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SUMMARY

Within the New Zealand red deer industry, there are a wide range of subspecies offering a 2-3 fold range in mature size. In this paper we use a model (based on Parks 1982) which predicts the ratio of outputs to inputs to quantify the effects of changing subspecies or hybridisation on biological efficiency. In all cases, there were two peaks of biological efficiency, the first with slaughter of progeny at about 30 weeks of age and the second, at about 68 weeks. In the case of changing subspecies, the increase in efficiency was about 10% for a 2.5 fold change in male mature body weight. This was about one-third of that achieved by hybridisation of the largest subspecies over the smallest.

INTRODUCTION

The red deer industry in New Zealand is unusual amongst meat producing industries with the availability of strains and sub-species with a 2-3 fold range in mature size. This large variation offers producers the opportunity to either vary the mature size of the sub-species being farmed, or to engage in hybridisation programmes where the ratio of mature size of the sire and dam strains is much greater than is possible in other meat producing ruminants. Given these options there is a need to quantify the effects of either changing sub-species, or engaging in hybridisation programmes. In this paper we use a preliminary version of a model, based on a series of feeding and growth equations proposed by Parks (1982), which predicts the ratio of outputs to inputs to quantify the effects of these alternatives on the biological efficiency of venison production.

THE MODEL FOR BIOLOGICAL EFFICIENCY

The life time biological efficiency of the hind/calf unit was calculated as a ratio of the life time outputs/inputs using the following equation:

$$\text{Biological efficiency of the hind/calf unit} = \frac{\text{slaughter weight of sale progeny}}{\text{food consumed by the progeny to slaughter excluding replacement hind}} + \frac{\text{cull weight of the hind}}{\text{lifetime food consumed by hind}}$$

Feed inputs Post-weaning weekly feed inputs for both the progeny and the dam were described as an exponential function of age, which included parameters for mature feed intake (ie, the asymptote of the exponential function) and appetite (ie, the rate at which an animal attains its mature food intake). Superimposed on this basic function were two sine oscillations in feed intake, the first resulting from day length and the second from climatic/environmental factors. The depression in food intake during the period of the rut in the stags, which would be expected

from about week 68, was not incorporated into the relationship. Parameters for the basic feed intake function and the amplitude and phase shift of the day length oscillation were estimated from feed intake data from indoor studies (Fennessy 1981; Fennessy unpublished; Suttie 1987), where red deer stags and hinds were fed ad lib. on high quality diets. The magnitude of the environmental effect on feed intake was taken from studies by Fennessy et al. (1981a) for the South Island of New Zealand. Feed requirements for lactation in red deer were derived from Fennessy et al (1981b). To allow appropriate scaling of parameters between the different sub-species, all parameters were expressed as a function of live weight raised to the power 0.75.

Outputs The patterns of live weight and growth for red deer were derived from Fennessy et al. (1981a), Suttie et al. (1987) and Moore et al. (1988). Body weight from weaning to maturity was calculated as an exponential function of cumulative feed consumed. The rate at which cumulative feed was converted to liveweight was described by a feed efficiency factor (AB), which effectively describes gross feed efficiency of the animal, adjusted for the stage of maturity of body weight (Parks 1982). To calculate cumulative feed consumed, the weekly feed intake function (not including the environmental oscillation) was numerically integrated with respect to age. The day length oscillations in feed intake were incorporated in the body weight/cumulative feed intake function utilising the controlled growth functions of Parks (1982), which effectively resulted in a three week lag between changes in feed intake and the resultant change in body weight. Carcass weights or slaughter progeny and cull females were calculated as a linear function of slaughter liveweights (Drew 1985, Drew and Fennessy unpublished).

Management constraints Both food inputs (MJ of ME for both the progeny and the dam) and weight outputs (kg carcass weight for both progeny and the cull dam) were calculated for a self replacing enterprise in which both male and female progeny (minus one female progeny to be used as a replacement hind) were sold for slaughter. Dams were first mated at 16 months of age and kept for 10 weanings before culling. Lactation was included as a cost on the dam. Over the dam's life time an annual mortality rate of 2% was assumed. A pregnancy rate of 98% was used with a pre-weaning mortality rate for progeny of 5% and an annual post-weaning mortality of 2%.

RESULTS AND DISCUSSION

PATTERNS WITH RED DEER

Feed intake For male progeny, feed intake increased slightly from weaning (in the first week of March at 13 weeks) to a maximum in May, before declining during the winter. Feed intake then increased during spring-summer to reach a maximum at 58 weeks of age (mid-January). The pattern of feed intake for female progeny was similar although the increase in feed intake between the week after weaning and the January maxima was only 46% in the females compared with 113% in the males.

Body weight Using a preliminary analysis of liveweight/feed intake data collected at Invermay, the efficiency at which food was converted to liveweight after adjustment for body weight (ie, the (AB) value, see

Parks 1982), was estimated at 0.018 and 0.014 (MJ of ME feed intake/kg of liveweight) for hinds and stags respectively. This is in contrast to sheep and cattle where (AB) has been estimated at 0.022 for males and females of both species where ME content of the diet is assumed to be 10.5 MJ/kg (Parks 1982).

As expected, oscillations in feed intake in both sexes were reflected in body weight. At weaning and 67 weeks of age males were 24% and 65% mature respectively, compared with females which were 44% and 92% mature at the same ages.

Biological efficiency The shape of the biological efficiency curve reflects the seasonal oscillations in feed intake and body weight. There were seasonal peaks in biological efficiency at 30 and 67 weeks of age, with the second peak being about 14% higher than the first. The 67 week peak was the maximum attained at any age.

THE EFFECT OF SUB-SPECIES ON BIOLOGICAL EFFICIENCY

Table 1 presents the calculated biological efficiency values for different sub-species of red deer at slaughter ages of 30 and 67 weeks. In all sub-species the second peak of biological efficiency at 67 weeks was about 11-14% higher than the peak at 28-30 weeks. Therefore in a pure-breeding enterprise the optimum slaughter for efficiency was virtually independent of the mature size of the sub-species being farmed.

Table 1. The calculated biological efficiency of different sub-species of red deer, where the age at slaughter is 30 or 67 weeks

Mature live weight (A,kg) ¹		Biological efficiency (kg carcass/MJ ME X 10 ³)			
Males	Females	Age at slaughter : 30 weeks		67 weeks	
200	100	2.358	2.61	4.27	2.97
300	160	2.498	2.75	4.27	3.09
400	220	2.611	2.86	4.192	3.19
500	280	2.758	2.96	4.179	3.27

¹Sexual dimorphism in mature live weight was derived from the equation :
 $A_{female} (kg) = 0.606A_{male} - 21$

Increasing mature size by changing sub-species resulted in an increase in biological efficiency. The actual rate of increase declined as mature size increased (eg. 4.0% increase by shifting from a 200/100 to a 300/160 kg system compared with a 2.5% increase by shifting from a 400/220 to a 500/280 kg system with slaughter at 67 weeks). The decline in the rate of increase was largely due to the relative decrease in sexual dimorphism with an increase in mature weight across the sub-species. The overall increase is similar to that calculated for cattle by Thompson and Barlow (1986), where a 100 kg increase in mature size resulted in a 3.8% increase in biological efficiency.

THE EFFECT OF HYBRIDISATION ON BIOLOGICAL EFFICIENCY

Table 2 presents the calculated biological efficiency values for hybridisation between the various sub-species and NZ red deer. The shape

