

Separating the wheat from the chaff

Facts, myths and perceptions in Animal Breeding

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One of the most successful programs on TV was “Myth Busters”. It dealt with things people see or believed in, truth of fiction. In many cases, perceptions of what is real and what is urban legends.

Over the years, animal breeding and related aspects were always, and still are also subject to different belief systems and sometimes myths. Some still see it as a special gift to be able to select the right animals and others realise the science it is built on. The rapid development of predicting the true genetic merit of candidate selection material has opened new perspectives for several aspects related to breeding and genetics.

Who has ever heard of Telegony? This is the belief that, as Wikipedia puts it: “offspring can inherit the characteristics of a previous mate of the female parent; thus, the child of a widowed or remarried woman might partake of traits of a previous husband”. The old belief of Maternal impression where “an emotional stimulus experienced by a pregnant woman (or animal) could influence the development of the foetus” has, however come under the spotlight with the theoretical and subsequent experimental work related to epigenetics, and it's influence on the expression of genes (even over generations).

Although some myths might sound ridiculous to most breeders of livestock, some phrases or concepts are sometimes still misunderstood or

even misused in the breeding industry. Some are touched on.

Statement 1: “Natural selection is where you select animals in a natural environment.”

Although many definitions of Darwin's original observations and description exist, one appropriate definition can be as follows: *“The process by which organisms that are better suited to their environment than others produce more offspring. As a result of natural selection, the proportion of organisms in a species with characteristics that are adaptive to a given environment increases with each generation. Therefore, natural selection modifies the originally random variation of genetic traits in a species so that alleles that are beneficial for survival predominate, while alleles that are not beneficial decrease.”* (The American Heritage® Science Dictionary. Houghton Mifflin Company. <Dictionary.com <http://www.dictionary.com/browse/natural-selection>>.)

In short, this means, animals possessing the alleles (forms) of the genes best suited to specific conditions will be favoured to produce more offspring (that will survive). Many times, in animal breeding, the term natural selection is wrongly used to reflect the “natural conditions” where farm animals are supposedly being kept under to bring the “best” animals forward. In truth, any conditions, “natural” or “artificial” will be the source of natural selection. Where livestock producers “change” the

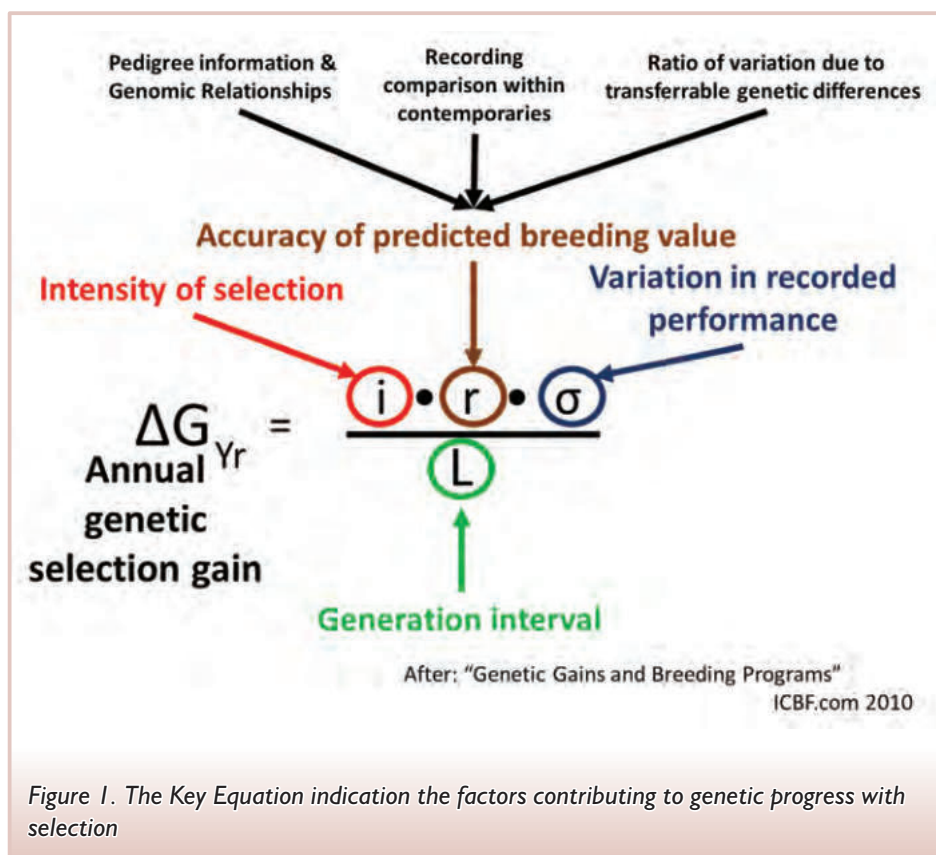
environment (such as putting up fences, applying other nutritional practices, treating or preventing diseases, etc.), natural selection will continuously take place, favouring those animals best suited to such conditions.

Statement 2: “Variation is bad in breeding farm animals.”

Although contrary to belief among some people involved with animal breeding, the basis of all selection remains variation. Without variation, no selection can take place, and it will be impossible to improve on existing production, reproduction, adaptation, product quality or any other property for production and other animals. Even for a breed (and obviously a species) to survive, variation at genetic merit level is essential.

“There can be little doubt that the existence of genetic variation is advantageous to the evolutionary survival of a species, the advantage it confers being the ability to evolve rapidly and to meet the needs of a changing environment, both through the course of time and to colonisation of new localities. Sexual reproduction and outbreeding are necessary conditions for the continued existence of genetic variation...” (Introduction to Quantitative Genetics. DS Falconer, The Roland Press Company, 1960).

The “key equation” for genetic progress (ΔG) through (artificial) selection is well known:



Irrespective of the desired trait or traits considered for selection, a reduction in variation will lead to a reduction in genetic gain obtained through selection.

Statement 3: “Faster genetic progress will be obtained for traits with a higher heritability.”

Who has heard the phrase similar this one: “By selecting for more highly heritable traits, as contributors to female fertility, faster genetic gain is possible”.

In essence this means that it is implied that direct selection for a less heritable trait will result in slower genetic gains that indirectly selecting for it with an indicator trait with a higher heritability.

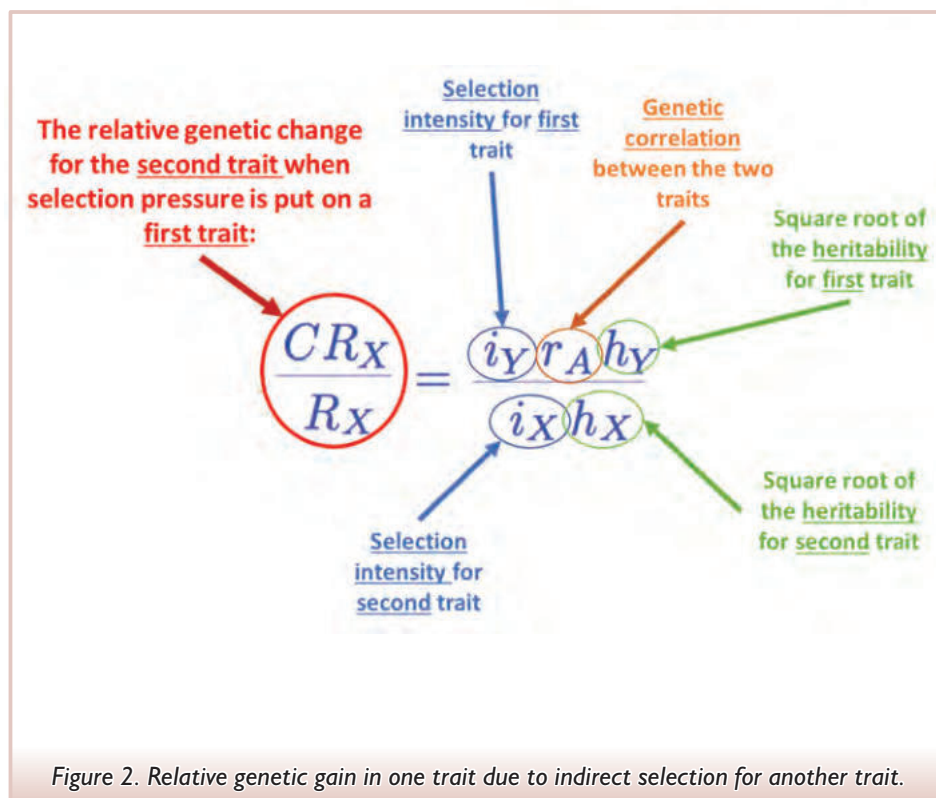
When looking at Figure 1 it is clear that the key factors contributing to change through genetic selection are how intense you select (what portion of the animals are selected from the group offered for selection, and how much their average performance differ from the originals), how much the decision

depends on a true reflection of each animal's genetic merit for the trait (was BLUP used, for example that take the relative transferable genetic differences into consideration) and ultimately the variation in performance from available.

Statement 4: “Indirect selection using different trait, result in higher genetic gains for traits with a lower heritability.”

Even in negating the fact that modern genetic merit predictions account for lowly heritable traits, such as female fertility, and that selection progress is primarily dependant on genetic variation, the myth of selecting for indicator traits (indirect selection) even in the presence of breeding value predictions for the primary traits, will always lead for faster gains where this major trait is lowly heritable.

Although appearing to be very complicated, the equation in Figure 2 shows the relative effectiveness where an indicator trait with high heritability is used for genetic gains in a related desirable trait.



The factors at play will be the heritability estimates of both traits, the genetic correlation between them and the selection intensity of the trait used to change the performance in the second trait. Selection intensity depends on the proportion of animals selected and the (phenotypic) variation for the selected trait. A ground level example will be where breeders want to select for more fertile cows, as expressed in the inter calving period (ICP) over the first four calves (“Cow fertility”) but uses indirect selection based on condition scores (BCS) (recorded in contemporary groups at a time of maximum variation, for example after winter) of replacement heifers. Even with heritability estimations of six percent for ICP (SA Stud Book calculations and average from numerous studies) and 25% (average from numerous studies) for BCS and a genetic correlation of 40% between the traits (the higher level from numerous studies), the effectiveness of the indirect selection will be in the region of nine percent!

The question could therefore be asked: “Is it really then bad to use indirect selection?” The answer will be a calculated “No, it is not bad, it is just not as effective as direct selection”. This is also given the trait targeted is well defined, recorded accurately, shows adequate variation and accurate genetic predictions are

available. It is also a good practice to include indicator traits, where available, in a selection index (a single value that includes all traits of economic importance) value. Indirect selections are frequently used for trait that are difficult, impossible or expensive to measure on breeding animals.

Statement 5: “Inbreeding is useful for genetic progress (and therefore a good thing).”

The average effects of inbreeding on animal performance have been researched far and wide. Many well written, well documented and very well peer reviewed scientific and other articles were written on the negative effects that high inbreeding levels have on traits of economic important, especially those associated with fitness. In essence, high inbreeding result in animals carrying the same forms (allele) of genes, leading to less variation and the ability to counter deleterious forms of the genes. Inbreeding is a “state” rather than a means of selecting animals. This also reduces the variation with a resultant ability to adapt to changing environmental pressures and usually a lower immune response. As the saying goes: one swallow doesn't make a summer. Why would the argument

therefore be that one exceptional high inbred animal should be the norm? With reference to the “key equation” for expected genetic progress through selection, highly inbred animals will show less variation in performance and have lower fitness levels (survival and fertility). These are all factors influencing the rate of genetic gain as illustrated in Figure 3.

The factors changing the gene frequency in populations (breeds, for example) are selection (natural and/or artificial), mutation, migration and genetic drift. The first three is known as “systematic processes” while the forth one is known as a “dispersive process” Falconer, 1960). Selection is the means of ensuring higher levels of the desired form of genes, whereas genetic drift could result in the fixation of undesirable forms of genes, as has happened in many instances in the past. It is simply not worth the risk.

Learn from the masters, use common sense, apply technological advances and know the underpinning science when selecting the animals that will produce progeny suited for your clients' profitability. That should be the main objectives for Stud Breeders.

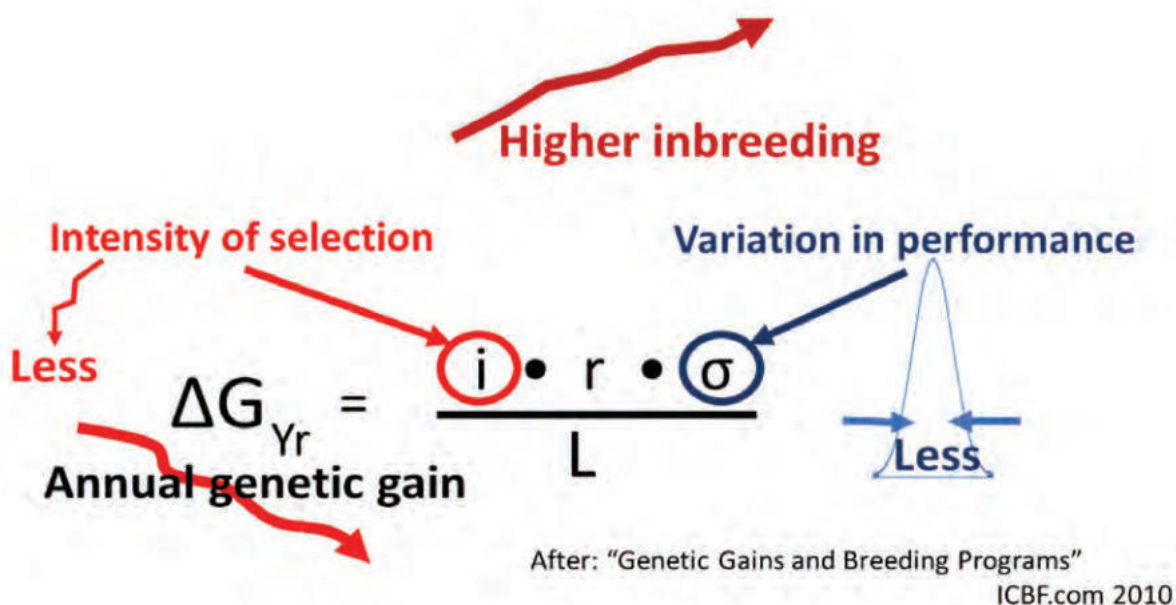


Figure 3. The impact of high average inbreeding levels on genetic gain through selection