ARTIFICIAL BREEDING IN THE NEW ZEALAND DEER INDUSTRY: GENETIC ASPECTS

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INTRODUCTION

The New Zealand deer farming industry has grown rapidly since the first animals were captured in the late 1960's and farming was legalised in 1970. There are now around 1.3 million deer on farms with export receipts exceeding $170 million for the last year. About 30% of the export income is derived from velvet antler with virtually all of the remainder from venison, with co-products such as hides making a minor contribution .

There has been considerable interest in artificial breeding technology since the mid-1980s. However application has been limited to a few breeders of high value ('stud') deer and commercial farmers seeking to breed rather than purchase sire stags. This paper briefly outlines the current industry structure, the current situation with artificial breeding (AB) technologies, the possibilities for genetic improvement and considers a possible future industry structure. The possible place of artificial insemination as the major AB technology is considered in this context.

INDUSTRY BACKGROUND

The New Zealand industry is built around red deer (*Cervus elaphus*) descended from the numerous liberations in the latter half of the last century (Yerex 1991a, b). These deer, imported for hunting originating from Great Britain, were probably mainly the *C. e. scoticus* subspecies. North American wapiti (*C. e. nelsoni*) were also liberated in the first decade of this century. Natural hybridisation between wapiti and red deer occurred in the Fiordland National Park (Smith 1974). This alerted farmers to the potential of hybridisation to improve productivity to better meet market requirements (Moore 1984; Fennessy 1992).

The first wave of imports specifically for farming were wapiti from North America in 1981. Since then, different strains or subspecies of red deer have been imported from Europe, Scandinavia and the UK. These new strains of deer have been imported to increase mature body size (growth rate) and antler size in the New Zealand red deer herd.

European fallow deer (*Dama dama dama*) which make up about 7% of the farmed deer, were also liberated last century. More recently Mesopotamian fallow (*D. d. mesopotamica*), a larger subspecies have been imported and are being used to increase body size and growth rate in farmed fallow deer.

ARTIFICIAL BREEDING TECHNOLOGY

Technologies currently being used in the New Zealand deer industry include synchronisation of oestrus with progesterone followed by either natural mating or artificial insemination (AI, Fennessy *et al* 1991), multiple ovulation and embryo transfer (MOET, Fennessy *et al* 1994) and to a minor extent, embryo splitting.

Artificial breeding (AB) technologies have narrow appeal in the New Zealand deer industry. Generally deer farmers do not perceive great benefits from widespread use of such technologies and currently they are largely restricted to a few "stud" breeders. The fundamental reasons are that current AB technologies require a considerable managerial input at a very busy time of the year in the deer farm management cycle (around weaning) and that the benefits for the commercial deer farmer are not clear cut in comparison with the costs.

However, with respect to AI, a number of commercial breeders have purchased a few straws of semen with the aim of breeding a "genetically superior" breeding stag. In such situations, it is seen as a relatively cheap way of getting access to some of the imported strains. If they manage to breed one or two stags, it is cheaper than purchasing a comparable breeding stag, albeit with a three year delay (ie a breeding stag will need to be at least two years old). "Stud" breeders of the European red deer strains have also used AI on NZ red females to produce hybrids for sale since very limited numbers of purebred animals are available. These breeders are also the major users of MOET to increase the numbers of purebreds.

THE GENE POOL

The pattern of demand for venison features a seasonal pattern which tends to pay the highest prices per kg in the August to November period coupled with a very marked increase in the price per kg for carcasses over 50-55 kg. The growth rate of New Zealand red deer is such that it is very difficult to achieve such slaughter weights at the yearling stage. The velvet antler market has parallels with the venison market in terms of requirements for larger products. The major velvet market in Korea pays the highest prices for the larger types of antler from the larger strains such as the Chinese malu or Siberian wapiti. This demand for the larger antler types has also stimulated interest in methods to increase antler size. Consequently the dual demands for faster growth rates and larger antlers have generated considerable pressure to develop breeding and management practices to achieve these aims. While there is potential for improved nutritional management the genetic route offers greater possibilities. In this respect the farmer has two basic options, namely to genetically improve the NZ red deer by selection within this strain (Fennessy 1982) or alternatively by hybridisation of the NZ red deer with larger strains or (sub) species such as the Canadian wapiti (Fennessy and Pearse 1990).

The broader red deer family is notable for its extraordinary diversity and the capacity of its members to hybridise with one another to produce fertile offspring. This capacity for hybridisation among the various subspecies of the red deer family (eg wapiti and European red deer) and with other related species (eg Père David's deer, *Elaphurus davidianus*) coupled with the genetic diversity now available within New Zealand offers considerable potential to increase the body size and antler size of the basic New Zealand red deer to better satisfy market requirements (Fennessy 1992). The New Zealand red deer, being basically of the *C. e. scoticus* subspecies, is small (average adult stags weigh 200-220 kg and hinds weigh around 100-110 kg) compared with the larger European red deer or North American wapiti subspecies. Consequently, hybridisation using a large male over the smaller New Zealand red female can be expected to result in an increased efficiency (eg Fennessy and Thompson 1988, 1989) and also offer more flexibility in terms of the ability to meet venison market demands with a younger animal (ie to attain the required carcass weight at a younger age). Hybridisation also offers the potential for increases in antler size due to the positive allometric relationship between antler size and body weight within the red deer family (Huxley 1931; Schroder 1983).

The potential for hybridisation to make major improvements in productivity means that there are numerous questions about the emphasis which should be placed on genetic improvement within a strain. The objective of such selection must be to improve efficiency or to select for characteristics which would have a place in an industry structured around hybridisation as the major method of producing animals for slaughter or other products. Consequently this relates both to the development of a specialist dam strain based on the New Zealand red deer and to the genetic improvement of the sire strains. Computer modelling analyses of a deer venison producing enterprise indicated that the major gains in efficiency would be achieved by hybridisation and twinning (Fennessy and Thompson 1988, 1989) while advancing the breeding season would enable better utilisation of spring pasture. An improvement in lactation performance in the dam strain would enable hybrid calves to grow at a rate nearer their genetic potential. The implications of lactational demand on the onset of oestrus in red deer hinds which have reared hybrid calves also need to be considered. Selection to change the rate of maturity so that females attain a higher proportion of their mature weight as yearlings is also a possibility but the impact of such a change in the total enterprise would likely be very small. Further development of genetic modelling procedures would greatly assist in developing answers to some of these questions.

IS THERE A PLACE FOR ARTIFICIAL BREEDING?

Artificial breeding does have a place in specific situations in the deer industry. For example MOET enables a far greater production of embryos from imported strains of European red deer. In the short term AI has much to offer the deer industry as it is essential for the comparative evaluation of the different sire strains to enable the use of reference sires across herds. However, generally AI has its major application in ensuring genetically superior semen is used across large numbers of breeding females in commercial farming situations such as in the New Zealand dairy industry. In hybridisation situations where the sire strain is clearly superior to the dam strain for the desired characteristic, the genetic gain arises mainly from the between strain difference, regardless of the genetic merit of the individual sire within his own strain. Consequently there is much less to be gained from selection within the sire strain although culling of the poorer performing males is still appropriate.

Therefore in the long term does AI have very much to offer the New Zealand deer industry? It is clear that the range in potential sire strains (probably up to 100% heavier than the New Zealand red deer, Fennessy 1992) is such that very large increases in weight for age can be obtained by simply choosing an appropriate sire strain so long as the management system is designed to accommodate the large sire (Pearse 1992). With only a low selection pressure required in sire strains, adequate numbers of stags are likely to be available for natural breeding. The real value of AI will be apparent when individuals markedly superior for particular traits, such as lactation performance or an early onset to the breeding season are identified. It is in this situation that the value of genetic improvement within a strain comes to the fore. These characteristics would be valuable in a dam strain and therefore schemes to identify particular individuals or strains which have especially useful characteristics would be worthwhile. The introgression of such desirable characteristics into the dam strain would be greatly facilitated by AI. In this respect molecular genetics studies may have value in developing procedures to use linkage between markers and traits to help identify potentially valuable individuals for evaluation.

At the present time, there are major impediments to the application of AI in the deer industry and large scale AI is simply not a practical possibility. Currently the benefits for the commercial farmers (as distinct from the "stud" breeder) are few but there is considerable potential. If it is to develop then research to improve the conception rate to cervical insemination and to develop much improved procedures for the collection and dilution of semen are urgently required.

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