The second article in a series

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Efficiency is something that most of us, regardless of what we do, feel we can recognise. The problem comes when you try to explain efficiency to others who are equally certain of its meaning.

Scientists don't even agree among themselves on efficiency. However, one of the main points in our first article of this series was that genetic progress could only be made if valuable characters in deer are identified and measured. Applying this to efficiency, the question becomes: Are bigger deer always better and if so by how much? The answer must be of more than passing interest to those considering the purchase of Wapiti or hybrids.

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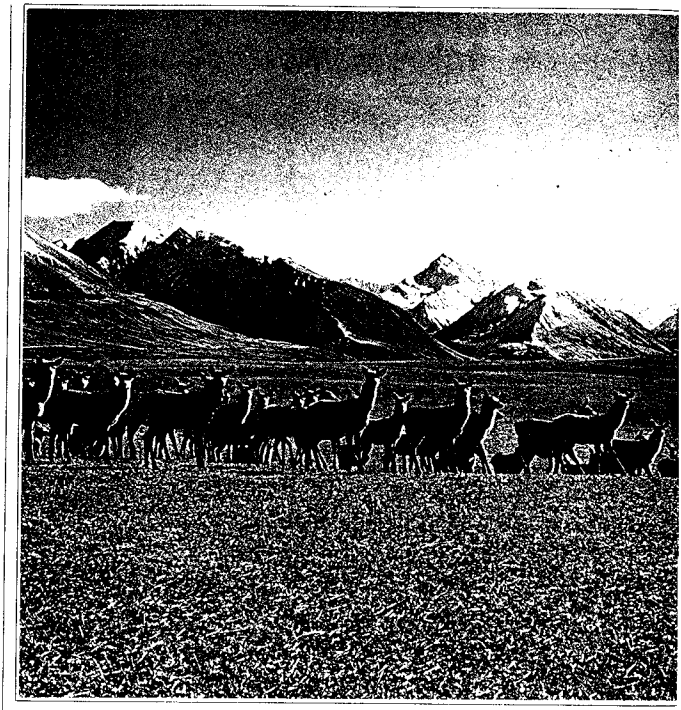


Directions in deer breeding....

EFFICIENCY

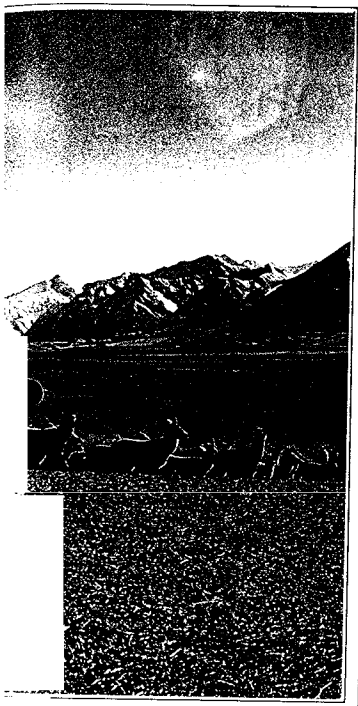
When bigger is better

IT IS A fact of animal life that bigger beasts are metabolically more efficient. A mouse must eat more each day, for its weight, than a moose. This is because for its weight more of a mouse is surface area, which gives off heat (i.e. once you have skinned a mouse, there is not much left).

In fact the actual heat loss of an animal is proportional to its body weight to the power of about 0.75 or 3/4. What this means is that two animals which differ four-fold in body weight (BW) will differ by less than three-fold in heat loss.

Since heat loss involved in keeping an animal warm is the major contributor to the maintenance requirement of an animal, it follows that the maintenance requirement is also proportional to BW to the 3/4 power. Thus larger animals require proportionately less feed for weight than smaller animals, all other things being equal.

Table 1 applies the heat loss/body weight relationship to deer species currently behind fences in New Zealand. Average hind weights from the previous article (The Deer Farmer, December 1984) are used; Pere David's



Size is not everything.

deer, a recent arrival, are included.

The table explains why Wapiti, without knowing the mathematical relationship, became the largest *Cervus elaphus*. They came to North America from Asia via the Bering Land Bridge during the last Ice Age. In that cold environment, the lower relative heat loss would enable a larger animal to eat proportionately less, a real selective advantage.

Those genes packaged in larger Wapiti thus were more successful in spreading across the Paleoarctic. (There are, of course, other successful adaptations for coping with cold: Musk ox improved insulation, bears dreamed up hibernation).

However as Wapiti spread south and the planet warmed, size alone was not such an advantage. This is apparent today when comparing the dwarf Tule elk from California with the Roosevelt elk further north. As fossil evidence from Alaska shows, the largest Elk or Wapiti are a thing of the past[4].

When bigger isn't better

The recent decline in size of Wapiti, as well as the example of Sika deer and other island populations, suggest that size is not always equated with efficiency. When food, land or shelter become limited, new selective factors intervene. These are precisely the conditions in the farm situation. They suggest a different equation to measure animal efficiency:

$$\frac{\text{Production}}{\text{Food intake}}$$

This equation makes more intuitive sense to the farmer. If a deer does not produce anything, regardless of what it eats, its efficiency is zero. The folly of selecting for food intake is obvious as it would lead to a higher intake, without necessarily affecting any useful productive character.

However, defining production in terms of weight gain (or weight for age) and selecting solely on this criterion may also have hidden costs. For example, selecting for weight gain will tend to increase weight at all ages and hence such selection will lead to animals of larger mature size. Because they are larger, there will be larger overheads in maintaining the same number of breeding females.

The essential question is, under what conditions will large size be of benefit in farmed deer? For producing big antlers there is little doubt, as antler size increases at a relatively faster rate than body weight. A two-fold difference in body weight results in at least a three-fold difference in antler weight. However, with selection for weight, the situation is not so clearcut.

Extending the discussion of heat loss and evolution of the Wapiti shows that in theory every increase in the average weight of the animals in a breeding herd should increase efficiency of meat production, all other things being equal.

But of course all other things may not be equal. For example, while animals of greater potential adult size may have a faster daily weight gain, they may not be growing relatively faster. And although it may look good to have fast growing animals, it may not be so important how fast they start, but how close they are to the finish. In other words, how close a deer is to its potential size at slaughter. With larger animals, the finish is further down the track.

In the National Deer Recording Scheme, it is precisely this problem of how to allow for differences in mature body size which has led to the requirement for an annual hind weight. The use of this weight will allow adjustment of the calf weight for that of its dam, as well as that of the sire. This will allow selection not necessarily for large hinds, but efficient hinds which produce large calves for their weight.

There are other factors to consider before jumping on the bigger bandwagon. Animals of larger mature size tend to become sexually mature relatively later. This is evident on some Chinese

TABLE 1

As size goes up, so does the metabolic rate, but not as fast

Average weight and calculated metabolic rates for farmed deer. Column two and three show that as relative weight increases, the relative metabolic rate increases at a slower rate.

Deer	Average Female Wt	Relative Wt	Relative MR
Sika	50 kg	1.0	1.0
Rusa	60 kg	1.2	1.2
Red	110 kg	2.2	1.7
Pere David's	130 kg	2.6	2.0
Wapiti	210 kg	4.2	2.8

▷ deer farms where the Meihualu (Sika deer) calve for the first time as two year-olds whereas Malu (Wapiti) calve at age three. Finally, Wapiti obviously require very different handling procedures, a fact which should not be underestimated particularly by farmers whose previous experience is with sheep.

After years of pushing selection for size and weight gain as the route to efficiency, the cattle industry is now having second thoughts[1,3]. Applying these lessons to deer farming, the most efficient herd would be composed of mature females that are large enough to produce and rear calves from a terminal sire (such as a Wapiti bull) but no larger.

This might be achieved with a Red deer herd covered by a hybrid stag or a hybrid herd covered by a Canadian Wapiti bull, depending on farming conditions. It does suggest, that with the exception of specialist terminal sire breeders, there is a limit to upgrading for size. Beyond that limit, the deer farmer is supporting big animals at the cost of other selection criteria.

The livestock industry generally is just realising that efficiency must eventually

"We might take a lesson from the American West and design selection programmes for the future . . ."

be measured in bio-economic terms[2,3]. Because deer farming is a young industry composed of diverse interests it is in a good position to avoid becoming fixated on one component of productivity such as size. Efficiency must ultimately be measured as:

$$\frac{\text{The value of a herd's products}}{\text{The cost of producing them}}$$

By this formula, a herd which calves early, taking advantage of spring feed, or a herd with a high calving percentage may prove much more efficient than a herd of huge hinds.

Given the recent value of velvet, the emphasis on big deer is understandable. But here we might take a lesson from the American West. Whereas, the value of cattle by-products once comprised 75 per cent of the live animal value, today it is the dressed carcase which accounts for more than 90 per cent of that value[5]. If venison is the primary product of the deer farming industry, we had best rein in our Wild West fantasies and design selection programmes for the future.

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