BREEDING AND GENETIC WORKSHOP

C. M. RAPLEY

OUTLINE

The following aspects of deer breeding programmes were discussed in a group situation. Emphasis was given to understanding the information required, clearly define the breeding objective and potential selection criteria. An appreciation of the factors influencing genetic gain within a herd was obtained through short exercises.

BREEDING OBJECTIVE

The breeding objective is a clear concise statement outlining the long-term goal of the breeder. Usually the breeding objective is based on profit, that is, returns less costs.

All traits affecting the profitability of the enterprise should therefore be included in the breeding objective. In practice, this is rather difficult, as traits such as feed intake are not currently measurable on an individual basis under extensive farming conditions. Biological efficiency, often defined as

$$\frac{\text{kg product output}}{\text{kg feed eaten}}$$

has also been proposed as a breeding objective. Ultimately, this is also a form of a profit type breeding objective.

Development of the breeding objective requires consideration of

- returns,
- costs,
- personal preferences, and
- species and breed strain constraints

For most deer farmers the breeding objective should be based on venison and/or velvet antler production.

SELECTION CRITERIA

The selection criteria are the traits that are used to select animals. They do not need to be the same traits as in the objective. That is, they can be used as predictors of the traits in the breeding objective. For example, carcass weight is likely to be included in the objective but is not measurable on the live animal, instead liveweight at a given age may be the selection criteria.

Traits used as selection criteria should be:

- heritable,
- measurable,
- cheap to measure, and
- measurable at a young age

When two or more traits are included in the breeding objective, selection on a breeding index is nearly always the most efficient form of selection. Independent culling levels may be used when there is a long time period between the measurement of one trait and another. Independent culling levels are also useful for traits such as temperament, which is extremely difficult to measure objectively and is influenced by many environmental factors, although there is some evidence to suggest that it is of moderate heritability.

Careful consideration of the method of selection is required to ensure that genetic progress is maximised. The number of traits that are to be selected for is also of importance. The more traits selected for the less genetic progress will be made in any one trait. A clearly defined breeding objective is the first step in attaining genetic progress.

CORRECTION FACTORS

Correction factors are adjustments made to the individuals raw record (for example, weaning weight) to account for environmental effects so that the animals in the group can be compared on an equal basis.

The most common correction factors for weaning weight are:

- age at weaning (with an adjustment for every day older or younger the fawn is from average).

- sex (males tend to be heavier than females).

- age of dam (first-fawners tend to produce lighter fawns than mature dams).

Should twinning become common within a herd then correction factors for single versus twin born and/or reared fawns will also be necessary.

The most important correction factor for weaning weight is age at weaning. The exact date of birth will allow the most accurate adjustment to be made. However, an assessment of birth date to within seven days will not affect the genetic ranking of individuals in most herds.

As weaning weight is used a measure of dam performance, as well as individual performance, it is important that correction factors are used to adjust raw records so that dams can also be compared on an equal basis.

The importance of correction factors varies with the age of the animal and the trait being measured. For example, 15-month live weight is little affected by age at weighing and age of dam. However, the difference between the sexes becomes greater. By 15-months of age selection is generally carried out within sex.

GENETIC GAIN

The purpose of a selection programme is to identify genetically superior animals for use as parents for the next generation. Therefore, each year, animals will be selected that are superior to the previous year and thus the average performance of the herd gradually increases. Genetic gain is permanent and cumulative, unlike changes in management.

The expected rate of increase can be calculated using the following equation:

$$\text{Genetic gain per year} = \frac{h^2 \times \text{Sel. Diff}}{\text{G.I.}}$$

where h^2 is the heritability of the trait, Sel. Diff. is the selection differential, and G.I. is the generation interval.

The heritability is the proportion of the variation in a particular trait within the herd that is of genetic origin. While the heritability is a percentage it is usually expressed on a 0 to 1 basis, where 0.0-0.2 is low, 0.2 to 0.4 is medium and over 0.4 is high. Present heritability estimates of liveweight traits in Red deer indicate a medium to high heritability. The Chinese estimate of the heritability of velvet antler weight in Sika-type deer was of medium heritability.

The selection differential is the difference between the average of the group and the animals selected for breeding from this group. The selection differential is dependant upon the phenotypic standard deviation of the trait in the group and the proportion of animals selected (on the assumption that the animals of highest genetic merit are selected first). The selection differential can be calculated using standard tables found in reference books (for example, Wickham and McDonald 1982). The selection differential table from this text is given in the appendix. Once the proportion of animals to be selected is determined the selection differential is read off the table and then multiplied by the standard deviation of the trait in that mob. The selection differential is the average of both males and females.

The generation interval is the average age of the parents when the offspring are born. The complete age structure of the herd is required to determine this accurately. As there are less male than female parents in the herd, the age of the males will have the greatest influence on the generation interval.

ANIMALPLAN FOR DEER

Deerplan, a recording scheme for deer, was introduced in 1985. The main purpose of Deerplan at this time was to collect performance data so that phenotypic (correction factors, phenotypic correlations) and genetic parameters (heritabilities, genetic correlations) could be estimated, thus providing the basis of full breeding programme for deer. From 1 October 1988 Deerplan will be incorporated into Animalplan.

Animalplan is a multi-species animal recording scheme, developed by the Ministry of Agriculture and Fisheries, which will meet the various recording requirements (performance and pedigree) of the deer, goat and sheep breeding industries. The scheme is designed to run on on-farm personal computers so

If 5% of the stags were selected each year then the selection differential would decrease to 0.3605 kg, and the genetic gain would decline to 0.020 kg per year.

The expected genetic gain was then calculated for the same herd after changing the breeding policy to using two and three year old stags plus one outstanding spiker each year which was selected on sire performance and 15-month liveweight. The number of stags used was increased to 7 and hinds were culled at 8 years of age. The generation interval was therefore decreased to 4 years. The result of these breeding policy changes and the influence of the effective proportion of males selected is given in Table 1.

Table 1 Expected genetic gain in an established herd of 218 hinds for 2-year old velvet weight assuming the heritability of 2-year old velvet weight to be 0.35 and the standard deviation to be 0.35.

Generation Interval (years)	Effective Proportion of Stags Selected (%)	Selection Differential (kg)	Genetic Gain (kg/year)
6.2	1	0.4655	0.026
6.2	5	0.3605	0.020
6.2	20	0.2450	0.014
4.0	2	0.4235	0.037
4.0	5	0.3605	0.032
4.0	20	0.2450	0.021

From Table 1 it can be seen that decreasing the generation interval by 2.2 years increased the genetic gain by 12 grams per year when the top 5% of stags were selected, over a herd of 100 velveting stags this is equivalent 1.2 kg. With a return of $120/kg this is equivalent to $144 per year. As velvet antler production appears to be a highly repeatable trait, then the returns over the lifetime of the herd will be much greater.

These calculations assume that there is no selection for velvet antler weight in the females. As genetic parameters become available it may be possible to select hinds for velvet antler weight based on the performance of their sire, grand-sire, brothers and half-brothers.

SUMMARY

The establishment of a sound breeding programme requires consideration of expected financial returns, costs (including labour) personal preferences and genetic gain (including the heritability and variation of the traits, herd size, selection potential, and correlated traits). As many of the productive traits of deer are of medium heritability and there is high variation in these traits within herd rapid genetic progress can be attained, but only with a clear breeding objective.

that breeders can operate their own recording system. Bureaux services will also be available for those not wishing to run their own system.

In contrast to previous breeding schemes Animalplan is highly flexible. Breeders can now define their own breeding objective and the relative economic values of the traits in the objective.

A large number of traits will be able to be recorded, with each breeder choosing which traits are to be recorded for their enterprise. Breed standards, which are being developed in conjunction with the industry, are available for use in each package.

Animalplan will provide within herd deviations, breeding values (a measure of the genetic merit of the individual as a parent for a given trait) and index values (an overall value of the genetic merit of the individual in monetary terms). Report formats can be designed by the user and may include as much or as little information as desired. Within reports, mobs can be sorted by individual tag number, sire number, breeding values, index values or some other criteria to allow for ease of identification and selection of animals of superior genetic merit.

As with previous performance recording schemes the breeding and index values are only comparable within herd. In order to compare animals across herds, a genetic link is required. This is the basis of sire referencing schemes.

SUMMARY OF EXERCISES

The expected genetic gain in 2-year old velvet antler weight was calculated for an established herd of 218 hinds, with a 50:50 sex ratio at birth and 80% survival to 2-year old velvet weight. Six stags used each year (2 two-year old, 1 three year old, 1 four year old, 1 five year old and 1 six year old). The hinds are culled at 15 years of age. The generation interval is 6.2 years. Assume the heritability of 2-year old velvet antler weight to be 0.35 with a standard deviation of 0.35. The top 1% of stags are selected for 2-year old velvet antler weight each year.

Calculation

Selection Differential

$$= \frac{(\text{std. dev. x 1\% males}) + (\text{std. dev x 100\% females})}{2}$$

$$= \frac{(0.35 \times 2.66) + 0}{2} = 0.4655 \text{ kg}$$

The genetic gain per year

$$= \frac{h^2 \times \text{Sel. Diff.}}{\text{G.I.}}$$

$$= \frac{0.35 \times 0.4655}{6.2} = 0.026 \text{ kg per year}$$

FURTHER READING

Fennessy, P.F. (1987) Genetic Selection and Recording. Proceedings of a Deer Course for Veterinarians 4 : 81-93.

Wickham, G.A. and McDonald M.F. (1982) Sheep Production Volume One. Breeding and Reproduction. New Zealand Institute of Agricultural Science 269 pp.

APPENDIX

Table 2 Selection Differentials for a Trait with Standard Deviation of one Unit (from Sheep Production Volume One. Breeding and Reproduction, page 75).

Proportion Selected (%)	Selection Differential
0.01	2.66
0.02	2.42
0.03	2.27
0.04	2.15
0.05	2.06
0.10	1.76
0.15	1.55
0.20	1.40
0.25	1.27
0.30	1.16
0.35	1.06
0.40	0.97
0.45	0.88
0.50	0.80
0.55	0.72
0.60	0.64
0.65	0.57
0.70	0.50
0.75	0.42
0.80	0.35
0.85	0.27
0.90	0.20
0.95	0.11
1.00	0.00