A BREEDING PROGRAM FOR FARMED FALLOW DEER

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INTRODUCTION

There is increasing archaeological evidence that deer were being systematically cropped or "ranched" much earlier than has been previously supposed. In the Mediterranean region, fallow deer (*Dama dama dama*), made a sudden appearance on several islands at the same time as sheep, goats and pigs, and subsequently their bones make up 70 percent of those found at Neolithic sites between 6000 and 2000 B.C., suggesting that they may have been introduced for meat production. However, the resurgence of interest in the use of deer for intensive farming began in Scotland about 25 years ago and has developed to the highest level in New Zealand, where one million deer are now farmed. The predominant species being farmed in New Zealand is the red deer (*Cervus elaphus*) while for similar reasons of availability, European fallow deer are the predominant species being farmed in Australia. Fallow deer are the only deer species in Tasmania, being introduced early last century and now well established in a wild population estimated to be around 10,000 animals. In addition there are 7,000 fallow deer on deer farms and I shall confine my discussion to the breeding of fallow deer.

HISTORY

The world-wide distribution of fallow deer is almost entirely due to the efforts of man, as archaeological evidence suggests the species became extinct from much of its original European range during the last ice age. Evidence from archaeological sites suggests the Phoenicians were involved with trade and translocation of the fallow deer, redistributing them from east of the Mediterranean Sea throughout Europe as far as Great Britain. This translocation was continued by the Greeks and Romans, with fallow deer depicted on Roman coins and written records exist of catching, taming and rearing fallow deer in Roman Parks. They owe their popularity to their beauty, religious and hunting values and excellent venison.

GENETIC VARIATION

While the extinction of fallow deer from the whole of Europe is by no means certain, there seems little doubt that this was the case in Britain. No remains of fallow deer have been discovered from the numerous Mesolithic and Neolithic sites extensively studied in Britain, and yet fossil and skeletal remains from earlier periods are extensive.

Studies of modern British fallow deer, based on gel-electrophoresis, failed to find any detectable genetic variation (Pemberton and Smith 1985) suggesting the presence of a severe genetic bottleneck in the past, such as the ice age hypothesis. More recent work with a herd of wild fallow deer in Italy (Randi et al 1988), did identify some genetically linked bio- chemical variation, but it was still very limited and in-breeding as a result of selection by man is cited as another possible cause. The fallow deer which were introduced to Australia and New Zealand last century originated in Britain and could therefore be expected to show a similar lack of genetic variation. Studies of weights for age, oestrus cycle lengths, gestation lengths etc in New Zealand have shown levels of variation consistently lower in fallow deer than red deer (Pemberton 1987). These findings lend support to the idea that British fallow deer experience low levels of inbreeding depression (Smith 1979). The assumption being that any deleterious recessive genes would have long since been eliminated from the population by natural selection. Still further evidence of the limited genetic variation in fallow deer has been Pemberton's work (1990) with DNA finger-printing, which showed that in many British parks, any two female fallow of approximately the same age are about as closely related as mother\calf pairs in a red deer herd. In-breeding has certainly made a significant contribution to this, for example, Houghton Hall in Norfolk is known to have had a herd of 4-500 fallow in 1745 and now has over 1000 head of all-white fallow - a coat colour controlled by a recessive gene. Such parks were the source of the handful of foundation stock which was liberated in Tasmania. We have an indication of the limited genetic base of the Tasmanian fallow deer in the very distinct geographic populations of the various coat colour types - ie. the majority of the deer living to the east of the midlands highway are black, while those to the west are basically spotted.

The message for the farmer from this history and early studies, is that the level of genetic gain to be made from selection within the European fallow deer population may not be very great and so it is necessary to determine that an expensive animal really does have some genetic merit. Yet we have already seen the emergence of deer studs, purporting to have superior fallow deer, recently imported from such places as Hungary, Denmark, Sweden and even England. However, it seems likely that claims of earlier maturity and quieter temperament will prove largely unfounded when properly compared with the fallow introduced to Australia 150 years ago.

MESOPOTAMIAN FALLOW DEER

Perhaps the most exciting recent development in fallow deer farming has been the availability of genetic material from this ,the only other sub- species of fallow deer. Mesopotamian or Persian fallow deer (*Dama dama mesopotamica*) are one of the rarest deer species in the world, being listed as endangered in the Red Data Book compiled by the International Union for the Conservation of Nature and Natural Resources. Latest estimates put the total world population at 250 animals with around 200 surviving precariously in reserves and remnants of native habitat in Iran. The remaining fifty are spread between various zoos in Germany, the Hai-Bar Carmel Nature Reserve in Israel and deer farms or parks in Britain and New Zealand (Pemberton 1990). Mesopotamian fallow deer are up to 30% larger than their European cousins, which range in size from 42-55kg for does and 90-110 for mature males. The distinctive palmation of fallow deer antlers is generally confined to the top half in European fallow, while it commences at the base in Mesopotamian fallow antlers. Potentially the difference of most value to agriculture is that Mesopotamian fallow appear to fawn up to four weeks earlier than European fallow (Walton 1990). Mesopotamian fallow deer readily hybridise with European fallow to produce fertile offspring. The most advanced program to grade-up European fallow to "pure" Mesopotamian has reached the stage of seven eighths Mesopotamian. Through the use of artificial insemination, three quarter breds have been produced. Conception rates to A.I. have ranged between 10 and 75%. In addition, two fawns from pure parents survive in New Zealand and one in Britain. Electrophoretic studies of Mesopotamian fallow have already shown detectable differences between the pure breds, European fallow, and their hybrids (Pemberton 1987).

BREEDING OPTIONS

At this stage of industry development, the profitability of the majority of fallow deer farms could be most economically improved by better management of the existing deer. Perhaps a deer farmer could then consider diverting resources into modifying his animals to better suit his farm, climate or market. There are now two alternative pathways to genetic improvement of fallow deer; selection within the European sub-species, or hybridisation of European fallow with the Mesopotamian sub-species. The degree of variability within or between the two sub-species and the proportion of that variation which is heritable has not been established, so defining a breeding program is difficult as a mix of the two is likely to be counter productive.

SELECTION WITHIN THE EUROPEAN STRAIN

Defining the objectives of such a program immediately presents problems. Do we select for weight gain, earlier fawning, carcass composition or temperament, to name a few possibilities, and is it valid to rank animals on such simple measurements? For example, selecting for weight gain may tend to increase weight at all ages up to maturity, increasing overheads for maintaining these larger females. In the extreme case, the animals may take an extra year to reach reproductive maturity. Conversely, selecting the heaviest yearling bucks in the absence of carcass quality measurements may simply favour the fattest animals. Given that a major marketing advantage of venison is perceived to be its leanness in comparison to other red meats, then a selection program which favoured increased fatness is clearly undesirable. Accurate records are required to adjust the weaning weight between progeny of different does. This includes the sex of the fawn (males grow faster than females), the age and weight of the mother (does become heavier with age and heavier does generally rear heavier fawns), the sire of the fawn, and the age of the fawn at weaning. Even with these details, sufficient information just does not yet exist to permit a valid herd ranking taking all these factors into consideration. At the end of the day it is the question of efficiency which should most concern farmers, but this is difficult to define and even more difficult to measure. In view of all this doubt and debate, I have now restricted the selection of my European fallow to just one trait, temperament, and have elected to go down the more exciting and expensive road of hybridisation.

Temperament Fallow deer are more nervous and excitable than most other species of deer being farmed and I feel selection for temperament will produce more immediate returns through; cheaper fencing, efficient grazing management, relaxed animals and easy stock handling etc. than any genetic gains in venison production per animal. The ability of individual animals to cope with the stress of handling and transport associated with slaughter may well effect meat quality and be heritable. The success of A.I. programs may be similarly influenced. My method of selecting for temperament is to record the tag numbers of the weaned fawns which are first up to a feed trail, first through a newly opened gate, or last to run away at the approach of a vehicle and the quietest animals tend to be the fastest growing. This then begs the questions - do the quietest animals grow more quickly for the rather simplistic reason that they spend more time eating and resting

, instead of rushing around in nervous excitement and how heritable is temperament? My observations and early trials lead me to suspect a high degree of heritability of temperament , and with weight gain and temperament apparently so closely correlated , one could suggest that heritability of temperament could be of a similar order to heritability of weight gain - about 0.3 - 0.4 has been suggested for red deer (Rapley 1988).

Antlers Velvet antler is the glamour product of the deer farming industry, with its supposed use as an aphrodisiac inevitably attracting media attention. The financial returns from fallow deer velvet antler are never likely to be sufficiently large to warrant selection pressure for increased yield or quality. An average fallow buck retained solely for velvet antler production will not return more than his costs for maintenance and capital. However, antlers must be removed from fallow deer if they are to be farmed humanely and the most satisfactory time for removal is while the antler is in velvet because the animal is not aggressive. As such, velvet antler from herd sires is a by-product from a necessary management procedure and can usually be sold to recover the cost the procedure - rather like crutching sheep. A gene I would very much like to isolate, ideally a single dominant, is one which would produce antlerless fallow deer. Surgical polling of sires and castration to prevent antler development on venison bucks is the alternative I have chosen, but it still involves considerable cost. There are anecdotal reports of polled deer being shot in Tasmania.

In the meantime, there are some much more urgent and straight forward selection requirements for every fallow farmer to address, but which may not produce significant genetic gain.

(i) At weaning time, consistently "dry" does should be sold for venison. However, unlike the situation reported in sheep (Haughey et al 1985) the ability of two year old fallow does to rear their first fawn is not a good indication of lifetime reproductive capability (Mulley 1990). It is therefore important not to cull does on the basis of one reproductive failure. In a group of 393 does, Mulley(1990) found that 92.3% of does failed to rear a fawn at one of seven breeding opportunities, but only 9.9% failed to rear a fawn at two or more breeding opportunities. Fallow deer are known to be very fertile in their wild state (Chapman and Chapman 1975; Chaplin 1977) and on farms (Asher 1986; Mulley et al 1987), with annual conception rates ranging between 95% and 98%. The majority of reproductive wastage on fallow deer farms has been shown to be due to perinatal mortality of non-viable fawns. (Asher 1988; Mulley 1990) This non viability is primarily due to inadequate nutrition of the doe and is particularly apparent if young does are inadequately fed during their growing years.

(ii) If an annual score is given to the tooth wear in each breeding animal, then eventually a picture can be established of the commercial life expectancy of your deer. The teeth of fallow deer do not become over-grown and broken with age, but rather tend to evenly wear down until level with the gums. Appropriate records will permit the sale of aged females while they still have some commercial value as breeders. In my own situation of heavy stocking on irrigated pastures, no tooth wear is evident until the eighth year. I know of two pet does which weaned 21 and 22 fawns each, but in a commercial situation, 12-15 fawns is a more realistic expectation.

(iii) Any animal that is consistently hard to yard or handle in the yards, is obviously better sold to a keen young new-chum who would benefit from the experience !

HYBRIDISATION

Efficiency The most biologically efficient meat producing system will utilise the smallest doe that will breed with the largest buck to produce offspring of the required quality. If this can also be achieved with animals of different genetic background, then we gain the added bonus of hybrid vigour. To convert your entire doe herd to pure Mesopotamian would therefore do little if any thing for production efficiency. There may however be more important advantages of a pure Mesopotamian herd relating to carcass size and finish which will also need to be considered when establishing a breeding program. Interestingly, the price of venison in Europe is in inverse proportion to the size of the animal, with the highest price for the tiny Roe deer (*Capreolus capreolus*).

Fawning date Of equal importance in the farming environments of most southern Australia and New Zealand is the earlier fawning time of Mesopotamians compared to European fallow. My deer currently fawn at the end of Spring when the lambs and calves are already 2 months old. Although no data is available for the feed consumption pattern of a herd of Mesopotamian fallow or even hybrids, the possible advantages can be summarised as such :

(i) Increased venison production per hectare as a result of hybrid vigour and reduced maternal costs.

(ii)Improved feed utilisation by better alignment of feed production and demand. Apart from the breeding herd, the larger rising yearling bucks in the venison herd should also produce better utilisation of the Spring surplus. These larger bucks should reach slaughter weights before Christmas -leaving the valuable Summer feed for lactating does and young fawns.

(iii) Improved conceptions and fawn survival as a result of decreased weight loss in does over the previous lactation. This may in part be countered by the greater lactational demands of the hybrid fawn, particularly with first and second fawning does.

(iv) Increased market flexibility. Particular difficulty is experienced in raising slaughter weights of yearling European fallow to meet the pre- Christmas increase in demand and prices seen in the important markets of the Northern Hemisphere. Mesopotamian hybrids should be able to fill this requirement, and , when grown-out to a greater age, be able to provide the larger cut sizes demanded by other markets.

(v) Reduced processing costs. Mesopotamian fallow bucks, when grown out to greater weights, will incur lower killing and processing costs per kilogram than lighter European fallow of the same age. A saving of 10 cents per kilogram can be made in the slaughter and processing of prime lambs by increasing carcass weights from 20 to 26kg (Hopkins pers. comm. 1991). A similar saving can be expected by increasing deer carcasses from 26 to 32kg.

(vi) Increased export sales of live animals as the perceived benefits of Mesopotamian fallow are confirmed.

(vii) A net benefit to Tasmania, over 20 years, of $8.9 million in 1990-91 dollar terms has been calculated by the Tasmanian Dept. of Primary Industry. In real terms, this equates to just over $1 million per annum (at a discount rate of 10%) and a pre-tax internal rate of return of 54.5 percent.

The expected variability in the hybrids is a potential down-side in the early days of using

Mesopotamians. The very compact mating and fawning of fallow, perhaps contributing also to low variability in carcass sizes, is an aspect greatly envied and aimed for by other livestock producers. Specialist venison producers may well wish to retain these characteristics in their doe herd, in which case they would use the Mesopotamian bucks as terminal sires over European does and leave the development of new hybrid strains to specialist breeders.

Although irrigation of perennial pastures provides an excellent match of feed supply and demands on my deer farm, the earlier fawning of Mesopotamians would greatly lessen my dependence upon pumped water. Any advancement of fawning time greater than 6 weeks would place fawning too far back into the unsettled early-spring weather and the rut (mating) back into our dry summers NB. The gestation period of a fallow deer is about 2 months longer than the similarly sized sheep. Fallow and red deer farmers in Southern Australia who don't have cheap irrigation or summer rainfall are committed to unreliable fodder crops or months of hand feeding during summer in addition to the usual Winter requirements. They are unlikely to remain competitive with other red meat producers unless they alter the time of fawning.

While melatonin implants have advanced first conceptions in fallow deer by 6-8 weeks (Asher 1990), and up to 6 months in red deer when used in conjunction with artificial light regimes (Adam 1990), there are still practical limitations to the widespread adoption of this procedure on deer farms, such as the requirement for one of the two recommended treatments to be administered at a time when does have very young fawns at foot or even unborn. Asher(1990) reports that does treated during pregnancy failed to initiate lactation and there may well be consumer resistance to the administration of hormones to meat producing animals. The Mesopotamian option therefore seems to offer a more permanent and natural alternative to advance the time of fawning.

Inevitably there are some political considerations associated with the use of Mesopotamian fallow such as possible consumer resistance to eating venison from an endangered species. Already concerns have been expressed about the loss of the genetic integrity of the two sub-species of fallow if hybridisation is not well controlled and environmental damage is possible if feral hybrids move into fragile areas not favoured by European fallow. Traditional trophy hunting values may be effected along with the ability to set hunting seasons around the very predictable annual reproductive cycle of European fallow. All of these arguments have so far been used to prevent the introduction of Mesopotamian fallow to Tasmania.

THE GENETICS OF COAT COLOUR

European fallow deer occur in a range of colours not normally seen in a wild population of mammals, and it is an indication of mans long association with, and semi-domestication of fallow deer. The only other deer species with a similar range of coat colours is the long domesticated reindeer (*Rangifer tarandus*). There have been premiums paid for certain colours and countless anecdotal claims of a correlation between colours and production factors, going back many years (Winans 1913). These claims are often contradictory, not supported by data from randomly mating herds and ignore environmental influences. Although up to ten colour types have been described for fallow (Winans 1913), there are really only five main colours that could be regarded as normal: Common, menil, black, brown and white. Categorising the five colours we see there are two spotted types (common and menil) and three unspotted types. The two spotted types have the normal agouti hair pattern (Smith 1980), with the difference caused by variation at the brown locus. The non-agouti black or brown melanisms are similarly controlled by variation at the brown locus. White appears to be produced by a third allele at the brown locus, being recessive to both black and brown and epistatic to alleles at the agouti locus. The genotypes of the pure bred (homozygous) colours would therefore be : Common A\A,B\B ; Menil A\A,b\b ; Black a\a,B\B ; Brown a\a,b\b and White a\a,bw\bw

Mesopotamian coat colour This sub-species of fallow deer may represent the only surviving wild fallow in the world and as such could be expected to have the top-dominant common genotype AA\BB. This appears to be the case because all the F1 progeny of European x Mesopotamian are common coloured, regardless of the colour of the European parent. Given that one reason for grading-up European fallow to "pure" Mesopotamian is to perpetuate this very rare animal then I believe some consideration should be given to preventing the introduction of the recessive coat colour mutations.

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