (adapted from Asher *et al.* 2006).

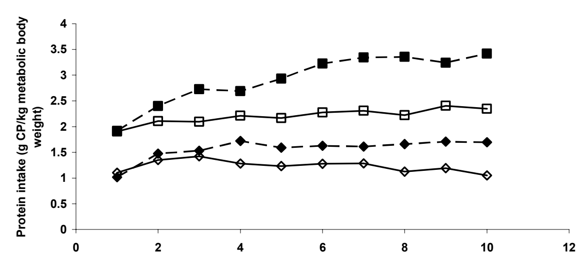
a) Dry matter intake



b) Energy intake



c) Crude protein intake



Mean calf growth rates did not vary significantly between treatment groups, ranging from 500-600 g/day within the first two weeks to ~350 g/day for the remainder of the suckling period (Asher *et al.,* 2006). Ten-week weights averaged ~40 kg. Mean live weights of hinds generally increased by ~10 kg during the 10-week period immediately post-calving. While treatment allocation based on birth date and calf sex produced a 10 kg difference in mean post-partum weights of hinds across groups, there were no significant treatment group differences in mean live weight change over the next 10 weeks of lactation (Asher *et al*., 2006). Correlations between energy intake of the hinds and calf growth were significant (Asher *et al.,* 2006), but not for protein intake. This study concluded that in a red deer breeding system it was energy intake rather than protein intake that was driving lactational output in the hinds.

HOW DO MILK AND FORAGE INTERACT IN LATE LACTATION?

As the calf develops a functioning rumen it moves from a reliance on milk to forage as a primary source of nutrition. The type of forage on offer may influence this shift and so influence the reliance on, or demand for, milk. Two experiments have been done at Invermay to investigate the role of forage in late lactation calf performance.

While investigating the role of brassica crops in lactation Stevens & Corson (2006) found that the dry matter intake of both hinds and calves was reduced when grazing a leaf turnip (*Brassica campestris* × *Brassica napus cv*. Pasja). Consequently, calf live weight gain was reduced by 2.2 kg over the 44 day grazing period. The energy intake of the calves was reduced by 1.7 MJ ME/d though this was not significant (P=0.22), but was reduced by 13.2 MJ ME/d in the hinds (p<0.01) (Steven & Corson, 2006).

Investigations into the role of specialist pastures in late lactation (Stevens, D.R.; Corson, I. pers. comm.) produced another result. The voluntary feed intake and live weight changes of hinds and calves grazing either a perennial grass and white clover pasture or a specialist pasture containing ryegrass, white clover, chicory, red clover and plantain were measured during February 2001. Nine hind calf pairs on perennial grass and 11 hind calf pairs on the specialist pasture were monitored in herds of forty hind calf pairs.

The feed intake, measured by alkane dilution (Dove & Mayes, 1991), was significantly lower (P<0.01) in calves on the perennial pasture than those on the specialist pasture, being 0.61 and 0.92 kg DM/d respectively. The digestibility of the pasture eaten was also significantly different (P<0.01) being lower in calves eating the perennial pasture than in calves eating the specialist pasture (604 and 640 g/kg DM respectively). However, this did not translate into an increase in live weight gain, with this being not significantly different, averaging 412 g/d.

The feed intake of hinds grazing the standard pasture and the specialist pasture averaged 4.16 and 3.78 kg DM/d (P=0.23), while the digestibility of the pastures were similar being 675 g/kg DM. The hind live weight gain averaged 240 and 222 g/d for the standard and specialist pasture respectively (P=0.37).

DISCUSSION

Recent research has begun to illuminate the lactation process in the red deer. The potential for the red deer hind to produce milk is high, as demonstrated by the lactational outputs recorded when suckling F1 wapiti crossbred calves . However, this appears to be related to calf demand, rather than hind nutrition. Asher *et al.* (2006) has demonstrated that the hind can increase her intake markedly if energy concentration declines, maintaining a constant live weight gain in the calf. However, the range of energy concentrations was between 10 and 12 MJ ME/kg DM and this relationship cannot be extrapolated beyond this range. Stevens & Corson (2006) have shown that the digestibility of forages consumed by hinds is relatively constant even though the forages consumed were on significantly different chemical composition. This reinforces the contention of Asher *et al.* (2006) that the hind is very adaptable, being able to maintain her lactational output in the face of fluctuations in feed quality.

The upper limits of lactational output that are approached in the research with F1 wapiti crossbred calves may, however, test this adaptability. When these upper limits are approached then feed quality may have a much greater role in ensuring that the hind can maintain an intake high enough to meet calf demand. When intake cannot meet the demand for milk production then the hind must use body reserves or produce less milk. These may be the circumstances when F1 crossbred calves do not perform to their potential, a situation that appears to be relatively common in some New Zealand herds. The forage intakes recorded were not significantly different between the red or F1 crossbred calves. This indicates that the calves may not be able to buffer a low milk intake if feeding conditions do not meet the demands of the hind. Indeed, when feeding conditions cannot meet the hind demand, they will also be insufficient for the calf as feed quality has a significant effect on both forage intake and digestibility in the calf (Stevens & Corson, 2006).

The interaction between forage supply and milk production in late lactation can produce relatively complicated outcomes. New data (Stevens, D.R.; Corson, I. pers. comm.) have provided evidence that an increase in calf forage intake does not necessarily translate into an increase in live weight gain. The increase in forage intake appeared to reduce demand on milk from the hind, with a significant reduction in hind intake. Therefore the increase in forage quality provided a higher intake in the calves and reduced milk demand in these red deer calves. However, when both hind and calf intakes were reduced by the forage presented (Stevens & Corson, 2006) then the hind did not compensate with a greater milk output in late lactation.

Based on the evidence presented here it appears that the hind has a unique ability to increase her intake as the energy density of the diet declines thus maintaining a relatively constant intake, similar to the findings of Webster *et al.* (2000) for weaners in winter. This may be compromised by feed type or the amount of feed on offer. The lactational outputs of the hind appear fixed by calf demand if enough feed is on offer. Those lactational outputs appear to be increased to near maximum by an F1 wapiti crossbred calf. However, the ability of the hind to modify her lactational output through increased intake or mobilisation of body tissue to feed an F1 crossbred calf when feed conditions are limited have not yet been tested and may explain why the growth rate of F1 crossbred calves is sometimes compromised on New Zealand farms. Calf performance in late lactation is a result of the interaction between forage quality and lactational outputs. Feed quality in late lactation appears to be much more important for the calf than the hind, as they are yet to exhibit the flexibility to increase intake when feed quality declines.

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