Elements of a Working Dog Breeding Plan

Eldin A. Leighton, PhD
Per Arvelius, PhD
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Introduction

Working dog breeding programs are usually begun because an organization needs to obtain a larger number (somewhere between 25 and 2,000) of new puppies per year in order to meet the needs of the organization. Of course, the goal is to produce puppies being genetically healthy and with behaviors ideally suited for the task at hand, and to improve these traits for each generation. Organizing a breeding plan that meets these broad goals while also producing this many puppies year after year requires attention to details and meticulous planning. The purpose of this document is to provide one way to think about organizing the details and where to focus planning attention.

Overview of four key elements

1. Clearly define a **DIRECTION** that will determine the focus of this breeding plan.

2. Choose a **PRODUCTION METHOD** for producing the largest number of puppies that will be trained to do the work at hand. There are really only two major options:

    a. Focus on purebred production within already established breeds, or

    b. Focus on crossbred production where females of one breed are mated with males of another breed. A common crossbred scheme is to mate a purebred Labrador Retriever with a purebred Golden Retriever.

3. Create or obtain access to a robust **RECORD KEEPING SYSTEM** to organize and manage all the data required to achieve and monitor progress. A key purpose of the record keeping system is to enable making objective, well-informed decisions that identify a genetically ideal set of young dogs to become parents of the next generation of puppies. Another important reason for keeping records is to enable quick and easy evaluation of genetic progress.

4. Finally, define a **METHOD OF SELECTION** to identify the young dogs that will become parents of the next generation of puppies born into the production system.

Details of the key elements

DIRECTION

Deciding upon an overall direction to be taken by a specific breeding plan will identify the major phenotypic traits that need to be the focus of selection. Examples of canine phenotypes that might need to be genetically improved include:

1. Orthopedic traits like hip and elbow quality,
2. Ocular traits that define the health of eyes,
3. Cardiac traits that define the health of hearts,
4. Immune-mediate issues, often manifest by lack of allergies to foods or environmental allergens,
5. Temperament traits, such as Engagement, Confidence, Emotional resilience, and Ability to focus on doing the task at hand.

To know whether or not a phenotype will respond to genetic selection requires knowledge of the degree to which the trait is heritable, also known as the trait's estimate of heritability. Traits with lower heritability are more difficult to genetically improve and genetic progress will be slower. This means that especially for traits with low heritability, the method of selection is important – see METHOD OF SELECTION below. Larger genetic gains in one generation of selection will occur for traits that are more highly heritable. Hip quality measured by an extended view score, like OFA or FCI, for example is generally found to be about 25% heritable in many breeds. The heritability of a trait depends on how accurately the trait is measured. As a consequence, the success of genetic selection to improve traits or phenotypes with a lower estimate of heritability might be accelerated by improving accuracy of the measurement used to characterize the phenotype of each dog.

It is also important to note that an estimate of heritability is population specific. Heritability is defined as the proportion of total variation observed in a phenotype that can be attributed to additive genetic differences among individuals. The word "additive" is important here because that implies that parents will pass along to their offspring a sample half of their genetic composition, with the other half coming from the other parent. This means that full-sibs (littermates) are genetically very similar, but each is slightly different when compared to the average of all full-sibs.

PRODUCTION METHOD

Purebred production is the most common method for producing large numbers of puppies destined to become working dogs. In some guide and service dog breeding programs, a smaller number of crossbred puppies are produced, mostly by using a Golden Retriever (GR) male as the mate for a Labrador Retriever (LR) female. Crossbreeding, in these cases, is generally not the primary production method, but rather comprises a small niche proportion of the total puppies produced. It is a somewhat common practice to produce an F1 LR x GR litter from which a female is chosen to keep for breeding. In many cases, this F1 female is mated with a LR male in a backcross mating to produce offspring that are 75% LR:25% GR. If this backcross mating scheme is continued over successive generations, the proportions of LR:GR germplasm in the resulting puppies is: 87.5% LR:12.5% GR, etc., with the percentage of GR remaining in the puppies being reduced by one-half in each successive generation. Of course, an F1 LR x

GR female could be backcross mated with a GR male, in which case the percentage of GR would be increasing with each successive backcross generation while the LR percentage decreases.

RECORD KEEPING

Maintaining an electronic database of phenotypes such as medical diagnoses and temperament traits is essential for monitoring genetic improvement. A key element of obtaining genetic improvement over successive generations will be determined by the set of young dogs in each generation that are kept as replacement breeders, because these young dogs become parents of the next generation. The amount of genetic improvement seen in their puppies will be determined by the selection differential. This is defined as the average amount by which the dogs chosen to become parents exceed the average of the whole generation that produced them. Only by keeping well coded records in an electronic database can assessments like this be made.

Only by maintaining phenotype data in an electronic database will the calculation of estimated breeding values (EBVs) be possible, thereby improving genetic progress. In the canine world, there are a few breeding organizations calculating EBVs internally, but many working dog breeding programs will benefit from putting their data into a shared database that supports keeping the data private within an organization, while enabling the system to pool all data from a given breed into the calculation of EBVs. The exact set of EBVs for a given dog are only visible to the organization that owns the dog, but breed-wide, all the data for a particular phenotype are used to calculate each dog's own EBV. The International Working Dog Registry (IWDR) is one cloud-based system accessible worldwide that meets all these requirements of a record keeping system.

METHOD OF SELECTION

For a breeding plan to be effective in producing genetically improved puppies over successive generations of selection, the plan needs to have a well-defined approach for choosing young dogs to become parents. Over the past century, two broad approaches have evolved: (1.) family selection, and (2.) individual selection. We will briefly discuss family selection, then we will focus on a more detailed discussion of individual selection.

Historically, family selection was used to obtain genetic improvement in a small number of phenotypes or traits where the estimates of heritability for each trait were low, say below 25%. Family selection means that when choosing young animals to become parents, a group of full- or half-sibs are chosen based on the average performance of the family. In other words, if the family ranked in the more desired end of the range of average family values, then a small set of families would be identified to be the source of the replacement breeders for the next generation. This is easy to visualize working in litter bearing species, but is less likely to be used in species like cattle or horses that generally bear only one offspring at a time.

Individual selection is defined as basing the selection decision on the relative merits of each individual animal compared to all others that could be chosen as a replacement breeder. In practice, the canine world for centuries has relied upon the assessment of each individual dog's characteristics, also known as the dog's phenotypes or traits, to decide which ones would become parents. In the modern age, say the last 3 or 4 decades, the working dog world has begun to use EBVs to guide selection decisions for traits that have a polygenic (additive) mode of inheritance. For traits with an autosomal recessive mode of inheritance, the availability of

genetic tests has enabled breeders to avoid making matings that would produce genetically affected puppies.

Because most of the performance traits important to the working dog world have a polygenic mode of inheritance, EBVs are a powerful tool for identifying the small subset of young dogs with the most desired genetic merit. To implement the use of EBVs requires having accurate phenotypic measurements and it requires having those measurements stored electronically, so solutions to statistical models can be obtained using high-level mathematical methods. These methods have evolved over the past century to become very powerful tools for identifying the young dogs best suited to become parents. Working dog programs that produce fewer than 100 puppies of a given breed per year need to work together by combining data into one globally accessible database. One reason is that EBVs can be more accurately estimated in large populations. But even more important, is that a small breeding program is frequently forced to recruit replacement breeders externally in order to maintain genetic diversity. Basically the only way to make well-informed, and thereby mostly successful, decisions about which external dogs to recruit is by collaborating with other similar programs and combining data in a common database.

Summary

There are four key elements of a well-structured breeding plan. Successful execution of such a plan can, rightly so, be called a breeding program. Working dog breeding programs that successfully operate over decades are truly remarkable. This is especially true when the breeding goals are reached and the population continues thriving by producing new puppies generation after generation that serve the needs of the organization. Such high-functioning breeding programs will have embraced these four key elements: (1.) Established a clearly defined **DIRECTION**, (2.) Have chosen an appropriate **PRODUCTION METHOD**, (3.) Obtained access to a **RECORD KEEPING** system that enables completing all the data summaries and reporting required to make objective, data-driven decisions, and (4.) Established an **METHOD OF SELECTION** to identify young animals with genetic merit ideally suited for producing puppies that are genetically endowed with characteristics to do the task at hand.