Breeding objectives for farmed deer

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Introduction

The design of a genetic improvement programme cannot logically proceed without definition of the breeding goal. In most farming circumstances, this goal involves profitability, which in pasture-based production systems can sometimes be specified as profit per unit feed produced. Given the goal, a selection or breeding objective specifies the manner in which progress might be achieved towards the goal. A selection objective comprises a list of traits that influence the goal, along with the relative emphasis of each trait in the list. The establishment of a soundly-based selection objective is fundamental to the development of a cost-effective breeding programme. This paper briefly outlines some of the considerations involved in the development of selection objectives for deer farmers. The actual development of some selection objectives for deer farmers will be left as a workshop task.

Background

Prior to the formation of Breed Societies in Europe (early 1800's) a breeding objective consisted of an individual image of "what animals should be like". Animals that deviated sufficiently from this ideal were culled. The objective varied with time and location, leading to the geographic development of a range of breeds of domestic livestock.

In the last 50 years, selection objectives for livestock species have been specified more precisely, often using an equation derived from a profit function. Specifying the profit function involves a range of disciplines, including a good knowledge of production circumstances, financial issues and a great deal of forecasting. The results of applying this technique typically give rise to different weightings for different selection circumstances. These circumstances include weightings for selection of:

i. Animals for future lifetime production;
ii. Candidates to use as parents of the next generation of commercial animals;
iii. Candidates to use as parents of the next generation of sires.

A selection objective allows animals to be ranked for a single characteristic, sometimes called *aggregate economic value.* Selection on aggregate economic value will balance all the good and poor characteristics of each individual available for selection. In the absence of an aggregate or index value, selection on each individual characteristic could be applied *independently* of all other characteristics. Selection using *independent culling levels* has the disadvantage that some animals culled for one trait may be exceptional for another different trait. What is really required is a modification of the severity of culling on one trait depending on how good the animal is for the other traits. This is exactly what is achieved by selection on an overall index.

The development of a practical selection objective involves two steps. First, one must identify the *list of traits* that affect the satisfaction of the animal manager. In many cases satisfaction will relate to economics of production and therefore profitability. Second, the relative importance of the traits in the list needs to be assigned. The relative importance is described using *relative economic values*. From a computational viewpoint the economic values can be obtained by partial budgeting techniques, considering, for each trait in turn, the impact of one unit change in that trait, other traits held constant. The impact of the trait change on farm income and expenditure must be considered in order to determine the change in profit. An equivalent approach is to calculate the partial derivative of the profit function with respect to each trait in turn. This may not be straightforward unless the profit function can be simply described.

Knowledge of how the livestock manager will modify their practices as a result of selection will impact the profit function, (or partial budget) and therefore the relative economic values. For example, if a production system that finished offspring for venison at 11-15 months of age achieves genetic progress in the form of increased weaning weight and growth rate, what will be the impact on the system? The answer will depend on whether the farmer uses the extra growth rate to finish the animals *earlier* in the season (at higher prices), or at the same time as usual (at *heavier* weights) or whether stocking rates are slightly increased such that *more* offspring are wintered and finished. These three situations will likely result in three different sets of relative economic values.

Selection Objectives for different industry groups

One difficulty in determining selection objectives from an industry viewpoint is that the selection goals are often different for different components of industry - the list of traits that are considered important will differ between sire breeding herds, velvetting herds, self-replacing venison breeding units, terminal sire venison units, finishing units, meat processors, marketers and consumers. Some traits may influence quantity of production, some impact costs of production, while others dictate quality of produce. Not all quality attributes are rewarded to the producer and costs are not usually evenly distributed among the different players in the industry. Accordingly, each sector of the industry may have a different selection objective, incorporating different traits and certainly a different emphasis on each trait. If the goal is to improve consumer satisfaction, it is necessary to rely on the consumer's selection objective being transferred back to the breeders through market forces.

Time frame for improvement

It is fairly straightforward for most breeders to identify the list of traits that are considered important to include in the selection objective. However, it is far more difficult to obtain the relative importance or relative economic values of the traits in the list. In some cases, *current* economic values are readily obtained (e.g. for weaner deer, venison and velvet antler) as these weightings are currently used in the payment system, but it is *future* rather than current relativities that should be used.

Genetic advances made by the breeder can take considerable time to filter through to the consumer. Consider matings taking place in autumn 1997 to produce sons for sale as breeding stags. The progeny from these matings will be born in spring/summer 1997. Those stag fawns with acceptable conformation will typically be sold as two year olds in summer 1999. They will first be used for breeding in autumn 2000 with their commercial progeny born at the end of 2000. If these first crop offspring are used for venison production, they may be slaughtered from spring 2001 through to spring 2002. Subsequent crops might be sold for the next five years or so. If daughters are kept for breeding, their offspring will be produced from spring 2002 until say 2010. If the sons are used for velvetting, they will produce significant velvet from 2002 until say 2012. Thus decisions already made in sire breeding herds this year, will directly impact venison and velvet production for about a decade from 2002. It is far too late to be breeding for todays producer and consumer wants - the selection objective must relate to *future* requirements. This is particularly difficult if the demand for particular traits is related to fashion trends.

Now consider the velvet payment schedule. What will be the basis for grading and payment in 10-15 years time. Will velvet conformation be more or less important? Will chemical composition determine the quality attributes? Judgement calls as to the future market circumstances are important in defining breeding objectives. Accordingly, there is considerable advantage in different breeders making different decisions, as this provides some security that not all breeders will get it wrong.

The actual future returns for traits are not a good indication of the value of changing a trait as costs of production need to be accounted for. That is, the *marginal returns* from a (small) change to the current system should be the basis for economic values.

Time and number of expressions

In some cases the list of traits that the breeder desires to improve will include characteristics that are expressed early in life (e.g. growth rate to weaning) as well as traits that are expressed late in life (e.g. reproductive performance, longevity). The relative importance of various traits in the selection objective should account for the *time* of expression since the rewards from selection that come earlier may be more valuable than rewards that are much later. A technique for weighting returns at different time periods (e.g. discounting procedures to obtain net present values) may be usefully applied. In extreme cases, the benefits from selection will accrue well beyond the lifetime of the current breeder.

The number of expressions of a trait must also be accounted for in determining the relative emphasis of traits in the objective. Genes relating to carcass composition will only be expressed once at the end of any one animal's lifetime whereas genes relating to velvet production or milk yield will be expressed once per year over the adult life of the animal.

Deer farm production circumstances

Consider some common deer farming operations. These include: velvetting; self-replacing breeding hinds with sale of weaners; terminal sire breeding for sale of weaners; finishing weaners for venison. For each circumstance, list the traits that influence profit. For each trait that influences profit, one must consider how management might change if that trait is modified from its current value. There may be more than one answer, and different farmers may react differently. Given the management response to a change in the trait, calculate the impact of the trait on incomes and expenses. The net effect on profit is the relative economic value.

In many cases, as you will find, calculation of the relative weightings requires considerable knowledge of a production system and may require detailed computer modelling. For example, what is the value of liveweight relative to velvet antler weight in a whole farm system? Heavier stags will have greater carcass values but must be run at a lower stocking rate because of their greater maintenance requirements. How much more velvet antler does a heavier stag have to produce to be of the same value to the farmer? Some computer modelling to consider biological (rather than economic) efficiency has been undertaken by Fennessy and Thompson (1984). Further work on the economic aspects would be worthy of research.

It is generally difficult to find economic weightings for traits that are not directly related to production. Consider some of the traits other than production in deer. How does one obtain economic values in this situation? What is the value of temperament? Fence pacing behaviour? Calving ease? Resistance to Tb?

Practical use of breeding objectives

Given a breeding objective, the next step is to evaluate animals such that the individuals can be ranked for their ability to progress the system towards the breeding goal. This involves, as a first step, considering the genetic evaluation of each of the traits listed in the objective. Some traits may not be heritable, or may be of very low heritability, implying that selection will have little impact on the mean performance in the next generation. Given that a trait is heritable (which is determined by comparing variation among and within families), one must identify characteristics that can be measured on-farm and used to predict the genetic merit for the trait in question. In some cases, the trait itself can be directly measured. In other cases (e.g. carcass traits) an indirect measure may need to be used. The value of various on-farm measures in terms of predicting genetic merit can be ascertained by statistical means to allow comparison of alternative strategies. For example, should velvet antler selection be based on a single record, or two or three velvet harvests. Is progeny testing sufficiently more accurate to justify the extra monetary costs and time delays required to measure the progeny?

Analysis of available pedigree and performance records will generate estimates of breeding values (and producing values). These values can then be weighted by their relative economic values and summed across all traits in the objective to obtain a single index figure that should be used for selection purposes. Animals should be ranked on the single index figure, and then livestock managers should go through all the qualifying individuals and check them for conformational soundness and cull any animals that are unacceptable on this basis, or for any other traits that impact the objective for which relative economic values could not be assessed. Such an approach is yet to be routinely applied in the New Zealand deer breeding industry.

Summary

The development of an industry selection objective must take account of consumer requirements, farm costs, market and manufacturing knowledge and information along with genetic principles. This requires integration of information supplied by a number of agencies involved with the overall industry (Game Industry Board, Meat Companies, Farmers, Breeding Organisations, Scientists, Advisors, Consumers etc.) Further research into consumer requirements for velvet and meat products, factors affecting cost of farm production and the cost of manufacturing is expected to be of substantial value in clarifying the breeding objective. This breeding objective must reflect the unique production, processing and market circumstances for New Zealand.

The long-term efficiency of New Zealand agricultural industries is dependent upon the pursuit of breeding objectives which take due account of the needs of all sectors involved.

All players in the industry, especially sire breeders and commercial deer farmers should try and formally identify their breeding objectives.

Further reading

Fennessy, P.F. and J.M. Thompson 1989 Biological efficiency for venison production in red deer. *Proceedings of the New Zealand Society of Animal Production,* **49**:5-10.