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Gene editing — what's the difference?

Key points

- ✔ New gene-editing technology different from GM
- ✔ Allows precise changes to DNA
- ✔ Regulations need to be reviewed

LAST year was a challenging year. We had a significant fall in milk price and a two per cent fall in milk production, which put dairyfarmers under significant pressure.

As price-takers in an increasingly volatile market, dairyfarmers must constantly innovate and adapt to keep their costs of production down. The ability to access new technologies is crucial to this. In recognition, Dairy Australia invests a substantial amount of funding into research and development (R&D) and extension activities across the supply chain.

The main focus of R&D is to assist dairyfarmers with innovation on-farm and drive productivity. This is done through pre-farmgate programs in sustainability, business management, climate change, animal nutrition, farm systems and modelling; plus, extensive DataGene and DairyBio research in the field of animal health, fertility, herd improvements and genetics.

Right now, our industry has a unique opportunity to capitalise on the combination of new technologies in genetics, engineering and computer science. The adoption of these technologies is going to become increasingly important to help farmers remain sustainable, profitable and competitive with the rest of the world.

What is gene editing?

As one of the new biotechnologies designed for health and/or economic benefits, gene-editing would have to be one of the most talked about topics in science and covers a range of techniques. From new cancer treatments to reducing the impact of mosquito-borne diseases to widespread application in cropping and now pastures — it is a technology that compels all of us as farmers to better understand how it might shape the future of our industry.

Gene editing describes new scientific methods that can cut and edit a DNA sequence. These new methods are precise in selecting the site of editing, and more importantly, some methods can alter the DNA of a living organism in a way that mimics changes that occur in nature. The DNA is cut with a protein at a predefined location and then modified by inserting new sections, replacing the section or deleting the section altogether.

Biotechnologies have significantly sped up the breeding process by enabling specific traits of plants to be targeted.

Traditional techniques

Traditional genetic engineering, or modification (GM), introduced new genes to the DNA of plants or animals to impart new characteristics. The ability to transfer a gene from one species to another, or from one organism to another, was a significant development in biotechnology. However, its adoption has led some consumers opposing plant or animal products that contained genetic material of another organism.

By contrast, gene editing is a targeted technology that can produce improved crops and animals without the need to introduce foreign DNA into the genome of the individual, therefore overcoming the opposition of some groups in the community to products of genetically engineered plants and animals.

Conventional breeding, on the other hand, is the process of changing a species through successive generations. By identifying particular traits, the species then breeds to pass on their genetics. Over time the desired characteristics become the norm and the species has been permanently altered.

Conventional crossbreeding methods can take 10 to 20 years to select, breed and develop a stable line of plants and animals with a targeted trait. Gene editing allows for a more precise breeding outcome in significantly less time.

Technically, both GM and conventional breeding happen in nature and we have been eating genetically modified organisms (GMOs) for thousands of years. Take for example the sweet potato, the genomes of which were naturally altered by a specific type of bacteria that inserted itself 8000 years ago. By implementing traditional genetic engineering, scientists are fast tracking what could have essentially been a natural process of evolution.

Transforming the industry

Biotechnologies have significantly sped up the breeding process by enabling specific traits of plants and animals to be targeted and changed in a matter of years.

This new technique provides scientists with a quick and accurate way to improve plants and animals; this, in turn, will assist agriculture to remain sustainable and productive under pressure from a changing climate and population growth.

The major advantage is that, gene-

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editing, when combined with the knowledge gained from the mapping of genes for valuable traits on genomes, provides a precise method to develop lines of plants and animals that will thrive in new conditions, increase yields, increase protection from diseases, produce higher quality food and provide products for emerging markets.

Uncertain regulation

The excitement and optimism shared by many about gene editing, especially with the development and accessibility of new gene-editing tools, does not currently translate to ready adoption by agriculture.

The implementation of gene editing is limited primarily by the uncertain regulatory environment for products of gene editing. The hesitation, some of which arises from the complexity of the science underlying the technology, is reflected in the diversity of views regarding the adoption of the technology.

For Australian agriculture, gene editing is used in research and has huge potential for practical application. However, at the present time, regulations do not adequately distinguish between 'traditional GM' and the new gene-editing techniques leaving confusion as to whether regulators will interpret products of gene editing as different to genetically engineered products.

In 2016, the Australian Gene Regulations 2001 review started where the question of gene-editing regulation was a top priority.

This is a similar question being asked around the world with scientists and biotech companies in Europe being asked their thoughts in regards to the regulation of gene-edited organisms. D

ADIC and the gene technology review

Key points

- ✔ Review of gene technology underway
- ✔ ADIC and Dairy Australia put forward recommendations
- ✔ No regulation required if technology mimics natural process

THE dairy industry must be able to access new and better varieties of pasture to capitalise on opportunities for growth and prosperity.

By developing new gene-editing techniques, we will be able to down-regulate gene functions that cause toxicity in cattle, human allergies from ryegrass pollen and reduced digestibility in ryegrass and tall fescue. These techniques do not incorporate foreign DNA into forages but rather 'delete' some undesirable traits.

Gene editing is not just important for the agricultural sector — it has the potential to transform the medical world in terms of how we treat human diseases such as leukaemia and muscular dystrophy.

However, clarification about how these emerging techniques will be regulated is critical to ensuring these new innovations have a place in Australian dairyfarming systems.

At the present time, it is not clear about whether this new gene editing technique is captured by Australia's regulatory scheme. Regulatory resolution is critical to researchers and investors so they can access the benefits and productivity gains these new technologies will provide.

Where we stand

On October 18, the Office of the Gene Technology Regulatory (OGTR) announced its first round of public consultation on options for amending the Gene Technology Regulations 2001 Act with the release of a discussion paper Options for Regulating New Technologies.

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A range of techniques and technologies used, particularly in plant breeding, are currently exempt from gene regulations.

Australian Dairy Industry Council (ADIC) and Dairy Australia responded to this review by contending that regulation of new technologies should be commensurate with risk, underpinned by rigorous science, and ensure farmers have access to innovations that will drive our industry forward.

Where scientific processes and resulting products mimic those that can occur in nature, the extra regulation currently applying to "genetically modified organisms" in Australia ought not apply. Following this public consultation phase, Australia's Gene Technology Regulator will clarify how new breeding techniques are to be regulated.

Current regulations are recognised by the regulator, industry and scientists as out of date and do not offer legal clarity about whether new gene technologies are captured by Australia's regulatory scheme.

ADIC understands that the Gene Technology Act will be reviewed this year, allowing the opportunity for more broader policy-based decisions to be made. We believe that farmers should be able to choose which technologies and systems they adopt to meet their specific farming needs — be that organic, genetically modified (GM), low-input, robotic milking etc.

As an organisation, we support regulation that adequately safeguards against possible risks and we support new technologies if those technologies have been subject to a rigorous regulatory process.

A similar position that many Australian scientists have, ADIC believes that over-regulation means that investment in research and development becomes expensive and time-consuming.

Gene editing is a rapidly evolving field of biotechnology that has already outpaced existing legislation not only in Australia but around the world. Across all industries, the use of gene editing will be considered in terms of human ethics, animal welfare and environmental responsibility. New policies and regulations are essential to ensure the benefits of the technology are realised. D

DataGene to drive dairy genetic gain

Key points

- ✔ DataGene created to drive herd improvement in Australia
- ✔ Central data repository will bring benefits
- ✔ ADF major shareholder

FOR the past 30 years, the role of genetic evaluation of Australian dairy cattle has been performed by the Australian Dairy Herd Improvement Scheme (ADHIS). Late last year a major decision was made to form a new independent and industry-owned organisation called DataGene.

DataGene is responsible for driving herd improvement for the Australian dairy industry through genetic evaluation and managing the software that runs most herd test centres (DataGene Centre).

One of the first deliverables will be the much-anticipated central data repository (CDR), the first stage of which is due for release in mid-2017. Combining these three functions will create a critical mass of scientific and computer power on a scale the industry has not yet experienced. This will enable the dairy industry to access vastly more data and this will generate opportunities to deliver modern tools and resources that will transform dairy herd improvement in Australia. There is a lot at stake; the Lacey and Coats report, from 2013, estimated that better herd improvement decisions could deliver an extra $25 million in profit on farm.

Dairyfarmers can expect to benefit from DataGene through: easier decisions, smarter systems, faster access to data, better tools and more profit.

DataGene is developing modern, user-friendly tools and software programs designed specifically for dairyfarmers and their service providers. These tools will draw upon data made accessible through the central data repository. The CDR will allow seamless access to herd records from multiple sources, for example, records held on farm computers, at vets and breed societies. Smarter systems will allow for easier data entry by farmers and others in the industry.

Having access to vastly more data will enable scientists to provide more reliable Australian Breeding Values and indices; as well as opportunities for world-leading research and the development of breeding values for new traits. Combined, these things will make it easier and faster for dairyfarmers to make better herd improvement decisions, based on relevant data. Two new tools are scheduled for release this year: the Herd Test Dashboard and a new app for entering herd health and other data on a smart phone or tablet.

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The ADF influence

As a major shareholder in DataGene, Australian Dairy Farmers (ADF) retains a strong influence over genetic evaluation and herd improvement directions. While the DataGene board is elected based on skill, it will always include a minimum of three directors with expertise in milk production. Current farmer members of the DataGene board are John Harlock (southwest Victoria), Simone Jolliffe (NSW) and Craig Lister (northern Victoria).

Australian Dairy Farmers and Dairy Australia together have at least 50 per cent membership rights in DataGene while the National Herd Improvement Association (NHIA) has a 15 per cent stake. However, DataGene's success will rely on a highly collaborative approach so it has been set up to allow for the remaining 35 per cent of membership to be made up by industry organisations.

In recent months, 19 industry organisations have taken up membership in DataGene. Members come from all sectors of the herd improvement (HI) industry including herd test companies, artificial breeding companies, breed societies and other organisations.

DataGene chief executive officer Dr Matt Shaffer said the response from the HI industry signalled strong support for a collaborative approach to herd improvement through DataGene.

"DataGene is a major investment by Australian levy payers through Dairy Australia," he said. "With such a strong commitment to collaborate by industry organisations, we are well placed to leverage levy funds to drive herd improvement into the future." D

Farmer in focus: Gavin Robb trail blazer

Key points

- ✔ Farmer involved in research and development programs
- ✔ Helps improves herd performance
- ✔ New ideas and research key to industry future

THE dairy industry is a vital part of the broader food system. Dairyfarmers produce products that deliver key nutritional benefits to people, and in turn, consumers contribute to the farming industry by delivering key economic benefits across the value chain.

Encouraging innovation on farm allows for greater sustainability and improved profitability for individual farmers, something Gavin Robb has been working towards for the past 30 years.

Mr Robb is a fourth-generation dairyfarmer from Alstonville, on the far north coast of NSW, and works in both dairy and beef production in partnership with his wife, Kath, and son, Steven. His farm has supplied Norco since commercial dairying production first started on the property more than a century ago.

In an effort to overcome the problems of traditional European dairy breeds performing at reduced levels in tropical and third-world countries, Mr Robb was involved in the CSIRO's cattle breeding program in the 1970s and 1980s, which saw the development of the Australian Milking Zebu.

"The breed was developed around breeding values for tick resistance, better heat tolerance and higher milk production yields," Mr Robb said.

While he no longer milks this breed, he said they are still used in other parts of the world and taught him the high value of research and development (R&D).

"Being a part of the research and development around herd genetics has helped me to increase my herd's performance," he said.

The reason this technology worked so well was because the project was not just talk, it was something he could be a part of and offered tangible benefits for countries importing cows.

"Continuous advancements in technology has given me practical solutions to achieve improved on-farm outcomes and provide long-term commercial value both for my herd genetics as well as improved pasture growth, application of new on-farm technologies and overall farm management, all of which have been achieved through R&D in one form or another," Mr Robb said.

Encouraging innovation on farm allows for greater sustainability and improved profitability for individual farmers.

'Investment into R&D is vital to ensure I have a profitable future with the tools that support best practice.'

Adapting to new technologies has always been a top priority for Mr Robb and he believes that the future success of his farm is based on the continual improvement of the health and welfare of his animals.

"Through the ongoing research into genetics, I was able to use the technology to improve the genetic merit of my cows by assisting in developing breeding values that are relevant to the Australian climate," he said.

"Investment into R&D is vital to ensure I have a profitable future with the tools that support best practice, and we all know that happy, efficient cows mean improved milk quality and better reproductive performance."

Mr Robb said he believed his contribution to advancing R&D through the dairy levy is solving many of the problems he faced on-farm. Smart decisions mean making long-term goals — not just chasing short-term fixes.

"There is always room for improvement and new ways to do things," he said. "Breeding programs and efficiencies on-farm need constant review and it is important to continue research in this area.

"Australian dairy competes on a world stage, and our ongoing success means consistent industry investment into improving genetic outcomes through research and development.

"The key to our future in the dairy industry is to support the continued advancement of new ideas and to make sure science is at the forefront."