Selection for Adaptation & Growth

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In the past, livestock was selected on single traits for increased production, e.g. heavy weaners in beef cattle, high milk production in dairy cattle or high litter size in pigs. This was easily measured and improvement in the measured trait was high. However, animals are generally in balance, and traits are genetically correlated. If the animal is in an environment with limited energy, and if one trait is selected to use most of the available energy, other traits, usually fertility, health, and longevity, are likely to suffer. This can generally be remedied by changing the environment: highly specialized feed resources and improved housing environments go a long way to improve production. Changing the environment is however not a desirable option for most beef cattle farmers, as beef cattle can convert low value grasslands into meat and are therefore mostly extensively farmed. This leaves the question: How do you know which animal is genetically the best on your farm?

Adaptation and growth

During the 1950s and 1960s some baffling and confusing selection experiments on growth in mice were performed by the renowned geneticist Professor Douglas Scott Falconer from

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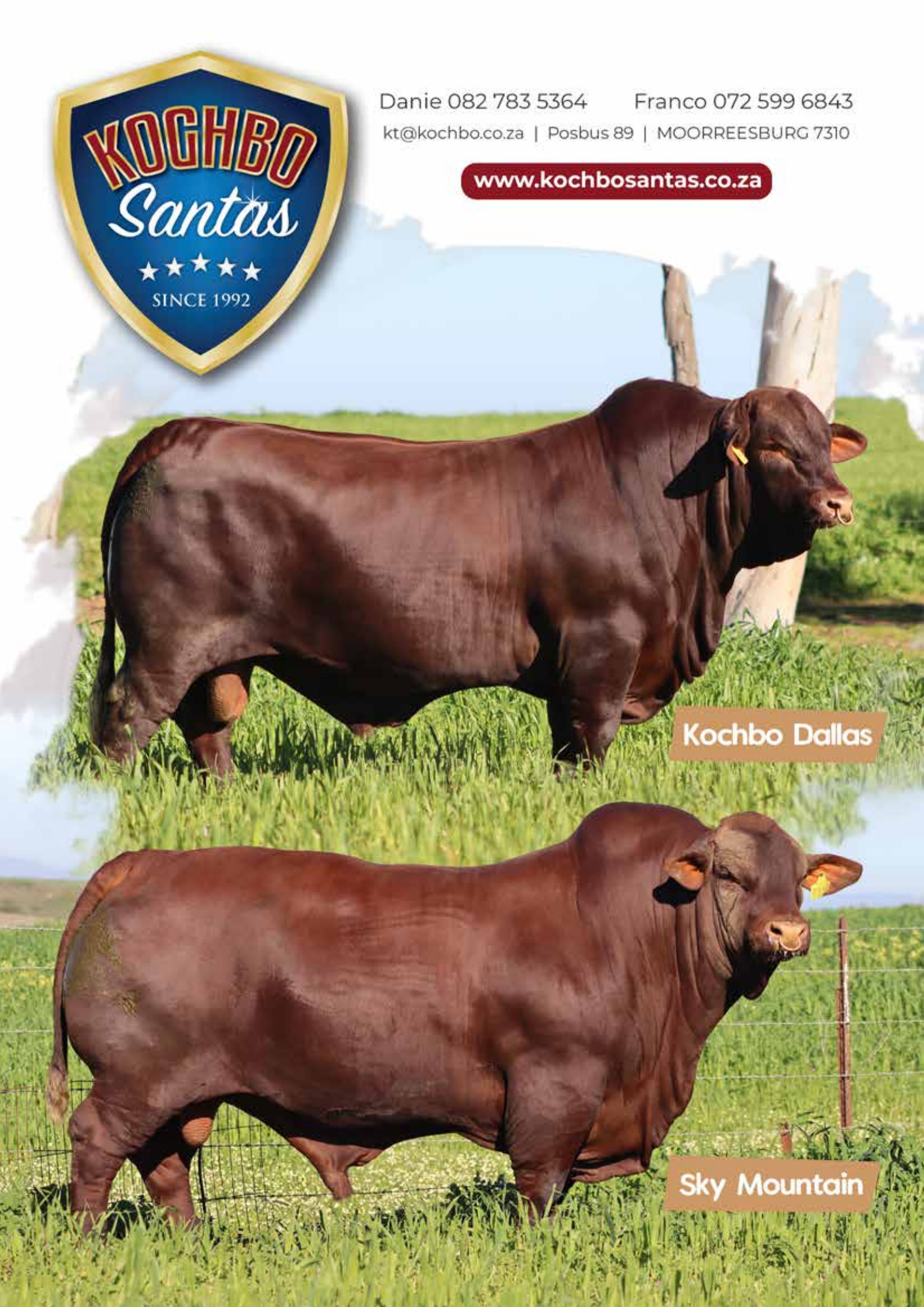

the University of Edinburgh. Lines of mice were selected for growth on a good diet, while other lines were selected for growth on a restricted diet. After some generations, they switched the mice, expecting that they would still grow, as both lines were successfully selected for increased growth. However, the mice selected on the good diet did not grow as expected on the restricted diet, while the mice selected for growth on the restricted diet not only grew, they 'were heavier, had less fat and more protein, and were better mothers' (Falconer, 1977) than the mice selected on the good diet.

What has a study on growth in mice in the 1960s has to do with beef cattle breeding of today? Animals adapt to the environment they are selected in. During a process of resource allocation, animals distribute available resources (energy) optimally between traits. Maintenance is the most important, usually followed by growth, lactation, fertility, and lastly fat reserves. This process is under genetic control. Selecting animals for increased growth in a good environment may be successful if there is sufficient energy for fertility and health functions. However, these animals may not perform well in a poor environment, as energy allocated to growth has genetic priority, resulting in a decline in health and fertility due to insufficient energy in the system. These animals are then not adapted to the new environment, like the good-diet mice on the restricted diet in the Falconer experiment.

However, animals are able to genetically develop methods to thrive in poor environments. Adaptability is defined as the ability of an animal to survive and reproduce within a specific environment. This ability is genetic. It is well known that beef cattle have developed adaptive traits like disease and heat resistance. Some are able to cope with poor quality and quantity feed by reducing their metabolism, while others have the ability to store fat during favourable seasons to be used as an energy source in unfavourable seasons. Other traits that indicate adaptiveness in hot climates include smooth coats and better developed sweat and sebaceous glands.

'Thus, a clear difference was that selection on the restricted diet produced mice that diverted less of their intake to fat. This allowed better growth because, presumably, of the higher energy content of fat than of protein. The reduced diversion to fat was not just a response to the restricted food intake because it remained when intake was not restricted' Falconer, 1977.

Selecting animals that grow in a restricted environment is therefore selecting for animals that are genetically adapted to the environment and therefore have enough energy left for growth, and they have growth genes as well. Animals that are not adapted to the prevailing environment, have to waste valuable energy on coping in the environment, whether it be heat, low quality feed, parasites, etc., to the detriment of growth, fertility, and health traits. An example of these differences can be seen in heifers weighing less at 12 months than at weaning, while others that have overwintered in the same group have been able to grow because they are adapted to the environment. Selection goals should therefore include all traits, like fertility, longevity, and maintenance in addition to weaning weight, thereby ensuring that the animal is in harmony with nature and the specific environment in which it has to perform. Select for animals adapted to the specific environment in which they must produce, whether it is a good or a poor environment. (Any deficiencies in the environment should however be addressed, like a lick in winter, or extra fodder during droughts).

How do Breeding Values fit in?

Weaning weight of a calf is influenced by environmental as well as genetic factors. An animal with a high genetic potential for growth, will not grow to its full genetic potential in a poor environment, due to a lack of feed (energy). Determining the genetic potential in a breed is therefore not as simple as weighing all calves at weaning and assigning the highest breeding value to the heaviest calf, as this would incorrectly confound genetics and environment (the older bull calves in the better environments will incorrectly get the highest breeding values).

Breeding values indicate genetic potential, without the environmental influence. Breeding values are estimated by comparing within-group weights of animals exposed to the same environment, correcting for known effects like sex and age of dam, and genetically linking these groups together with link-sires (bulls with progeny in different contemporary groups and herds). Link-sires are used to rank the breeding bulls in the breed, e.g. Bull A tends to produce above-average weaners, irrespective of the weaning weight of the herd in which his calves were measured, and genetic performance of all other animals in the breed can therefore be determined accordingly. Simply put, Bull A's calves may weigh less in Mpumalanga than in the Western Free State, but if they are above average in their respective groups, his breeding value for weaning weight will accordingly be high. This scientifically proven process is quite complicated, but is used world-

wide in the selection of all livestock species.

Genetics do play a role in determining weaning weight, and being able to identify a sire that will breed the desired traits in his calves, will improve profitability. In general, a sire with a high genetic potential for weaning weight will sire calves that will grow better than a sire with low genetic potential, if their calves are raised in the same environment. In the same way, a sire with high genetic potential's calves will not weigh the same in different environments, due to environmental influences on the calves.

If a calf with a high genetic potential for weaning weight (growth) is placed in a restricted environment, it will not grow to its potential and other traits may be affected as well. Fertility is a good example: In a superior environment, nearly all cows will calve, but in a restricted environment, some will skip, giving a more accurate indication of the genetic ability for fertility. In the estimation of breeding values, the fertility performance of related cows in poor environments will reflect in the breeding value of the cow in the superior environment. A cow with a short ICP in a superior environment, may therefore have a low breeding value for fertility, due to family performance in other environments. This will happen with all traits.

Breeding values therefore take cognisance of what is happening in all environments, providing that all family members in all environments are measured. It is also important to not only select on single traits, but to look at all breeding values, to be able to select for balanced animals which will produce well in your environment.

Conclusion

The production of an animal is a combination of genetics and environmental influences, of which the environment plays the biggest part. Selection means identifying and multiplying the animals with the best genetic combinations to grow, survive and produce in your specific environment. Over time selection goals have changed: rather than measuring and selecting singly and only for specific maximum production traits, like heavy weaners, selection is aimed at efficient, fertile, long living cows that produce many healthy, strong, and profitable calves. Selecting for and improving many traits at the same time turned out much more viable and sustainable in the long run.

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