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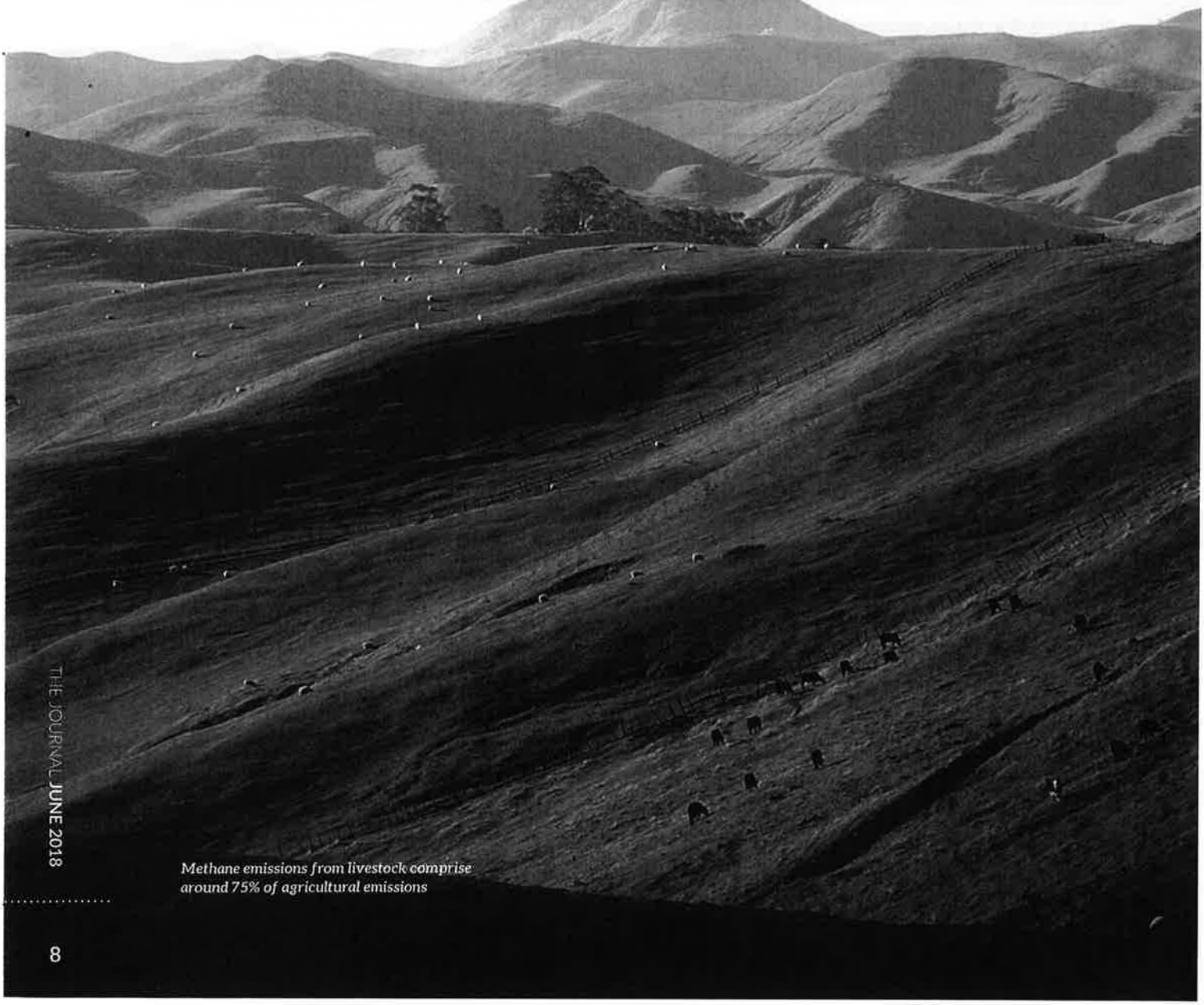
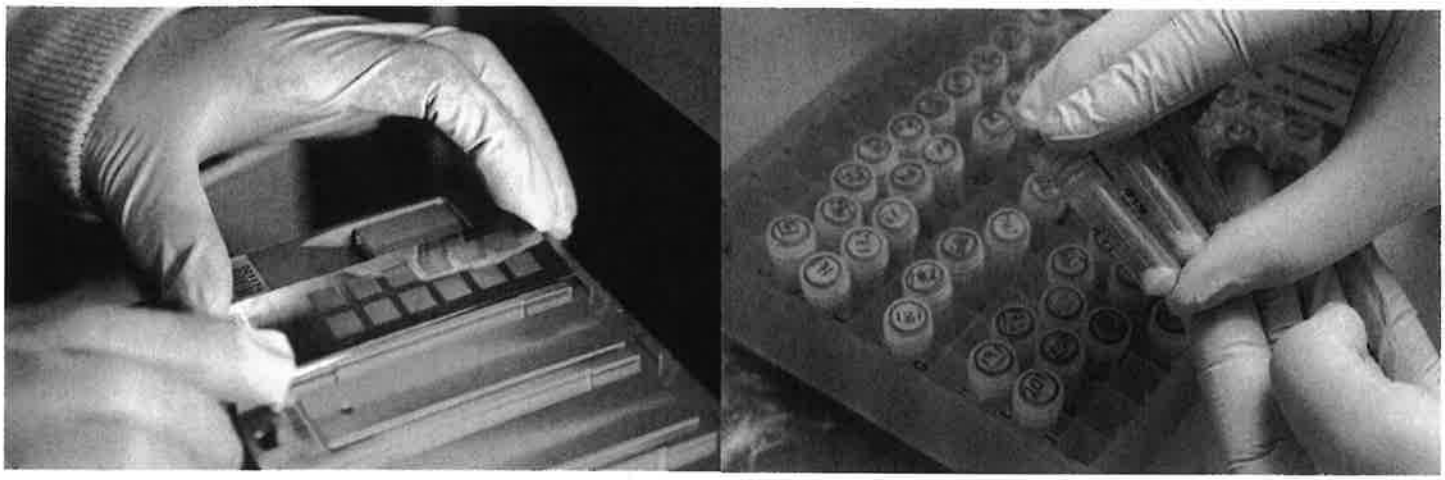
CLIMATE CHANGE IMPACTS AND MITIGATION – A NEW ZEALAND PERSPECTIVE

Agriculture will be affected by global climate change and it also releases gases such as methane and nitrous oxide that contribute to this. Efficiency improvements are reducing emissions per unit of product, but new technologies will be needed to help reduce absolute emissions in line with our international commitments.



Methane emissions from livestock comprise around 75% of agricultural emissions



Government, industry and researchers work together to develop tools to help reduce emissions intensity and total emissions without curtailing production

Positive and negative impacts

Just as the New Zealand economy is sensitive to international events, our agricultural sector is susceptible to impacts from global climate change. Some will be direct, such as climatic impacts on domestic agricultural production. However, further indirect impacts could come from overseas via trade, such as climate-induced production shifts, greenhouse gas (GHG) mitigation measures, consumer perceptions, purchasing preferences and reputational issues.

Not all of these impacts will be negative. Many climate impacts and responses overseas, such as increased demand, higher returns, competitive advantage and smart marketing, could all help to offset (even outweigh) domestic weather impacts and emissions mitigation costs.

A hungrier world

If, as projected, the world's population reaches 9.1 billion by 2050, the UN Food and Agriculture Organisation (FAO) says global food production will need to increase by some 70% by 2050. The demand for livestock products could increase even more. Under a business as usual scenario, meat demand in low and middle income countries will increase 80% by 2030 and over 200% by 2050.

Food security is already a major problem. Approximately one in nine people suffer from hunger or are undernourished and the number is growing. The FAO also estimate that a further two billion suffer what it calls 'hidden hunger'. While not malnourished, they cannot access an optimum diet and suffer adverse health effects from poor nutrition.

Food exporters such as New Zealand stand to benefit from increasing food demand. Our agricultural exports already feed an estimated 20 million people, but the industry's stated aim is to double export production over the next decade.

Market forces

If climate change drives overseas productivity down, or costs up (either directly through climatic effects or indirectly through constraints on, for example, GHG emissions), this could benefit New Zealand farmers and agricultural exports.

Such benefits are difficult to quantify, but studies of yields of major commodity crops under climate change found that global maize and wheat production fell between 1980 and 2008. The European heat wave of 2003 resulted in maize yields falling by 30% or more in France and parts of Italy. Under unmitigated climate change, such heat wave conditions are expected to become the norm in Europe by mid-century.

New Zealand producers will be affected by changes in our weather patterns, such as increased drought risk, but generally they are forecast to be less severe than those experienced by some major food-producing regions overseas. So, as demand rises and climate change puts increasing pressure on food production in other parts of the world, New Zealand farmers could be well placed to fill any supply vacuum.

Amid the interactions with many other economic drivers, the benefits from such opportunities remain uncertain, especially with uncertainty around the rapid developments in synthetic milk and meat products. However, current studies indicate that New Zealand farmers would benefit from production losses caused by climate change in other world regions.

Effect of climate change on domestic production

Climate change will bring mixed prospects for New Zealand farmers. Climate science is constrained by many variables, but modelling has indicated that under the most likely scenario western and southern regions will largely receive more rain and warmer temperatures. However, drought frequency could double (or even triple) by 2040 in eastern and northern regions.

Under a less likely (yet still plausible) projection, most of New Zealand would become drier by the middle of this century. Drought has a profound effect on primary producers – the 2007-2008 drought cost around $2.8 billion in lost production.

Water security in regions such as Marlborough, Hawke's Bay, Waikato and Northland will be affected by warmer temperatures and increased evaporation, and existing pests and diseases might be expected to spread as conditions become more favourable. New pests and diseases could also establish.

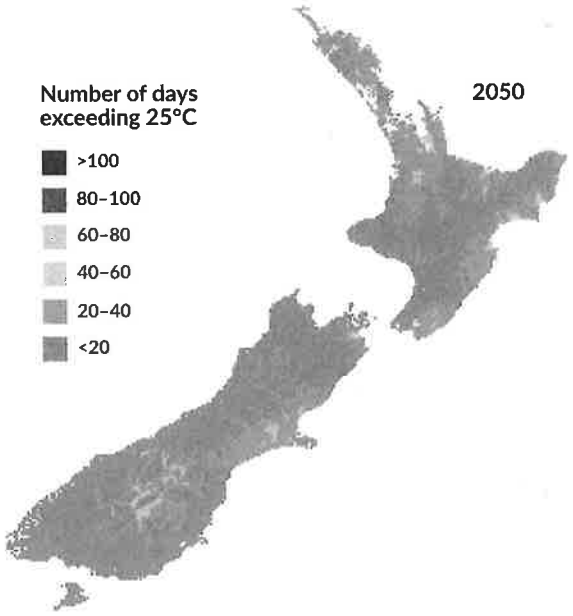


Figure 1: Estimated number of days with maximum temperatures exceeding 25°C for mid-21st century (~2050)
Source: Royal Society of New Zealand (2016)

All cattle have an optimal environmental temperature range. Beyond that range (estimated at around 25°C) they suffer a number of negative responses, such as reduced intake and milk solids production, and difficulties in conceiving. By the 2040s, under a mid-range emissions scenario, the number of such days in the Northern Bay of Plenty, for instance, are likely to nearly double to 42 a year (see *Figure 1*).

As climate patterns shift, most sectors of the primary industry – meat and wool, dairy, arable, horticulture, viticulture and forestry – will experience changes in productivity, profitability and management. They will also experience more frequent severe weather. These changes will test the adaptability of farmers and could shift production zones within New Zealand.

International policy – losses and gains

New Zealand farmers will also be affected by international climate policy, which will have important implications through the global trade in food and livestock products. Many of those global responses, some of which are already being implemented, bring potential gains (but also risks) to our farmers.

Some policies, such as past US legislation to boost biofuel production, had a positive effect on our economy through increased international food prices arising from the introduction of subsidies and mandates that diverted corn used as an animal feed into ethanol production. Likewise, overseas policies to limit deforestation (and reward afforestation) will constrain land clearing for food production, and could therefore increase commodity prices. The Inter-American Development Bank has stated that deforestation bans in Latin America and the Caribbean could strip US$12.7 billion worth of agricultural production from those regions by 2030.

If other countries were to move towards actively constraining their agricultural GHG emissions this could also benefit New Zealand via increased global commodity prices. Since agricultural production in this country is less GHG intensive than in most other countries, model studies suggest that it is better for New Zealand if everyone mitigates agricultural emissions than if no-one does because this would enhance our competitive advantage.

However, it is not just hard costs that will influence New Zealand's fortunes. Consumer preferences may well play an important role. Low carbon branding offers opportunities and risks. New Zealand is recognised internationally as being a highly efficient producer of livestock products, but these products themselves tend to produce more GHGs per unit of protein and energy than plant-based products.

What are we doing to reduce agricultural GHGs?

The implications of climate change go beyond dealing with changes in the weather. Agriculture is the largest contributing sector to New Zealand's GHG emissions (49%), compared with an OECD average of about 12%. Agricultural emissions comprise mainly methane and nitrous oxide emissions arising from livestock farming. On a global scale, however, this country's total emissions are small – New Zealand produces less than 0.2% of total global GHG emissions.

Under international agreements New Zealand has committed to reducing its emissions to 5% below 1990 levels by 2020, and 30% below 2005 levels by 2030 (this equates to 11% below 1990 levels). The 2030 target will be a challenging target if agriculture does not contribute. Currently, the agricultural sector does not have any obligations under the domestic emissions trading scheme (ETS), but this could change as the newly-formed New Zealand Interim Climate Change Committee has been asked specifically to consider agriculture and the ETS.

Current situation

New Zealand farmers are already demonstrating part of the solution to limit climate change. On average, GHG emissions per unit of meat or milk on-farm produced have dropped by about 1% per year for at least the past 20 years. In technical terms, the 'emissions intensity' (emissions per unit of product) has decreased, because farming has become more efficient. Improved animal genetics and management, combined with better grassland management and feeding practices, means that farms are using resources more efficiently to increase their outputs.

However, the rate of decrease in emissions intensity has not been matched by a similar decrease in New Zealand's *total* agricultural GHG emissions. Total agricultural emissions in 2016 were 3% below those estimated for 2005, and this is simply because overall agricultural production has grown in response to international demand.

Without the efficiency improvements achieved by New Zealand farmers, total GHG emissions from agriculture would have increased by approximately 40% since 1990 to deliver the same amount of product (see *Figure 2*). Latest projections indicate that emissions would not increase

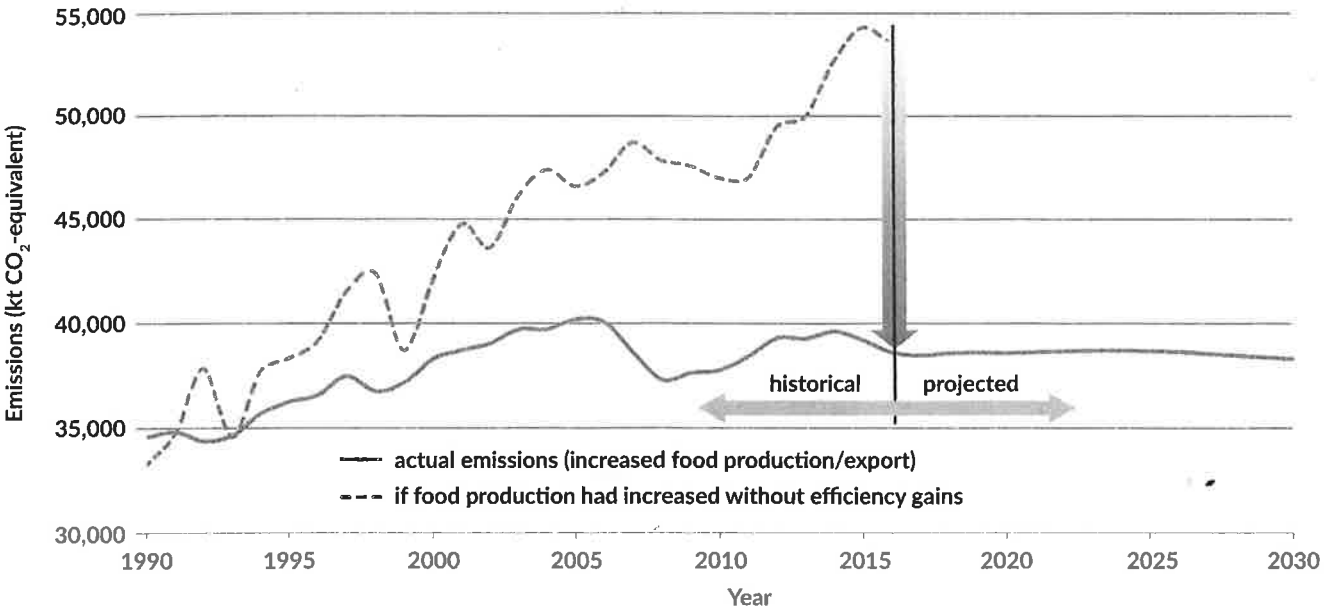


Figure 2: Overview of New Zealand's actual and projected agricultural greenhouse gas emissions from 1990 to 2030
The solid orange line shows greenhouse gas emissions from agriculture in the past (1990–2016) and projected for the future, including changes in production and on-farm efficiency gains. The dotted orange line shows where emissions would have been in 1990–2016 if farmers had increased their production but had not made any efficiency gains

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further, reflecting a balance between declining animal numbers and increasing performance per animal. However, decreases in emissions intensity are unlikely to be enough on their own to bring about substantial reductions in absolute emissions, given the generally positive international trading situation for livestock products.

As a responsible global citizen, and because our biological systems and economic interests benefit from a stable climate, New Zealand can be expected to contribute its fair share to the global effort to reduce GHG emissions and the risks from climate change.

At the moment, farmers can reduce their emissions intensity further by continuing to adopt good management practices and making additional efficiency gains as fast as possible. Since most of this country's agricultural GHG emissions are related to production for export, there is an active debate about where New Zealand should focus its efforts:

- Reducing absolute emissions (which is difficult without limiting total production), or
- Reducing emissions intensity without constraining production and absolute emissions (if we don't produce it someone with a higher GHG footprint will).

In an ideal world farmers would have the tools to do both.

Developing new mitigation solutions

Government, industry and researchers are making a concerted effort to develop practical new tools to help reduce emissions intensity and total emissions without curtailing production. This effort is driven jointly by the government-funded New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) and the industry-led, industry/government funded Pastoral Greenhouse Gas Research Consortium (PGgRc). Methane emissions from livestock, which comprise around 75% of agricultural emissions, are a major focus and the four main avenues of research are described below.

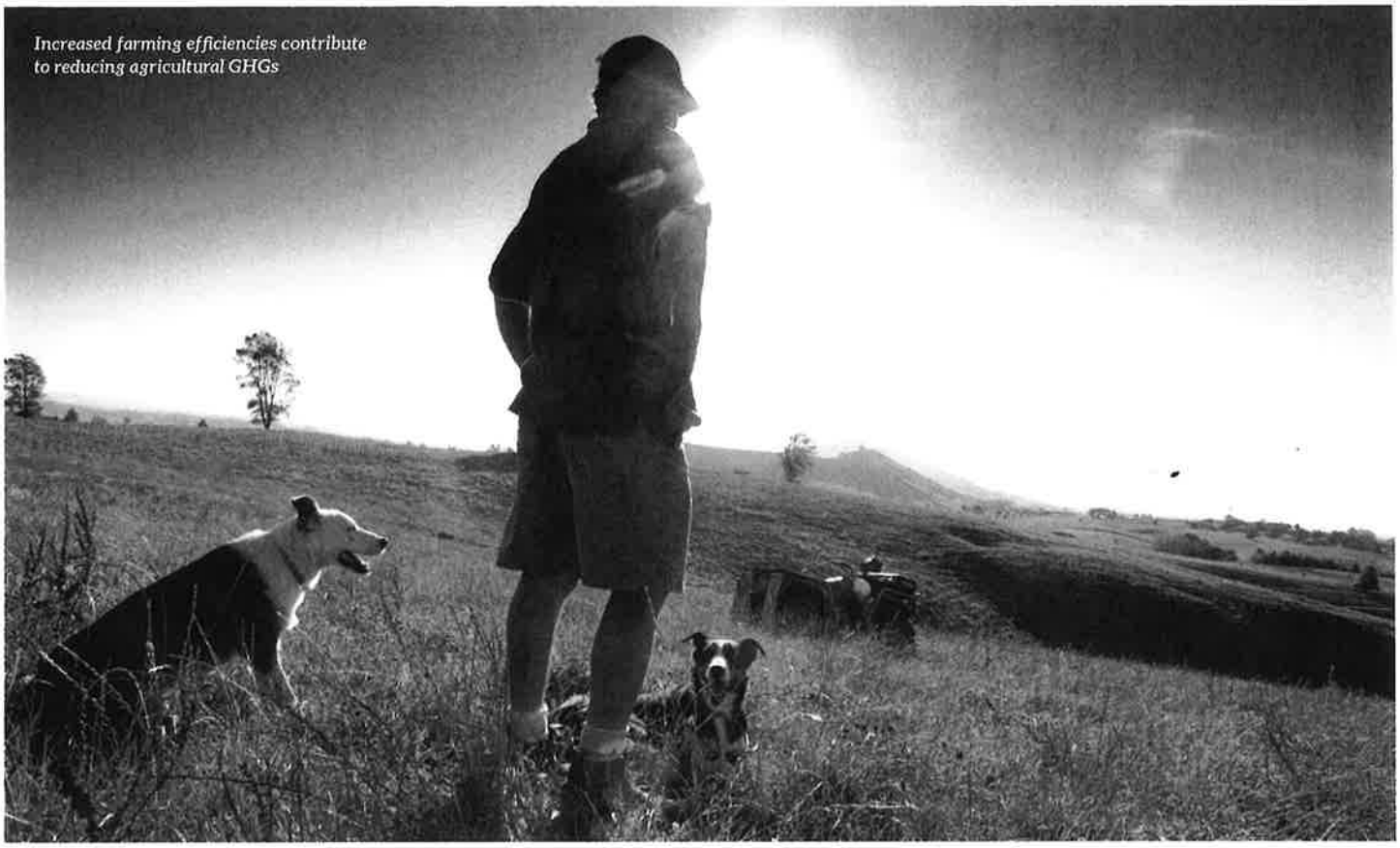
Breeding low methane-emitting sheep and cattle

Research has found that some animals emit less methane than others and that this trait can be passed on to their offspring. Based on data obtained to date, sheep selected for their low emission traits are ~5% lower than the average industry animal. These naturally low-emitting animals appear to be as productive as average animals, so there would be no direct financial penalty from selecting these sheep.

There is still an opportunity cost, however, since adding this additional breeding trait lowers the rate of gain in achieving other breeding objectives. The sheep industry is now trialling low-emitting sheep with a small group of elite breeders. Work on breeding low-emitting cattle is still at an early stage and is held back by the difficulties in accurately identifying low-emitting animals at a reasonable cost.

Low methane feeds and feed additives

The type of feed influences methane emissions, but making major changes to the diet of New Zealand's ruminants is



Increased farming efficiencies contribute to reducing agricultural GHGs

difficult. Our highly efficient farming systems are based around exploiting our natural ability to grow large quantities of highly nutritious pasture. Even our most intensive dairy systems still rely heavily on home-grown pasture.

Brassicas have been tested extensively in sheep in New Zealand and forage rape has consistently reduced methane emissions by 20-30% when fed as a full diet. However, the area grown is small and it is a minor component of the diet for most animals, so the impact on emissions is minimal. Preliminary studies with fodder beet have shown a reduction in methane when fed at >75% of the diet. However, the consequences of feeding fodder beet at such high levels need to be studied further.

Methane inhibitors

Researchers are looking for animal-safe compounds that suppress the methane-producing microbes in the rumen, and thus reduce overall methane emissions from animals without side effects. An inhibitor suitable mainly for feedlot animals has been successfully tested in long-term trials overseas, where it has been shown to reduce methane emissions by 30%. This inhibitor is being developed by the Dutch company DSM, with commercial release planned by 2019.

However, the effectiveness of this inhibitor is likely to be much reduced in New Zealand as the current formulations are designed for systems where it can be fed daily with every meal. DSM are, however, actively exploring formulations suitable for grazing animals. A New Zealand-led programme of work has also made substantial progress in identifying compounds that work at very low concentrations and hence are suitable for slow release delivery systems. These compounds have successfully reduced emissions in short-term animal trials and are currently being refined.

Methane vaccines

New Zealand scientists are working to produce a vaccine that stimulates the animal to produce antibodies that suppress key methane-generating microbes in the rumen of livestock. Prototype vaccines have demonstrated that they can generate antibodies that alter the microbial populations and methane production in laboratory studies. A comprehensive programme of testing is underway to identify vaccine formulations that can be shown to achieve substantial methane reductions (>20%) in sheep and cattle.

Summary

New Zealand livestock agriculture will be impacted by climate change. As a major agricultural exporting country, the global impacts of climate change and climate change policies will also have implications for the future prosperity of New Zealand farmers. Farmers, through their existing efforts to increase the efficiency of production and the resulting reduction in emissions per unit of product, are already making a contribution to reducing the production of agricultural GHGs. However, reductions in emissions per unit product may not be enough on their own to reduce absolute emissions. Domestic and international research is underway that, if successful, will give New Zealand farmers the tools to allow them to reduce absolute emissions below their historical levels.

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