Gene Editing

The following background information article has been prepared to inform breed associations and other interested parties on the topic of gene editing. This follows the September 2021 by the Red Angus Association of America[1] that they are going to provide herd book registry for gene edited Red Angus. It is fair to say that the topic of gene editing is very divisive. On one hand, it is based on Nobel Prize winning science and has the potential to enable faster genetic progress in the limited number of traits that are influenced by single genes of major effect. On the other hand, concerns have been raised about safety, beef consumer resistance, and the possibility of regulatory hurdles limiting the pursuit of this breeding approach.

Gene editing is a technology that allows DNA to be modified at a precise location. The basic method involves cutting DNA at a specific location based on recognition of the specific target DNA sequence. The cut site is then repaired using the natural DNA repair mechanisms of the cell. These repairs can be directed to introduce small changes, delete, or replace DNA, therefore 'editing' the genome. In some cases, gene editing will be difficult, but not impossible, to detect in the subject animal and their descendants.

While gene editing is scientifically considered to be a separate technique to the technique for creating genetically modified organisms (GMOs), a number of countries have applied the same laws and regulations to both techniques. In Australia, the regulation of gene technology is the responsibility of the Office of the Gene Technology Regulator[2] (OGTR) and, as of September 2021, the OGTR does not consider an animal to be a GMO when gene editing is used to delete DNA. However, the OGTR considers an animal and its descendants to be GMOs if gene editing is used to introduce or replace DNA (even if the new DNA is from the same species, e.g. the poll gene). Therefore, the resulting animals and their descendants are subject to the same extensive regulatory and testing requirements as other GMOs.

In simple terms, the advantage of gene editing is that it allows a breeder to introgress genes from other breeds or populations without the need to grade up over multiple generations. As such, gene editing requires knowledge of the function of the DNA being edited, and edits can only be applied to a small number of DNA locations in each animal to be edited. Thus, gene editing is only suitable to the limited number of traits where single genes of major effect have been identified. Well known examples of these include coat colour variants, horn/poll and a number of recessive genetic conditions. While the aforementioned examples all exist in cattle, gene editing technology can also be extended to allow the introgression of genes from other species, but with associated ethical, safety and regulatory concerns.

A further consideration for the use of this technology in cattle breeding include whether genetic material from gene edited animals and their descendants can be shared across borders, which will depend on the regulations of the jurisdictions (country, state etc.) involved[3]. Additionally, where a gene edit influences (directly or indirectly) traits that are included in a genetic evaluation, the similarity in performance between related animals (excluding direct descendants) will be reduced and this will adversely influence the accuracy of the relevant EBVs for this animal.

It is strongly advised that all individuals seek independent legal and scientific advice if the importation of genetic material from gene edited animals and/or their descendants is being considered.

1 https://www.beefmagazine.com/beef/beef-breed-approves-gene-edited-traits-animal-registration
2 https://www.ogtr.gov.au/
3 More details can be found in the records of the Fourth International Workshop on Regulatory Approaches to the Agricultural Applications of Animal Biotechnology - https://sites.google.com/a/vt.edu/animalbiotechresources/2020-online-workshops

Southern Beef Technology Services
Telephone: (02) 6773 3555
Email: office@sbts.une.edu.au

Tropical Beef Technology Services
Telephone: (07) 4927 6066
Email: office@tbts.une.edu.au