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Farm Working Dogs Breeding Selection and Improvement
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The working dog has been carefully selected for its ability to perform 'work' routines in actual, farm situations. This Aglink describes a breeding programme designed to produce this ability.

Genotype and Environment:
In estimating a dog's potential usefulness, its owner is constantly being forced to decide whether its performance is due to a superior 'genotype' (its genetic makeup) or to the 'environment' (its rearing and training, and the relationship it has with its handler).

Basic Genetics:
A farm dog's traits are controlled by genes, located (like beads) on thread-like chromosomes inside the nucleus of each cell. When the reproductive cells (the male sperm and the female ova (eggs)) combine at mating, the chromosomes split and recombine, producing a fresh combination of each parent's genes in the new offspring. Thus, each parent contributes one-half of the genetic makeup of each offspring, and the particular combination of genes that is passed on occurs at random. The only exception is when genes are 'linked' and are therefore passed on in blocks. (For a fuller explanation of basic genetics, you should consult the relevant texts (see under 'Further reading', below).)

Traits:
Breeders vary in the emphasis they attach to the various traits that are considered to be important for the working dog. Here are some of these traits.

Heading Dog:

- 'Eye' is the dog's ability to 'outstare' sheep. This is the dog's way of concentrating on its work and trying to anticipate the sheep's movements.
- Dogs vary, from the 'strong eyed' (which almost mesmerises the sheep and may be hard to shift) to the 'plain eyed' (whose approach is less intense).
- 'Heading' is a dog's ability to gather or encircle sheep. The method of doing so varies from a wide, circular cast to a straight one in which the dog heads straight for the sheep. An ideal is a 'pear-shaped' cast.
- 'Temperament' is the dog's 'nature' - its general reaction to other dogs and to people (especially strangers). Dogs vary, from the very 'soft' or fearful to the 'hard' or strong-willed one that is loathe to accept a command. Good temperament is to be seen in a dog that is keen to please its master.
- 'Early maturity' refers to a pup's ability to start working early in its life. Such a one is to be preferred to the pup that is late in maturing. The fear with a late-maturing pup is that it may never start to work at all. The considerable cost of rearing it is then completely wasted. Few shepherds can afford to wait for the late-maturing pup to start working.

Huntaway Dog:

- 'Noise' is the dog's bark (usually a loud, deep bark is required, rather than a 'yap').
- 'Heading' - Is the dog's ability (preferred by most breeders) to 'head' stock, even though driving is the major part of its work.
- 'Temperament' The huntaway requires a warm, friendly nature and should be anxious to please.
- 'Early maturity' refers to a pup's ability to start working early in its life.
- 'Force' is a dogs ability to shift animals that are reluctant movers. This it achieves by barking, by physically pushing at the sheep, and by working to and fro while it is barking.
- 'Backing' is jumping up on to sheep and moving across a blocked pen or race in order to start the sheep moving.

- Free of 'vices' - in the heading dog, the main fault is grabbing and biting sheep with its teeth
- Free of 'physical defects' - a correctly shaped mouth and sound teeth (for efficient chewing) and good feet and pads are essentials, as are normal reproductive organs.
- Free of 'diseases' - especially such inherited diseases as eye defects and hip dysplasia.
- 'Colour' - preferences vary, depending mainly on the dog's visibility against the terrain it works on; an all white dog is usually not popular.

Inherited Traits
'Simple' traits are controlled by single genes, inherited according to the laws of Mendel. The simple trait can be a 'dominant' one and 'covers over' another (designated 'recessive'). Some traits are 'homozygous' ('breed true') and others are 'heterozygous' (matings can produce differences) (see Dalton, 1980, under 'Further reading', below). Examples of this dominance in dogs are as follows.

- Hair -black hair dominates over red.
- Eyes - dark eyes dominate over 'wall' (pale blue eyes)
- Jaws - normal laws dominate over 'undershot' jaws.
- Palate normal palates dominate over cleft palates.

'Complex' traits are controlled by many genes. Their inheritance comes under' the heading of 'population genetics' (see Dalton, 1980). The breeder is concerned with such complex traits as fertility, survival, intelligence, temperament, and so on, in which any group of dogs (even members of the same litter) will show 'variations'. Some dogs will be 'good', some will be 'bad', but the majority will be around the 'average' for the population.

The breeder seeks to exploit this variation (the basic 'raw material') by selecting the very best individuals to be parents of the next generation, and by culling the worst performers. By this means, the whole working-dog population should be improved.

Inheritance
Traits are not all inherited to the same degree - some are 'strongly' inherited and some are 'weakly' inherited. This concept of 'heritability' seeks to measure the likelihood of the particular trait being passed on to the next generation.

The possibility (on a 0 to 100 scale) of a particular trait being inherited can be expressed as: weak, 0 to 15 percent; medium, 20 to 40 percent; and high, above 40 percent.

'Low heritability' means that the trait responds very slowly to selection and any improvement is often difficult to detect. Some low-heritability traits may also be difficult to measure. Much more rapid progress is possible when traits of high heritability are selected. They are, moreover, usually easier' to measure

In farm livestock, 'heritability' has been worked out for most traits. Thus, fertility and survival traits are 'low', but the growth tale is 'high'. Unfortunately, this information is not available for working dogs, but it does seem reasonable to assume that for them also the fertility and survival traits would be weakly inherited, so that the progress made through selection will be slow.

On the other hand, working ability and eye would seem to be strongly inherited, so that fairly rapid progress can be made by selecting parents who are well endowed with these traits**.**

Selection Pressure
The key to rapid progress is to apply 'selection pressure' to the parents of the next generation of dogs. This involves choosing the, very best available male and female, and making sure that their merit has been fully proven under real working conditions. A dog's merit must be judged on facts - not on hopes or fancies.

If parents are chosen for being as far above the population average as possible, their offspring will have a higher chance of improving the total average (see Dalton, 1980).

Measuring Merit
The 'working' dog is a special case. If it does not work, no farmer can afford (nor will he desire) to keep it. It has little appeal as a pet, and there is small chance that a poor performer would be used for breeding.

The 'dog trial' is the basic measure of working ability. As such, it is recognised by breeders worldwide. The trials may vary, but the basic tasks of gathering, holding, and moving stock remain similar. There are critics who consider the trial poses artificial tasks (working with only a small number of sheep, for example), but there is a strong relationship between a dog's ability to carry out such tasks, and to undertake similar tasks with larger groups, on the farm.

New trials are being introduced for the Huntaway, also. As well as driving sheep, they are now required to do yard and shed work. Trials in which dogs are required to work cattle are not common in New Zealand. 5 There is moreover ample opportunity for dog buyers to purchase their dogs from breeders who farm in similar conditions to themselves. The concern here is not so much with the dog's genotype, but rather with the environment in which it has been trained. For example, a hill-country farmer may find dogs that have been trained on 5-hectare blocks lacking in stamina and in the ability to cast widely.

Individual Merit
A dog's genetic merit (or breeding value) can be assessed from its own appearance and performance. It is then really a 'performance test'. To select a dog on the basis of traits that are assumed to be highly heritable ('eye', heading ability, and noise, for example) would be a fairly accurate measure of that dog's ability to pass those traits on to the next generation.

However, trying to judge such traits as fertility (litter size) and survival from such a test would not be accurate. One risk in judging a dog on its working performance lies in attempting to assess how much of the performance is due to the particular relationship between the dog and its previous owner. The dog may not work as well for you - but, as a breeding animal, it is likely to have the genes for performance which will have a high chance of being passed on to its offspring.

Pedigree Selection
A 'pedigree' is a record of ancestry. If it is just a list of names without any information on performance, then it is of little value.

The pedigree of a registered working dog should include some details of its performance in dog trials. They become valuable supporting data in that dog's pedigree. Such a record helps to forecast more accurately the 'breeding value' of the dog.

The pedigree may contain 'good performing' ancestors that have not competed at trials. You may therefore have to go and see these dogs at work (it they are still alive), or to rely on the opinion of other experienced dog men who were familiar with the dog. There is however a danger that with the passage of time the description of a performance will become exaggerated and assume legendary proportions.

The main point to remember in any pedigree..... is that as you work back, from generation to generation, the contribution of each of the ancestors is halved..... Thus, for the animal concerned (the 'subject' of a four generation pedigree), the contribution from each:-

- parent equals one hall,
- grandparent equals one quarter,
- great grandparent equals one eighth,
- great great grandparent equals one sixteenth, and so on.

The aim is to look lot top performing ancestors as close to your potential choice as possible (especially its parents and grandparents). Going any further back may be of little value. A dog may have an internationally famous great grandparent, but it will have contributed only one-eighth of the subject animal's genes, which is a very small genetic contribution. The other seven-eighths come from the other seven great grandparents. Beyond this generation, the contribution of any ancestor is very small indeed, and can be ignored. If good-performing ancestors cannot be found among the parent and grandparent generations, then that dog should not be used for breeding.

A breeder is sometimes faced with a dog that will not itself work, but that has a good performance pedigree. For some unknown reason the animal just does not live up to its promise. It can generally be assumed that this dog's failure to work is an environmental problem, and it would be worth testing the breeding possibilities of such an animal. This must however be regarded as a 'test mating'. There is always the chance that the problem was in fact genetic, and that the dog (and its offspring, if any) should be culled. No working dog can justify its keep on its pedigree alone.

Family Selection
The term 'family' is used often in breeding, but care should be taken to find out in what sense the breeder is using it. It can be used as a 'dam' family, which means all the offspring of a famous dam by a range of different sires. Or there is a 'sire' family, which is all the progeny of a sire out of different dams. Finally, there is the 'sire and dam' family, which are the offspring of the one sire out of the one dam. Family names may be maintained when the name of the original bitch is kept and used through each generation.

Again, it is important to remember the point (discussed under 'Pedigree selection', above) that the genetic contribution is halved for each generation you go back in a pedigree.

An often asked question is which is a better bet - a good individual frown a poorly performing family, or a mediocre-to-poor performer from a good genetic family? This is difficult to answer. Probably the best approach is to test -mate and to see what happens. But be prepared to cull ruthlessly if the animals do not perform as they should.

Progeny Testing
Progeny testing occurs when an animal's breeding value is judged, not from its own performance or by its ancestry, but from its progeny. It is in fact the most reliable method of judging breeding value, but it does have some disadvantages. Its first disadvantage is that it takes time, and the animal is often quite old before its merit is finally assessed. The generation turnover has been lengthened and the rate of improvement has thus been slowed (see Dalton, 1980). Also, such decisions must be based on a large number of offspring in order to be sure that a truly representative live sample of the genes the animal carries have been expressed (each offspring represents a completely random combination of the parents' genes).

In dogs with litters, it is easier to observe a number of progeny than it would be in other farm stock.

A bitch should have produced at least three or four litters, by different dogs, before her true worth can be guaranteed - also, a very high proportion of the offspring should have worked early and well. Because of 6 today's high costs of keeping a dog, breeders are not keen on the late maturer. They prefer the pup that works early. Late maturing offspring also delay a breeding assessment of the bitch.

Similarly, before a dog can be said to be fully proven, he should have sired welt-performing offspring out of four or five different bitches. Some breeders may require even more progeny before they would consider the dog to be proven. (The term does not mean merely that the dog has got a female pregnant and that some of the pups have been workers).

Thus, although the 'best bet' in terms of breeding value would be a dog out of a proven bitch by a proven sire, attention should still be paid to its individual performance if it was old enough to work. If however it was only a pup, then its parents' background would certainly justify its selection. The progeny test is most important in confirming that the desired traits have in fact been passed on.

Again, it needs to be stressed that verifiable records must be cited to be sure that the claimed merit is not just hearsay.

Breeding Methods
The methods of breeding, once the animals have been selected, are usually divided into two types - 'close breeding' (inbreeding and line breeding) and 'out breeding'. Close breeding occurs when animals that are related (that is, have genes in common) are mated, whereas out breeding covers a range of crossing in which unrelated animals are mated (see Dalton, 1980).

Inbreeding
Inbreeding is the mating of animals that have one or more ancestors in common (that is, the same ancestor on each side of the pedigree). Either parent (or both) may itself be inbred, but if they are not related to each other, then the subject of the pedigree will not be inbred.

Inbreeding increases the rate at which similar genes are concentrated in a population, regardless of whether they are good or bad. That is to say, homozygosity is increased and heterozygosity is reduced. It is the most effective way of concentrating genes in a population - for better or for worse.

The degree (called the 'coefficient') of inbreeding can be calculated from a pedigree. The rate at which this is built up varies with the matings (this is fully explained in Dalton 1980).

Inbreeding is viewed with fear by many breeders, because of the possibility of 'inbreeding depression'. This is a definite drop in fitness, which is seen as reduced fertility, small litters, high death rates, slow growth, and small mature sizes. Such problems appear when very high levels of inbreeding are reached over a short time (from mating brother on sister, or sire on daughter, for example). They can be avoided by inbreeding at a much slower rate, so that the advantages are gained and the disadvantages (inbreeding depression) are avoided.

In some lines, certain physical defects may occur at low levels of inbreeding. Examples are an undershot law or cleft palate, if these genes are present in reasonable frequency in the ancestors. Such animals are best culled and inbreeding can then continue until signs of real depression occur. Inbreeding is a very important technique in producing working dogs - it concentrates the genes that are needed for good performance. It may also concentrate undesirable genes, but they can be culled. Inbreeding is a technique which many breeders are forced to use after selecting a particular strain of dog, perhaps over their lifetime. There is no other way of producing similar animals without diluting their potential achievements. Breeders must therefore continue to inbreed.

Linebreeding
This is another form of inbreeding, but at a slower rate. The breeder tries to reap the benefits but avoid the problems. The method works something like a ratchet known benefits are held while efforts are made to gain "improvements, a little at a time. The two techniques of inbreeding and line breeding should be considered together.

Outcrossing
If real problems arise during close breeding, the breeder must 'outcross' to some unrelated genes. This will rapidly produce new gene combinations in the one generation. He may have to lose much, but he will overcome his problem. Often a breeder will try to find a line of dogs of similar breeding and selection to their own, hoping that an outcross will produce some new variation which will avoid the inbreeding depression, but will still preserve the good genes for which they have been selecting.

Most dog breeders are interested only in 'mild' outcrosses (introducing genes that are fairly similar to the existing ones).

A 'violent' outcross would occur in bringing in a completely different species, so that some 'hybrid rigour' (heterosis) may occur. This would cause a large increase in genetic variation. In some cases, it would be a very useful basis for starting again to select.

The history of the huntaway shows evidence of some of this type of crossing, in which different breeds are used to form a variation 'pool', followed by intense selection for performance.

An outcross (perhaps better called a 'breed cross') would be a cross between a heading dog and a huntaway in the hope of producing a 'handy' dog. A testimony to the high risk of failure of such a cross is to be seen in the few occasions on which it is attempted by dog men. Selection within a strain is often more reliable in meeting this requirement than the introduction of some new (and perhaps unwanted) variation.

Type
A big advantage with working dogs is that the term 'type' really means structural soundness - breeders are not concerned with show-ring features. Farm conditions call for a dog that can stand physically hard work. Breeders are thus concerned to select for such traits without much caring about what the dog looks like. There must of course be a small element of 'eye appeal' in the choice, but it takes a very low priority in New Zealand. No scientific studies have measured the strength of inheritance of physical traits in dogs. Until this is known, breeders should continue to select on individual merit in order to preserve these traits.

Pedigree Registration
The first stud book for 'sheep dogs' in New Zealand was opened in 1940. Its aim was to record the pedigree of the bust dogs of the day for the benefit of the breeders who wanted to improve their own dogs. Today, most of the good dogs have one or more ancestors who are recorded in the stud register.

Locating Information
To check on a dog's pedigree or performance record, you should contact the secretary of the local dog trial club. He maintains a 'Trial date book'. This will contain the name, address, and telephone number of the local 'Register representative', who can provide you with

- a full set of stud books, for reference;
- personal copies of stud books, for sale;
- registration forms; and
- transfer forms.

Any sheep dog with a proven pedigree can be registered, but when a dog wins a first place in an open trial, it must be recorded in the trial register before it can compete in further trials. This is a rule of the New Zealand Sheep Dog Trial Association. It ensures that a record of all the successful dogs can be kept. The registration form provides all the known information on the dog and shows its pedigree

Further reading: - Burns, M; Fraser, M.N. (1966): Genetics of the dog; Oliver & Boyd.; Dalton, D.C. (1980): An introduction to practical animal breeding; Granada; Hutt, F .B. (1978): Genetics for dog breeders: W.H. Freeman & Co.; Kelly, R.B (1958): Sheep dogs: their breeding, maintenance and training; Angus & Robertson.

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