STAG SELECTION, PROGENY TESTING AND RECORDING

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INTRODUCTION

There is considerable interest in genetic improvement within the New Zealand deer industry. This is evident from the involvement of farmers in importing from Europe and North America different subspecies and strains which will interbreed with the New Zealand red deer (Cervus elaphus), and also Mesopotamian fallow deer. It is also evident from the interest in sire referencing among red deer farmers (McCall 1989) and in the fallow deer group breeding scheme (Hazelhurst 1989).

Various aspects relevant to stag selection, progeny testing and recording have been discussed at previous Deer Branch Conferences (Fennessy 1986, 1987a; Rapley 1988). Therefore this paper is concerned primarily with some of the newer developments and on aspects particularly relevant to the commercial farmer rather than the stag breeder. While the paper will concentrate on the red deer family, the principles also apply to fallow deer.

STAG SELECTION

Objectives

The first requirement for the farmer selecting a breeding stag, either from within a herd or from a specialist stag breeder, is to define the commercial objective. A number of questions must be considered. Is the objective to produce high quality breeding hinds (as replacements or for sale), velveting stags or progeny to be slaughtered for meat or even a combination of all three? How important is cash flow? Can the investment be long term or is it necessary that it be relatively short term? Without a clear commercial objective any decisions are likely to be somewhat haphazard.

Breeding decisions taken now will often have very long term consequences. Therefore the successful outcome of any decision is dependent on one's assessment of the long-term market and involves an assessment of risk. For example, breeding for velvet antler production is particularly long term in that stags produced from matings in 1990 will only reach peak production in 1995 or 1996, while it will be December 1992 before there is any significant return on the progeny (ie the first velvet crop). Breeding weaner hinds for sale is probably somewhat less risky in that 1990 matings will produce progeny for sale in autumn - winter 1991. Production gains from a consistent policy, however, are cummulative and permanent.

Consequently the risks involved in a breeding operation highlight the importance of having a flexible system; that is a system which offers various alternative end uses of the progeny produced.

Table 1 summarises the factors to be considered in determining objectives in a deer breeding operation. Having broadly defined objectives, the next question relates to the two alternatives of hybridisation between strains (usually with the New Zealand red hind as the base) or selection within a strain.

TABLE 1. Stag selection : a checklist of factors to be considered in determining objectives

General issues	
Assess relativities of markets in the long term	
Assess the physical and climatic merits or limitations of the farm.	
Balance the perceived risk with economic realities: eg, cash flow, tax liability.	
Specific issues	
Consider alternatives	: hybridisation between strains selection within a strain
Breeding hinds (sale/retain)	: hind size handling/temperament animal health
Meat production	: efficiency market requirements - fat/lean carcass size seasonal price female progeny - meat production/breeding
Velveting stags	: antler weight/liveweight relationships performance of the strain temperament/handling animal health market requirements - velvet antler size quality?

In assessing the two alternatives of hybridisation between strains or selection within a strain, the factors to be considered can be summarised under:

* feed requirements and size
* management
* flexibility

Feed requirements, size and efficiency

Feed requirements are related to the metabolic rate of an animal. While larger animals clearly have a greater feed requirement than smaller animals, the overall requirements are approximately proportional to bodyweight to the power of 0.75 (ie metabolic bodyweight). The effect of this relationship between bodyweight, relative metabolic bodyweight and relative feed requirements are illustrated in Table 2. Therefore, in theory a 250 kg hind, although 2.5 times the weight of a standard 100 kg hind, would have a feed requirement of only about twice that of a 100 kg hind.

TABLE 2. Bodyweight, metabolic bodyweight (weight$^{0.75}$) and relative feed requirements for deer of different weights

Bodyweight (kg)	Weight$^{0.75}$	Relative feed requirements
50	18.8	0.59
100	31.6	1.00
150	42.9	1.36
200	53.2	1.68
250	62.9	1.99
300	72.1	2.28
400	89.4	2.83
500	105.7	3.34

The relationship between bodyweight and feed requirements indicate that theoretically there should be advantages from the efficiency perspective (ie meat production/unit of feed) in farming a larger species so long as relative growth rates and reproductive rate are essentially similar. However in practice, there is evidence that some of these assumptions are not correct. For example, sexual dimorphism between males and females within a species has a major impact on efficiency in that it influences the relative growth rate of males and females. Within the New Zealand red deer, there is evidence that the ratio of male to female adult bodyweight is about 2.0 (ie adult stags from 180 to 220 kg and adult hinds from 90 to 110 kg). However it appears that within the Canadian wapiti (elk) the ratio may be closer to about 1.8 (ie adult bulls 400 kg and adult cows about 220 kg). In addition, there is mounting evidence that female wapiti or elk are later maturing than red deer reproductively. In effect, they have a lower fertility than red deer at first calving as 2 year olds (Pearse and Fennessy unpublished data). The effect of both the reduced sexual dimorphism and the lower fertility is to reduce the advantages of size on efficiency of meat production, below that which could be expected based on the differences in relative feed requirements outlined in Table 2.

The most efficient system of venison production would entail the hybridisation of a large male strain (eg wapiti, elk, elk x red hybrid, large European red) with females from the smaller New Zealand red strain. Examples of the effects of these types of hybridisation systems on efficiency are given in Table 3 (Fennessy and Thompson 1989).

TABLE 3. The effect of hybridisation between various male strains of deer and the base New Zealand red hind on biological efficiency of the hind/calf unit (g carcass per MJ of ME utilised).

Mature bodyweight of the parental strains (male/female) Kg		Biological efficiency with slaughter of progeny at 63 weeks of age
Sire strain	Dam strain	
200/100	200/100	2.89
300/160	200/100	3.22
400/220	200/100	3.49

While the hybridisation of a 400 kg wapiti or elk male with New Zealand red hinds is achievable (Pearse 1988), it is not a system that is amenable to large scale production. However, the hybridisation of a male of intermediate size with a New Zealand red female is practicable on a large scale (eg, from Table 3, a 300 kg male with a 100 kg female). The efficiency values presented in Table 3 assume the same pregnancy rate and mortality rate in all 3 systems; in practice, lower pregnancy rates and higher preweaning mortality rates will reduce real gains. In this respect, though, these changes are not likely to have very much influence in the intermediate type system although at present practical data are limited.

Antlers

A number of studies have shown that there is a general relationship between hard antler weight and bodyweight (Hyvarinen et al 1988; 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 bodyweight had plateaued at 5-8 years of age. Also of considerable interest is the work of Huxley (1926, 1931) who showed that hard antler weight increased at a relatively faster rate than bodyweight in a large sample of European red deer. The expected hard antler weights for stags (*Cervus elaphus*) of various body weights calculated from the data of Huxley (1931) are presented in Table 4.

TABLE 4. Expected hard antler weight for stags according to bodyweight based on the data of Huxley (1931).

Bodyweight (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 of red deer have revealed similar patterns. For example, analyses within groups of red stags of the same age reveal increases of 0.1 - 0.2 kg velvet antler per 10 kg increase in bodyweight (Moore et al 1988; Muir & Sykes 1988; Fennessy unpublished). Unfortunately there are very few data available for velvet antler production for the larger species of deer. However an unselected population of mature Canadian wapiti (*Cervus elaphus manitobensis*) at Invermay average about 6 kg of velvet antler when cut at the A grade stage, compared with an unselected group of New Zealand red deer which yield about 2.3 kg. In both cases this is about 40% of the expected hard antler weight for stags of the same weight calculated from Huxley's data (Table 4).

The relationship between antler weight and bodyweight would suggest that there would be considerable advantages in farming larger strains of the *Cervus elaphus* family if velvet antler production is the major objective.

However, the demand for large quantities of such a product in South Korea is unknown. In fact there could be a greater market for velvet antler similar in size to the traditional Chinese spotted deer (meihualu) antler (Chinese 2- and 3- point, the latter equivalent to the New Zealand 'A' grade stage) rather than the larger antlers from Chinese malu and Asiatic wapiti. In this respect, the antlers from the larger strains in China and Russia are harvested at a later stage of growth than the usual New Zealand 'A' grade. Some of the very high yields quoted for the various strains of deer which have been imported into New Zealand are partly due to velvet also being harvested at this later stage of growth. Therefore when evaluating the merits of different strains of deer for velvet production, it is important to take into account the stage of growth at velvet harvest.

In considering meat production options from deer, two other factors must be evaluated carefully, namely the seasonal pattern of venison prices and carcass quality, both in respect of weight and fatness. In recent years a seasonal pattern of venison price has usually been apparent with higher prices in early spring associated with the demand for product during the Northern Hemisphere winter. A figure of 55 kg minimum carcass in the August-October period is often cited as the type of carcass required (Anon 1989). Consequently a deer of at least 100 kg liveweight is required. Assuming that particularly well-fed red stags average about 90 kg liveweight at this time, the top 20% would be over 100 kg. In contrast under the same feeding conditions the male progeny of a 300 kg sire stag over a standard New Zealand red hind would be expected to average about 110 kg at the same time in which case all but about 20% of the group would reach the 100 kg target liveweight. In reality, red stags do not often reach 90 kg by mid-late October.

In broad terms the degree of fatness at slaughter in stags is a function of the proportion of mature weight at slaughter and to some extent the time of the year (ie season). With young stags up to about 16 months of age and prior to their first rut, fatness is a function of weight. Young red stags at 50% of their mature weight have about 9 - 10% carcass fat, while at 66% of their mature weight, they reach about 13% carcass fat (Drew 1985; Drew and Fennessy 1986). The limited data available suggests that at the same proportions of their mature weight and at the same age, elk (wapiti) x red hybrids have similar carcass fat percentages; however the hybrids are substantially heavier (Drew pers. comm).

Management

There are some management issues to be evaluated when considering the possibilities in relation to hybridisation or selection within strains. In particular, temperament, handling and health are very important aspects.

New Zealand wapiti-type animals and their relatives from Canada have had a reputation for being especially difficult to handle. This reputation is probably unjustified and reflects a necessity to alter handling methods to deal with much larger animals. They are quiet in a paddock situation but specialist facilities are necessary when handling the animals in yards (Pearse 1988). More recently, some of the European red deer imports are reputed to be exceptionally quiet while others are reputed to be markedly less so. Some New Zealand red strains also have reputations for quietness. Obviously there are no objective data available but it is wise to consider remote handling facilities if animals much larger than New Zealand red deer are to be farmed.

Animal health is of particular importance especially with wapiti or elk. It is now well documented that purebred elk are more susceptible than red deer to a range of problems including ryegrass staggers, copper deficiency and internal parasites (Mackintosh et al 1982; 1986). There is also a frequently described "elk wasting syndrome", a complex which seems to involve parasitism and low copper status and perhaps some mycotoxins (Pearse 1988; Fennessy et al 1988). Therefore it is recommended that purebred elk grazing good quality pasture always have access to lucerne hay to provide a good roughage component in the diet. While purebred elk are particularly susceptible to such health problems, the problems are much reduced in hybrids making management a much simpler operation. In comparison with any system involving hybridisation, a straight bred red deer system is simpler to manage.

Flexibility

A key issue in considering any animal production system is flexibility (Fennessy 1987b). Running a base herd of New Zealand red deer offers a very flexible system. For example red hinds can be mated to wapiti or elk hybrid stags one year and large European red stags the next if so desired, so long as adequate replacement base females are produced in order to maintain the system. In such a hybrid system, female progeny can be sold as breeding hinds, slaughtered for meat production or even kept as replacements bearing in mind the issues relating to size discussed previously. A system which offers flexibility right up to the point of sale of progeny offers major advantages in terms of economics.

Hybridisation or within strain selection

The wide genetic diversity among the red deer family opens enormous possibilities in hybridisation between strains. Clearly this raises a number of questions about the real benefits of selection within strains for commercial breeders producing venison or velvet antler. Much greater gains in absolute production (eg velvet antler weight, carcass weight) and in efficiency of production can be expected by the careful use of hybridisation rather than selection within strains. A comparison of the two alternative strategies for velvet antler production is outlined in Table 6.

The calculations in Table 6 indicate clearly the advantages of hybridisation with a superior strain. However for the stag purchaser, the major question is whether the strain of deer being considered is genuinely superior or whether the so-called superior stags just represent the extremes of the same strain already being farmed. In this respect there is now good evidence that wapiti (elk) are genetically different from the typical NZ red deer in that the hybrids with reds are performing as expected or perhaps slightly better, suggesting that there may also be some hybrid vigour.

Economic benefits from hybridisation are dependent on the same or a higher price structure for the products of hybrid animals compared with the straight-bred red with little increase in real costs. It may be that in the longer term, the real benefits of a red deer system may lie in its applicability as a large scale low cost system producing red hinds for sale as replacements. This possibility highlights a likely place for the New

Zealand red deer as a dam strain in a self-sustaining system. The objectives in breeding a dam strain are fast early growth (in order to almost attain their mature weight by first calving) and high milk production.

TABLE 6. 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		Genetic progress	Yield of
	Stags	x red hinds	per generation	progeny
Selection within strain				
Average stags	2.5	2.5[2]	0.0	2.50
Top 3% of stags	3.6[1]	2.5	0.22	2.72
Hybridisation between strains[3]				
A) Average stags	3.6	2.5	0.55	3.05
Top 3% of stags	5.2	2.5	0.87	3.37
B) Average stags	5.2	2.5	1.35	3.85
Top 3% of stags	7.5	2.5	1.81	4.31

1 Assuming a standard deviation of 0.5 kg (a coefficient of variation of 20%) and a heritibility 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.

3 Calculations assume no hybrid vigour; ie progeny of average superior strain and average red hinds are midway between the parents.

Purchasing stags on records

Good performance records are now available from a number of stag breeders. The essence of good records is a comparison between an individual stag and his contemporary group for the traits of interest. As a minimum these should include yearling liveweight and 2 year old velvet weight. In addition, weaning weight, winter lean liveweights and additional velvet weights (depending on the age of the stag) can be expected while the ranking of the stag within his group for each trait is a particular advantage for the prospective purchaser. As Animalplan for deer gains ground, this type of information including an estimate of a stag's expected value as a sire, is likely to become more available.

PROGENY TESTING

Progeny testing is the comparative evaluation of the genetic merit of different sire stags by comparison of the performance of their progeny. In order that progeny tests involve fair comparisons, it is essential that all stags have the same opportunity to reveal their genetic merit. That is, all stags must be single sire mated to similar hinds (ie age, weight, strain) and the progeny run together as far as possible. In this respect, hinds should be run together except at mating and for a short time around calving to ensure accurate sire identification. The latter is particularly important and it is well to recognise that mismothering can be a significant problem with hinds calving in small paddocks or where a number of calves are hidden in a small area (Tate and Fisher, unpublished).

Progeny testing involves a considerable investment in recording, and probably has little place in a commercial breeding operation, although smaller commercial farmers often have the records and small scale progeny testing provides an added interest to their deer farming operation. This is particularly so where the records can be collected and analysed simply, such as with yearling liveweight. However a commercial breeder could well be better rewarded by purchasing a well performed stag from a breeder with a high performing strain of deer who is keeping good records and who is using sound genetic principles in a breeding programme than breeding from home-bred sires. As well, progeny testing usually involves a long term commitment, especially where velvet antler production is important. An example of the performance of 5 stags' progeny tested for velvet antler is given in Table 5. While there is clearly considerable genetic variation for velvet antler production which is of real economic significance, the long term nature of the investment may mean that even for stag breeders there may be better returns from selecting stags on their own performance as 2 year olds and the performance of their relatives where available rather than waiting for detailed later information. However advice on the most appropriate strategy awaits far more information on the genetics of velvet antler production than is currently available.

TABLE 5. Progeny test of 5 red sire stags : comparison of the deviations from average cumulative velvet antler weight (2 to 5 years of age) and the 3 year old winter lean liveweight for the 5 progeny groups.

Sire	Number of male progeny	Deviations from average (kg): Cumulative velvet antler weight	Deviations from average (kg): 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	126.0

The type of progeny testing outlined is only valid on a within herd situation due to the necessity for all stags to have the same opportunity. However, progeny testing can be extended to include comparisons across herds by incorporating reference sires. This involves the use of some of the same sires in different herds by artificial insemination. The progeny of the "home sires" can then be compared with the reference sires in each herd and an overall ranking of all sires produced for each particular trait of interest (eg yearling liveweight, 2 year old velvet antler weight). A pilot sire referencing scheme (SRS), for New Zealand red deer organised by MAFTech and the New Zealand Deer Farmers Association, got underway this year (McCall 1989).

In sire referencing there is little point in comparing stags from strains of widely differing mature liveweights. In the absence of major health problems the hybrids with the larger mature sire strain will be clearly superior in per animal performance simply because of the difference in mature size. This is even in the absence of hybrid vigour. Hybrids incorporating the larger mature size strain can also be expected to be more efficient in terms of meat production per unit of feed although there is no simple method for measurement of food intake in the practical field situation.

RECORDING

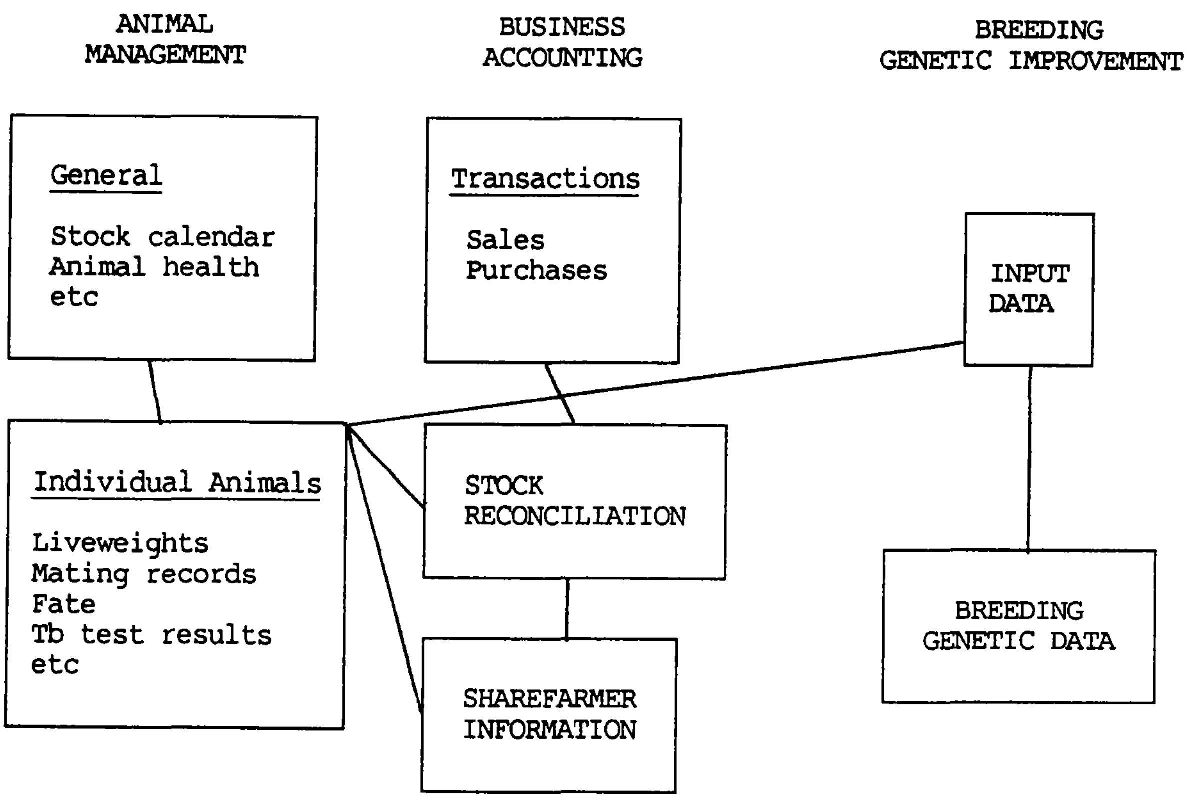
Over the last few years, there has been a prolification of animal recording packages designed for on-farm use on microcomputers. The choice of a recording package depends on the purpose for which it is required.

Generally there are three broad groups of schemes or packages for the deer farmer:

* animal management
* business accounting, ownership, etc
* breeding and genetic improvement

These three types of packages have a great deal of basic data in common and it is the way in which the information is used which highlights the differences between them (Figure 1).

Figure 1: General outline of some relationships between various recording schemes and software packages.



The different types of schemes have been described previously (Fennessy 1987a). From the deer breeding and genetic improvement point of view, Animalplan has the most to offer. It is a multispecies animal recording scheme, developed by MAF, which will meet the genetic recording requirements (pedigree, performance) of the deer, sheep, cattle and goat breeding industries. There is a specific package for deer (Rapley 1988). The package is designed for breeders who are involved in genetic improvement and it is not a general herd recording scheme, although it could be used as such. However, the information generated by the use of Animalplan will be very useful for farmers wishing to purchase stags on performance.

SUMMARY

The critical first stage in stag selection is for the farmer to define the commercial objective. Having done this, the basic question will be to consider hybridisation between strains or selection within a strain. Progeny testing involves a considerable investment in recording and will usually be carried out only by serious stag breeders. There are a number of different recording schemes available, with the essential question being the purpose for which recording is required.

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