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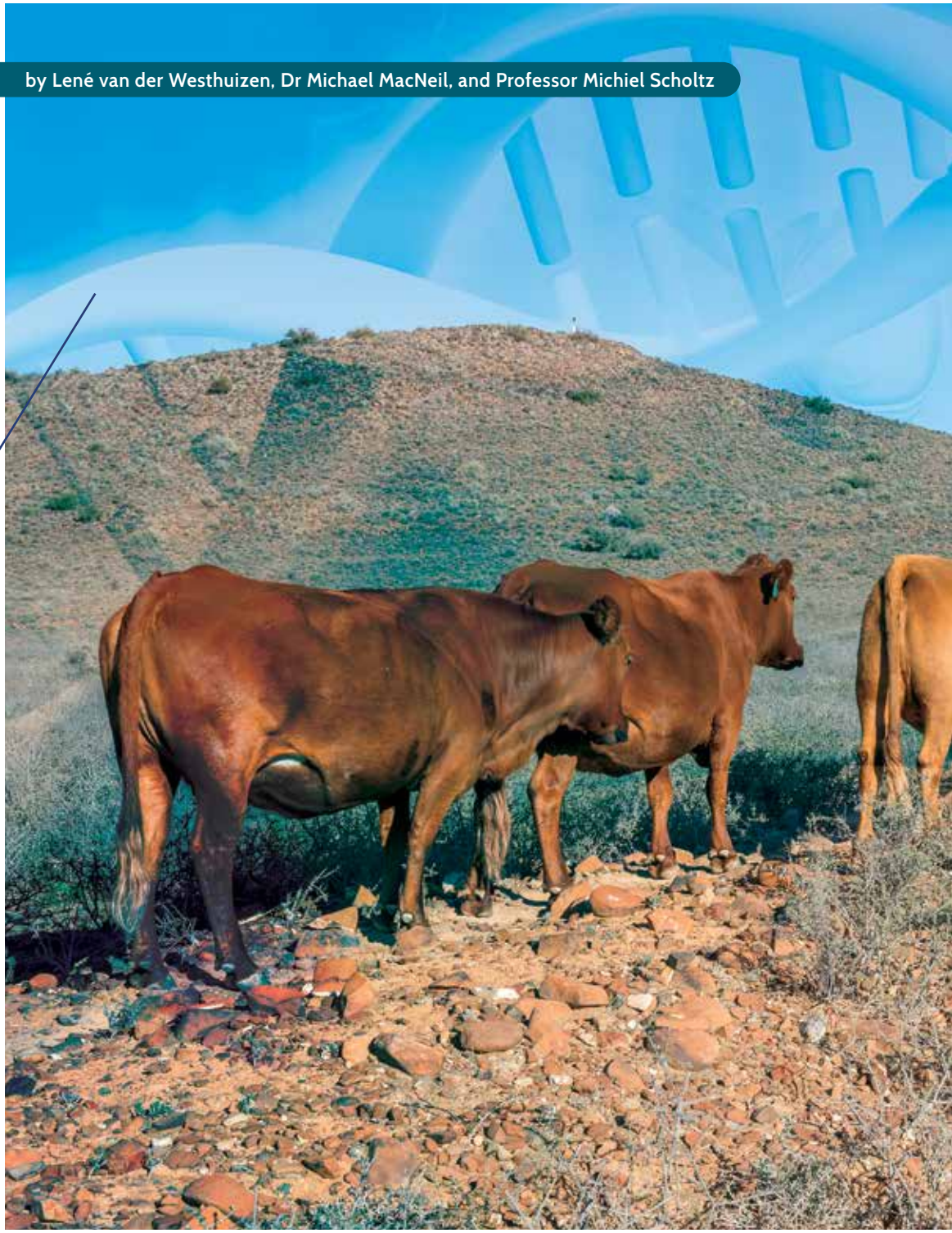
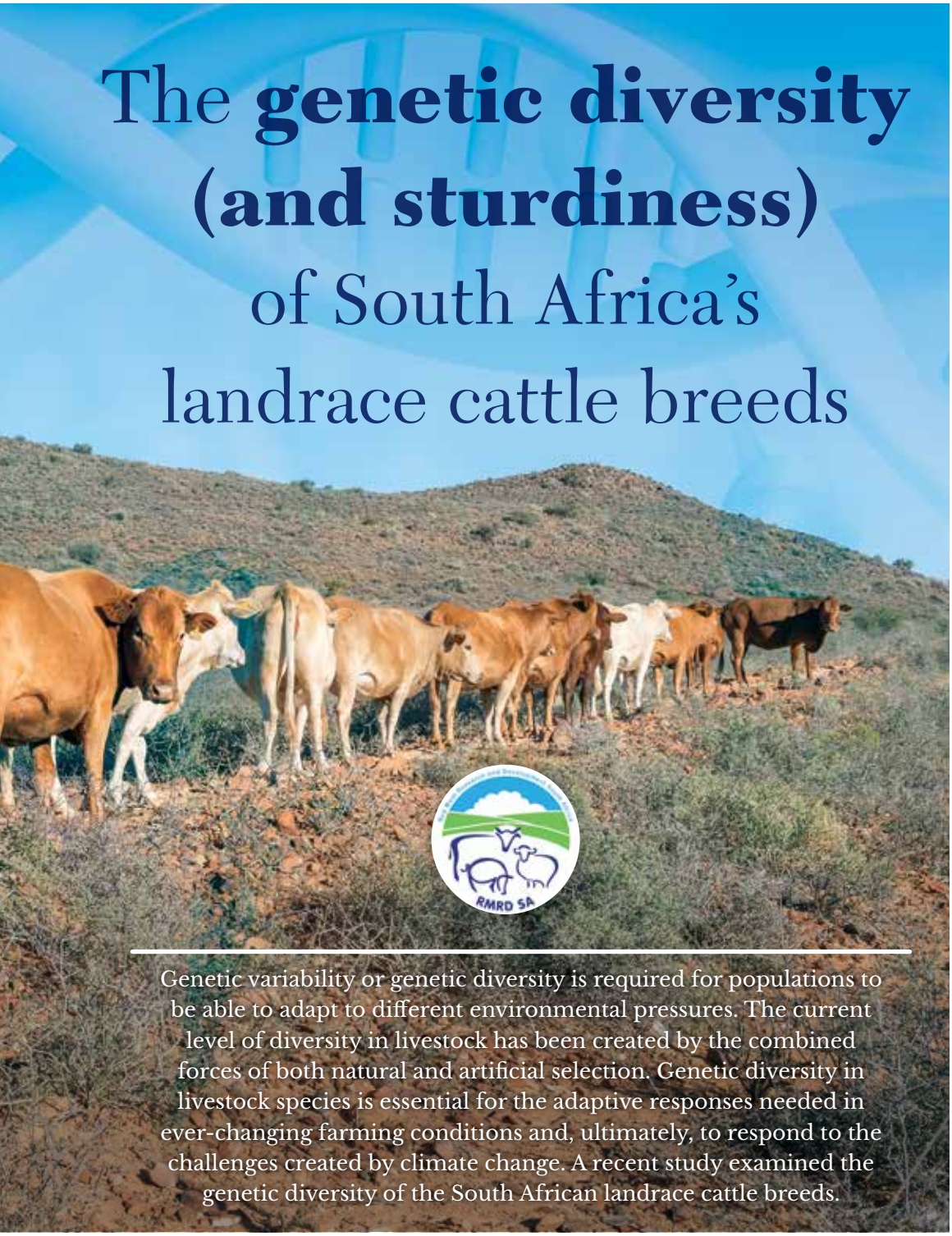


The **genetic diversity (and sturdiness)** of South Africa's landrace cattle breeds



Genetic variability or genetic diversity is required for populations to be able to adapt to different environmental pressures. The current level of diversity in livestock has been created by the combined forces of both natural and artificial selection. Genetic diversity in livestock species is essential for the adaptive responses needed in ever-changing farming conditions and, ultimately, to respond to the challenges created by climate change. A recent study examined the genetic diversity of the South African landrace cattle breeds.

The variation of alleles and genotypes present in the genetics of a breed provides the basis for adaptive and evolutionary processes. These forces can be described as mutations, adaptations, segregation, selective breeding, and genetic drift. Aside from allowing adaptation to environmental pressures like climate change, diversity also provides a reservoir for genetic variation to ensure that future market demands can be met through selection.

A BREED APART

The indigenous cattle breeds of Southern Africa include the Sanga and Sanga-derived cattle. Sanga cattle, especially those indigenous to Southern Africa, are classified as *Bos taurus africanus*. The indigenous Sanga cattle of South Africa includes the Afrikaner, Nguni, and Drakensberger, whereas the Tuli and Hugenoot are considered to be the landrace breeds of Southern Africa. The Bonsmara is a Sanga-derived composite breed. These breeds are extremely well adapted to the harsh climatic and other environmental conditions encountered under extensive ranching in South Africa. This will become even more important in the era of climate change.

Research has suggested that Sanga cattle, compared to European breeds, are favourable in terms of meat tenderness. There has been speculation that the landrace breeds may be closely related to other tropically adapted breeds (*B. indicus*), such as the Brahman, due to their morphological similarities. However, several genetic studies have demonstrated a closer relationship between Sanga and *B. taurus* breeds.

In the early 1900s, there was a perception in South Africa that the indigenous breeds were inferior and this led to the promulgation of an Act in 1934 in which indigenous breeds and types were regarded as 'scrub' (non-descript). Inspectors were appointed to inspect the bulls in communal areas, and to castrate them if regarded as inferior. Fortunately, this Act was applied effectively for only a few years, since it was very unpopular. The effect of this, however, especially on the 'purity' of the Nguni, was never established. In addition, the Bonsmara is supposed to be 5/8 Afrikaner:3/8 British composition. Through selection and subsequent upgrading, this composition may have shifted significantly. It is therefore important to also establish the relationship between the landrace, Zebu, British, and European breeds.

LANDRACE GENOMICS

The Southern African landrace breeds are relatively poorly characterised at the genomic level in comparison to many taurine and indicine breeds. Using genotypes derived from microsatellite loci, several research projects have characterised contemporary populations of Bonsmara, Afrikaner, Nguni, and the Tuli from Zimbabwe. Due to the cost of genotyping, substantially fewer animals (i.e., ≤ 50) have been characterised by single nucleotide polymorphism (SNP) arrays using approximately 50 000 deoxyribonucleic acid markers (DNA), to estimate the diversity of Afrikaner, Bonsmara, Drakensberger, and Nguni cattle and to evaluate their relationship to other breeds worldwide. Bi-allelic markers, such as SNPs, are currently the subject of interest, globally. However, in Southern Africa, microsatellite markers have been used routinely and are more cost-effective in the livestock, wildlife, and aquaculture industries.

The aim of the recent study was to use microsatellite marker databases (provided by breeders' societies) to estimate levels

of heterozygosity and inbreeding of nine Southern African Sanga and exotic breeds, and quantify the genetic relationships between the breeds. This allowed the use of substantially larger numbers of animals per breed to be studied than in previous investigations.

The breeds used in this study were Afrikaner, Angus, Bonsmara, Boran, Brahman, Drakensberger, Nguni, Simmental, and Tuli. Animals were genotyped in response to requests from industry for parentage verification. At least 300 animals were randomly chosen to represent each breed. All breeds had large numbers of alleles at each locus and high frequencies of heterozygous genotypes. Inbreeding was found not to be at a level where it will be problematic in the South African segments of these breeds. While the present study used microsatellite data, another study, using SNP data, showed similar findings regarding the genetic variability and inbreeding levels of Southern African Sanga cattle.

When provision was made for two ancestral populations (K=2), the two taurine (Angus and Simmental) breeds were separated from the Sanga and indicine (Afrikaner, Bonsmara, Brahman, Boran, Drakensberger, Nguni, and Tuli) breeds.

It was noted, however, that both Bonsmara and Drakensberger also showed some admixture of at least 30%, with the cluster belonging to Angus and Simmental. These results are consistent with the development of the Bonsmara breed with the *B. taurus* influence (5/8 Afrikaner, 3/16 Shorthorn, and 3/16 Hereford) and some uncertain or undefined breed origin of the Drakensberger.

When provision was made for three ancestral populations (K=3), it grouped the taurine (Angus and Simmental), indicine (Brahman and Boran), and Sanga (Afrikaner, Bonsmara, Drakensberger, Nguni and Tuli) breeds separately. When K=9 was used, breed individuality, and admixture between the breeds could be clearly defined.

GENETICALLY DISTINCT AND STURDY

The study revealed the Southern African Sanga and exotic cattle breeds found in South Africa are genetically distinct from each other. Furthermore, comparable genetic variability and inbreeding levels found in the present and other studies, demonstrated the genetic sturdiness of the Sanga and Sanga-derived breeds.

There is a notable similarity between the results observed in this study (using a limited number of DNA markers and large numbers of animals) with the results of other studies with similar objectives (using substantially greater numbers of DNA markers but much fewer animals).

Both analyses revealed the Southern African Sanga breeds, British and European breeds, as well as the tropically adapted Zebu breeds, clustered separately. Therefore, exotic breeds in South Africa are expected to benefit from favourable heterosis effects, when crossed with landrace breeds.

Finally, the results from this study indicate that genetic diversity in both the livestock and wildlife industries may capitalise on microsatellite marker databases, which remain cost-effective and accessible due to their use for parentage verification. R