The power of genetics

Siobhan English Photography

Teagasc equine specialist **Dr Alan Hurley** explains why breeders need to focus on genetics when making their goals

THE contribution of breeding to improving animal performance has been well recognised across a range of different species.

At its most fundamental level, genetics involves the passing of genes (both favourable and unfavourable) from parents to offspring, and unlike management (e.g., nutrition, exercise, and health protocol), genetic selection is permanent and cumulative. This implies that improvements achieved are compounded each generation.

For example, in poultry, the kilograms of feed required to produce a kilogram of meat was predicted to have reduced by 50% and growth rate increased by over 400%, between the years 1960 and 2005. Also, using a controlled experimental study in chickens, it has been demonstrated that up to 90% of the gains in performance in recent decades could be attributable to genetic improvement.

Therefore, genetic selection and optimum management when used together provides the best opportunity for improvement, yielding enormous benefits over time. For example, if a breeder introduces good genetics for traits such as soundness, performance, and athleticism, they can be improved every generation. In direct contrast, however, any indirect consequences of breeding are also compounded with successive generations.

A well-publicised example of such indirect unfavourable consequences of selection is the documented deterioration in reproductive performance in dairy cows concurrent with aggressive genetic selection for increased milk production. It is therefore imperative that breeding schemes are optimised to, where possible, achieve gains in performance where all traits affecting performance are accounted.

GENETIC TERMINOLOGY
The terms commonly used by animal breeders to describe the characteristics of a population are sometimes misunderstood and misinterpreted and need to be properly understood by breeders.

GENOTYPE
Genotype refers to the information contained within the animal's DNA, or genetic material. Every animal is born with a fixed genotype which remains the same throughout their life.

PHENOTYPE
The phenotype is simply the observed performance of an animal "in the field" (e.g., coat colour or height); it's the physical expression of the ani-

Dirk Caremans

The five-star Belgian Warmblood stallion Emerald Van't Ruytershof (Diamant de Semilly x Carthago), who enjoyed an international career under Harrie Smolders, is retired to stud. The horse is a good example of a targeted breeding goal

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mal's genotype. However, the phenotype is influenced by many factors in the animal's environment. For example, two horses with identical genotypes could develop quite different phenotypes if raised in contrasting environments and exposed to different nutrition and training.

HERITABILITY
Heritability is a commonly used statistic in animal breeding. Heritability summarises the proportion of phenotypic variation, or differences among a cohort of animals, attributable to genetic variation between individuals. Put simply, how much of the observed performance (phenotype) is due to genetics. Heritability varies from 0 (not heritable) to 1 (fully heritable). If the heritability is high, it is expected that a large proportion of the phenotypic differences of the parents will be passed on to the progeny. Human height for example is approximately 80% heritable.

Many characteristics such as athletic ability, coat colour, height and behavioural tendencies are all under genetic control. Osteochondritis Dissecans, a

joint disorder, is approximately 25% heritable; therefore, it is possible to make considerable genetic progress in reducing the incidence of this condition.

BREEDING PROGRAMMES
A breeding programme is a programme with a defined breeding goal and breeding objective for the production of the next generation of animals. It is the combination of recording selected traits, the estimation of breeding values, the selection of potential parents and a mating programme for the selected parents including appropriate (artificial) reproduction methods.

Fundamental to any breeding programme is a clearly defined breeding goal. The breeding goal is defined to improve the genetic ability of an animal's progeny to generate greater profitability. Every breeder should have a specific breeding goal. For example, the breeding goal of the KWPN (Royal Dutch Sport Horse) is to breed horses that can perform at Grand Prix level in show-jumping or dressage. A showjumping breeder might have the goal of producing a horse of international fame that will potentially jump 1.60m, as another illustration.

The chances of success for a horse that is "built" for the job, is greater than that of a horse whose build works against him. Moreover, because horses have a long generation interval, the likely circumstances that will prevail in several years needs to be taken into account; not only which animal characteristics will be important, but also their degree of importance relative to other traits.

Once the breeding goal has been determined, a breeder can then decide on the breeding objective (i.e., what are the traits/characteristics which make up the breeding goal?) The breeding objective must strike a balance between performance, soundness and health traits.

As an example, the breeding objective of the KWPN is to produce a horse with good conformation, a functional and preferably attractive appearance,

correct movement and an agreeable character. It is very important to have a horse with a healthy physical condition as the healthier the horse, the greater the chance that it can reach the highest level and that it can be maintained for a long period of time.

Any breeding programme should focus on quality over quantity using only proven mares and stallions with good genetics for performance, soundness and health traits. The resulting foals meet an industry demand.

With a view to the intensive and prolonged training path, a horse that is uncomplicated to handle, easy to ride as well as intelligent and diligent, are very important criterion in the pursuit of reaching the highest sport level attainable. A horse can have the best genetics for jumping ability, but if it isn't sound and therefore cannot get to a competition, this is impractical.

Breeders should be mindful and note that environmental effects can mask genetic effects where possible "bad" genetics can look better than "good" genetics due to environmental effects. For example, if a horse jumps a clear round, that achievement may be partly attributed to its genetic ability and partly due to its environment such as the skill of its rider and quality of its training. For breeding purposes, a horse's genetic ability is the only factor that is important, as a rider's talent cannot be passed on to a foal. Therefore, it is important that all traits are analysed correctly and breeding decisions are made on genetic information.

To reduce environmental bias, data is needed from multiple sources including phenotypic data, management/environmental data, pedigree data, and DNA/genomic data. Once this information is known, it allows calculating what percentage of a trait is genetic and what percentage is due to environment/management factors.

To increase data, breeders are encouraged to get their animals inspected. The inspection can be invaluable when making future breeding decisions as the process gives the owner a detailed description of an animal's conformational strengths and weaknesses.

▪ TAKE HOME MESSAGE

- ↘ Unlike management (e.g., nutrition, exercise, and health protocol), genetic selection is permanent and cumulative implying that improvements achieved are compounded each generation.
- ↘ Breeders need to define a clear breeding goal and breeding objective.
- ↘ A successful breeding programme needs to be based foremost on genetic selection in addition to phenotypic selection.
- ↘ Breeders are encouraged get animals inspected to increase data and assist when making future breeding decisions.

Dr Alan M. Hurley holds a BAgrSc degree (Animal Science – Equine) from UCD and PhD in quantitative genetics from Massey University, New Zealand. After his PhD, he joined Teagasc as an Equine Specialist. Having worked in leading equine organisations in Ireland, he combines expertise gained from both his academic equine science background and equine industry experiences to deliver leadership, training and support within Teagasc.