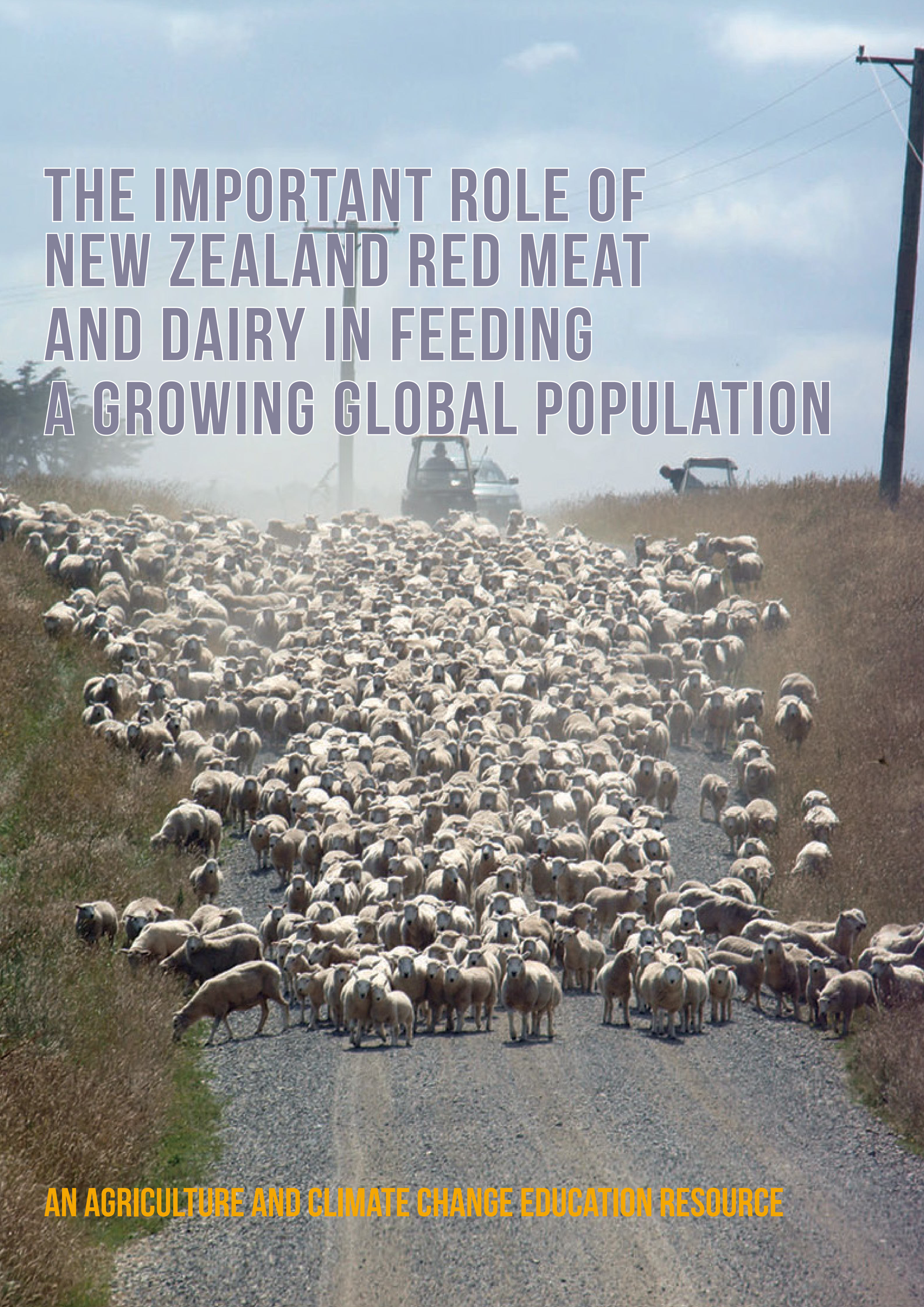
THE IMPORTANT ROLE OF NEW ZEALAND RED MEAT AND DAIRY IN FEEDING A GROWING GLOBAL POPULATION



AN AGRICULTURE AND CLIMATE CHANGE EDUCATION RESOURCE

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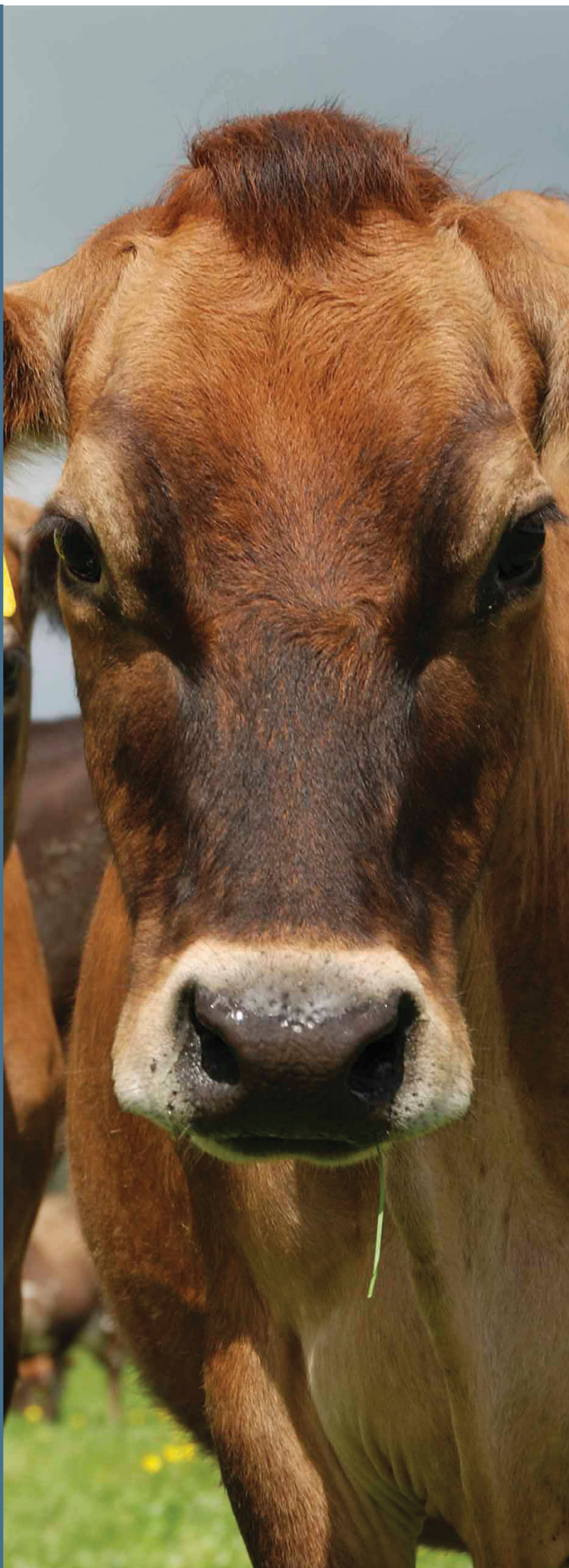


CONTEXT

One thing to takeaway:

The New Zealand livestock sector needs to both reduce greenhouse gas emissions while also continuing to produce high-quality, nutritious food for global markets and for New Zealand. This needs to be done because it is the right thing to do and we have signed up to international commitments.

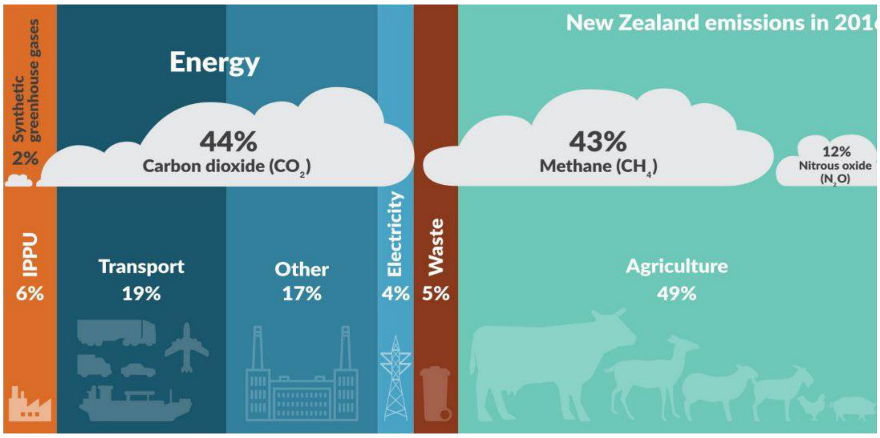
In October 2016, New Zealand signed the Paris Agreement. This meant that New Zealand, along with other countries under the United Nations Framework Convention on Climate Change, agreed to limit an increase in the global temperature to well below 2C, while pursuing efforts to limit the temperature increase to 1.5C above pre-industrial levels.[1]

Due to our emissions profile, New Zealand has a unique challenge reducing emissions in comparison to the rest of the world. While other countries' main emissions come from energy generation, transportation, or industry, using the standard GWP_{100} metric (explained in section five) about half of New Zealand's emissions come from agriculture[2], specifically from ruminant animals (cows and sheep).

The main agricultural greenhouse gases (GHG) in New Zealand are methane and nitrous oxide. Methane is produced in the rumen (stomach) of cows and sheep by methanogenic microbes (methane producing microbes) and are naturally present in all ruminant animals. Most methane is emitted when cattle or sheep burp. Nitrous oxide is emitted from soil when urine, dung and fertilisers are broken down by microbes in the soil.

The below illustrates the emissions profile of New Zealand using $GWP_{100.}$ This metric does not sufficiently include differences shown in the atmospheric lifetime of different GHGs. This issue is discussed in greater detail later in this resource.

Figure 1:
Emissions profile of New Zealand



Most countries have also committed to the United Nations' Sustainable Development Goals (UN SDGs). These goals address ending poverty, clean water and sanitation, universal education, climate action, and zero hunger, amongst other goals that will help achieve a better and more sustainable future for all.

The Zero Hunger, Climate Action, and Responsible Consumption and Production goals are especially relevant to New Zealand. We are an important source of dairy and red meat for the planet, with these products being major exports.

New Zealand is a substantial net exporter of food products, playing an important role in global food security through the provision of safe and nutritious food products to the world. The dairy and red meat industries also contribute significantly to our economy, representing 7.7% of our gross domestic product (GDP), and employing over 120,000 people[3].

Our commitment to the Paris Agreement and UN SDGs means that we must reduce our agricultural emissions while still providing high quality sustainable animal products to the world. The big challenge facing politicians and policymakers in New Zealand is how to achieve growing our economy, improving global food security and protecting the environment at the same time.

New Zealand farmers are aware of this issue and take climate change seriously. The New Zealand agricultural industry is committed to playing its part in achieving the goals of the Paris Agreement, while continuing to maintain a thriving industry.

A BREAKDOWN OF THE DIFFERENT GREENHOUSE GASES

One thing to takeaway:

There are three main GHGs, carbon dioxide, nitrous oxide and methane. The impact these gases have on warming the atmosphere is impacted by; the amount of time they spend in the atmosphere, how much warming each molecule causes, and how much of each gas is emitted.

There are three main greenhouse gases (GHGs), carbon dioxide, methane, and nitrous oxide:

1. Carbon dioxide (CO_2): This gas is created through burning fossil fuels (petrol, coal, oil, and gas) and industrial processes that produce products such as cement and aluminium. CO_2 is the 'heavy hitter' out of the main GHGs - it accounts for 74% of global warming occurring due to GHGs, and it can stay in the atmosphere for 300-1000 years[4].

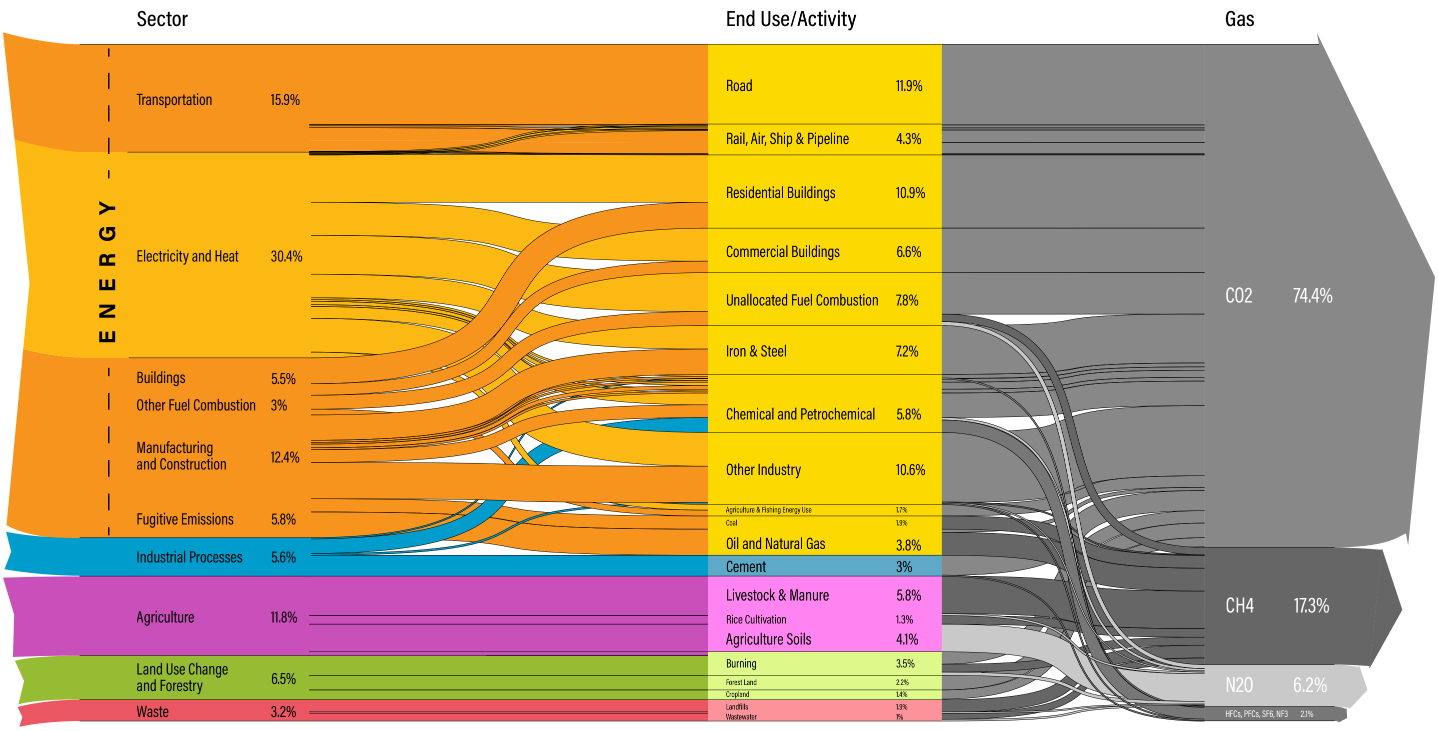
2. Methane (CH4): The majority of this gas is produced inside the stomachs of ruminant animals and burped into the atmosphere, it is also produced through rice cultivation, landfill waste and oil and gas extraction. Methane accounts for 17% of global warming occurring due to GHGs. It has a much shorter atmospheric lifespan than CO_2 (12 years), but in the short time it is in the atmosphere it is much more powerful as a heat trapping gas.

3. Nitrous oxide (N2O): This gas is created from the urine and dung from grazing livestock, nitrogen fertilisers[5], fuel combustion, and industrial processes. Nitrous oxide accounts for 6% of the global warming occurring due to GHGs.

Agriculture is both a source of emissions and vulnerable to the impacts of climate change. As the below figure demonstrates (also using GWP_{100}), about 6% of global emissions are from livestock, this is roughly the same amount that results from concrete production.[6]

World Greenhouse Gas Emissions in 2016

Total: 49.4 $GtCO_2e$



Source: Greenhouse gas emissions on Climate Watch. Available at: https://www.climatewatchdata.org

WORLD RESOURCES INSTITUTE

THE WORLD IS DEMANDING NUTRITIOUS FOOD

One thing to takeaway:

New Zealand farmers are very good at what they do, the animal products they produce are more emissions efficient than agricultural production in most other parts of the world.

The Paris Agreement recognises "*the fundamental priority of safeguarding food security and ending hunger*" and aims to strengthen the global response to climate change "*in a manner that does not threaten food production*".[7] This is critical in ensuring that as humanity attempts to achieve one SDG, it does not come at the cost of others.

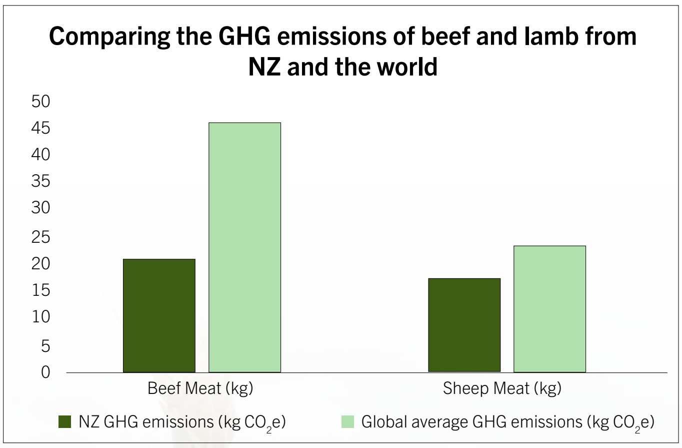
The agreement also states that "*sustainable lifestyles and sustainable patterns of consumption and production…*" have an important role to play in addressing climate change.[8]

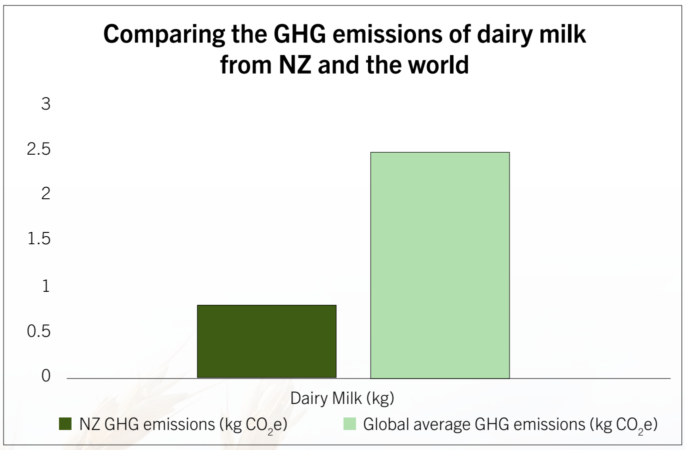
New Zealand's farms produce high quality and nutritious food, largely in a resilient, sustainable manner with low-GHG emission systems as described by the IPCC in their 2020 Climate and Land report.[9] This report states that "*Balanced diets, featuring plant-based foods, such as those based on coarse grains, legumes, fruits and vegetables, nuts and seeds, and animal-sourced food produced in resilient, sustainable and low-GHG emission systems, present major opportunities for adaptation and mitigation while generating significant co-benefits in terms of human health.*"[10] New Zealand farms have been producing more for less and reducing their environmental footprint since the 1990s.

- Roughly, the same amount of lamb is produced today in New Zealand, but from half the number of ewes. At the same time, the sheep and beef sector's contribution to GDP has doubled from $2.5 billion to $5 billion.

New Zealand produces beef, lamb and dairy products using pasture-based systems where livestock are free to graze and move around outside. As a result, we produce beef, lamb, and dairy with levels of greenhouse gas emissions far below those seen in other countries.[11]

- Using the best available peer-reviewed methods for counting greenhouse gas emissions, New Zealand sheep meat has about 17.2 kilograms of carbon dioxide equivalent (CO_2e) per kilogram of carcass weight (CW) compared to a global average of 23.4. Our beef has 21 kilograms compared to a global average of 46.2, and our milk 0.8 kilograms compared to a global average of 2.5 (this is shown in the below figure).[12]





BUT SHOULDN'T WE ALL EAT LOCAL?

One thing to takeaway:
International shipping has a small impact on the GHG footprint of livestock products compared to their on-farm production. While New Zealand is a long way from many international markets, Kiwi farmers are very emissions efficient.

'Eat local' is often talked about as a way of understanding what the impact of our food is on the environment. It assumes that the further food has travelled to your supermarket (i.e., its 'miles'), the more greenhouse gas emissions it will have created.

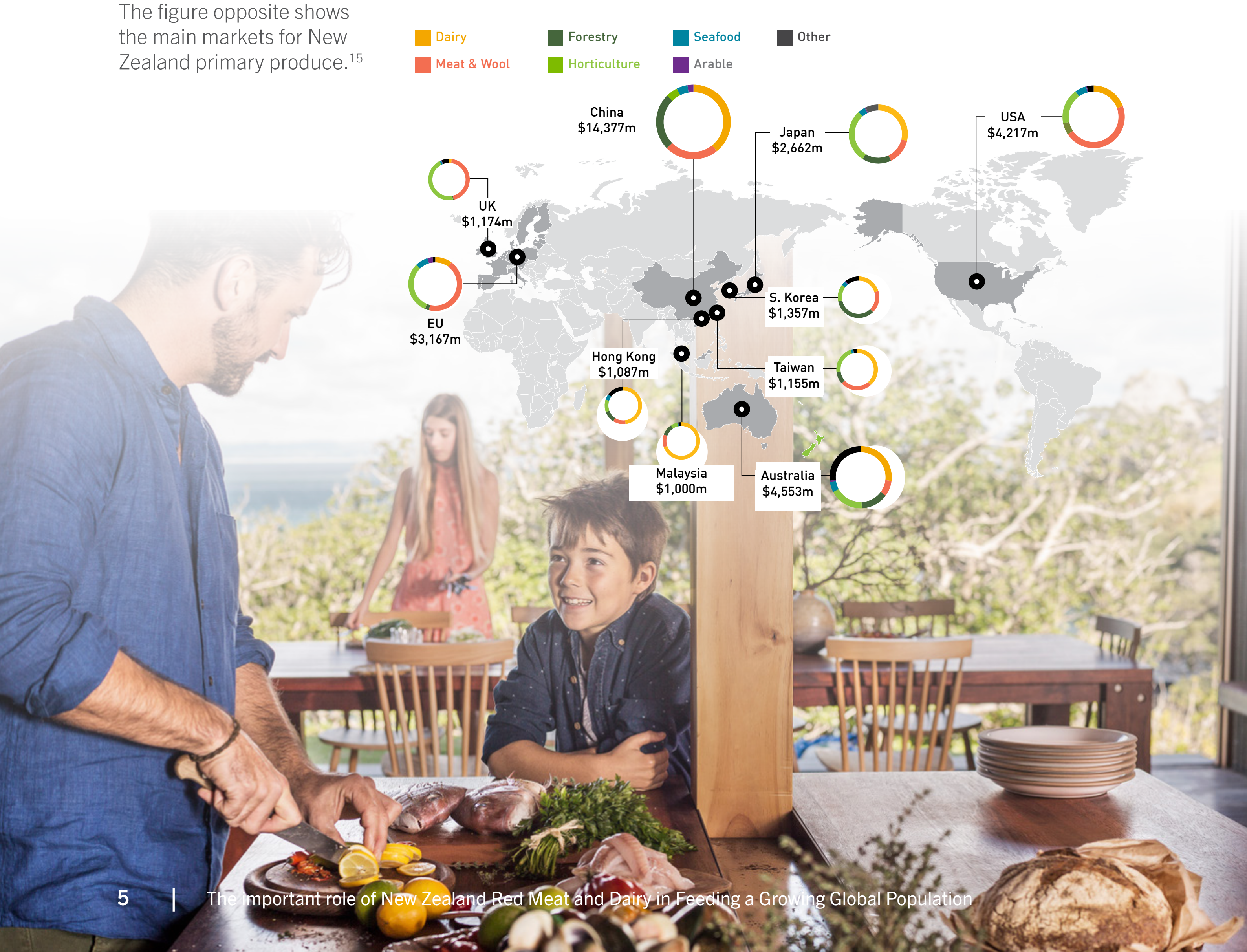
Over 90 percent of the lamb, beef and dairy produced in New Zealand is exported. Generally, the emissions from international shipping are less than 5% of total emissions. Consequently, New Zealand red meat and dairy products consumed overseas can result in less greenhouse gas emissions than the same food produced locally, even after the transport emissions involved in shipping the product across the world are calculated.[13] This is due to many factors including:

- The efficient unsubsidised nature of farming in New Zealand;
- Our favorable climate; and
- The pasture based farm systems where livestock graze grass, rather than grass being cut and carried to the livestock.

If you want to reduce the carbon footprint of the food you eat, it is much more important to understand how the food was produced than where it was produced. For example, studies have shown that, for a British consumer, the emissions from transport are small compared to the emissions that can result from producing food out of season or out of its preferred climate.[14]

The figure opposite shows the main markets for New Zealand primary produce.[15]

Top 10 Export Destinations, Year ended June 2019

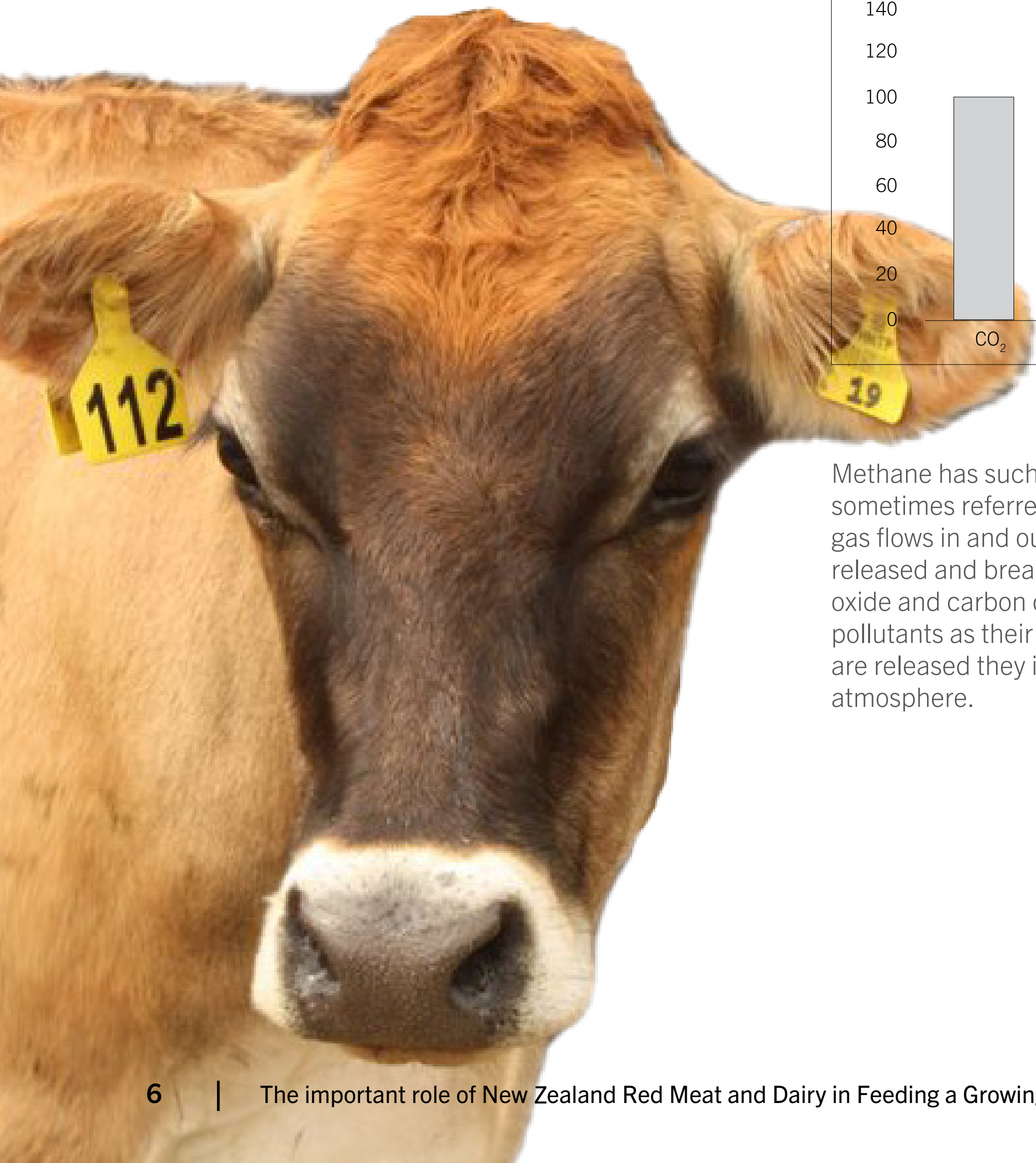


WHY CALCULATING THE CARBON FOOTPRINT OF FOOD IS NOT SIMPLE

One thing to takeaway:

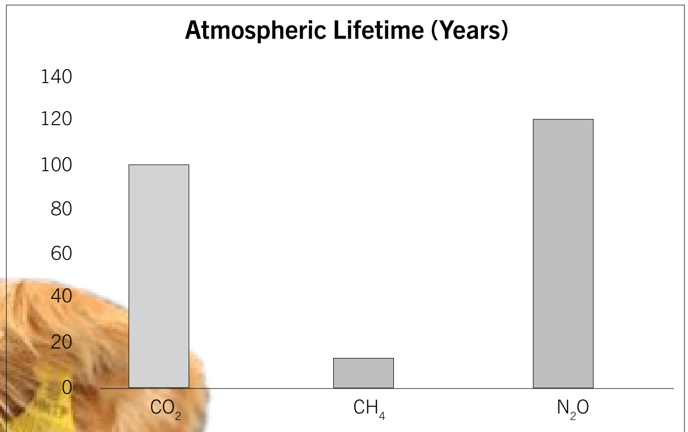
The commonly-used method for comparing greenhouse gases is not accurate when it comes to methane. Unless this is specifically accounted for, there is a risk that decisions will be based on inaccurate input data.

The three main greenhouse gases (carbon dioxide, methane, and nitrous oxide) all behave differently in the atmosphere. When the carbon footprint of food is calculated, different greenhouse gases are added together to reach a single number. To accurately reach a single carbon footprint figure, both the atmospheric warming capacity (how much each GHG warms the atmosphere) and the atmospheric lifetime of each GHG, need to be considered.



While both methane and nitrous oxide have a much greater atmospheric warming capacity when compared to carbon dioxide, this is not the case for the atmospheric lifecycle of the GHGs. The key difference is the 'lifetime' that the gases have in the atmosphere. The term 'lifetime' simply means how long each gas exists for (and contributes to climate change), before being naturally broken down. Methane has a short atmospheric lifetime of about 12 years. Carbon dioxide and nitrous oxide last much longer (as shown in the below figure).[16]

Comparisons of GHG are further complicated by the fact that no single figure can be given for carbon dioxide.[17] The majority of carbon dioxide dissolves into the ocean over a period of 20 to 100 years, the remainder being removed by processes that take up to thousands of years.[18] The 100 year figure was chosen in the below graph as a simple illustrative purpose. For comparative purposes carbon dioxide can be considered a permanent stock GHG.



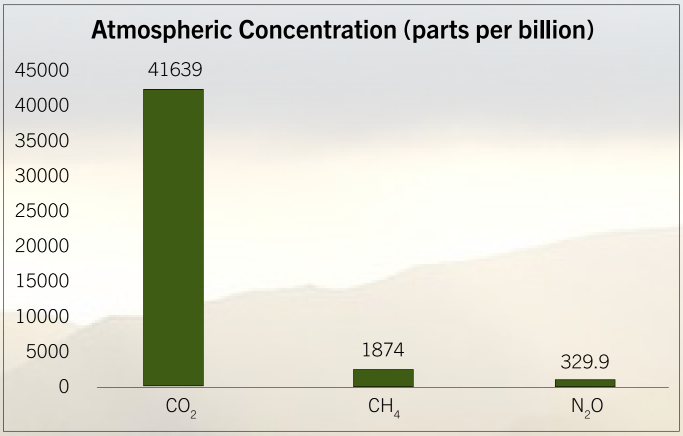
Methane has such a short atmospheric lifetime it is sometimes referred to as a 'flow', pollutant, as the gas flows in and out of the atmosphere as it is both released and breaks down. In contrast both nitrous oxide and carbon dioxide are referred to as 'stock' pollutants as their longer lifetimes mean once they are released they in effect remain permanently in the atmosphere.

One helpful metaphor is to compare the atmospheric lifetime of greenhouse gas emissions to a bathtub with both taps turned on:

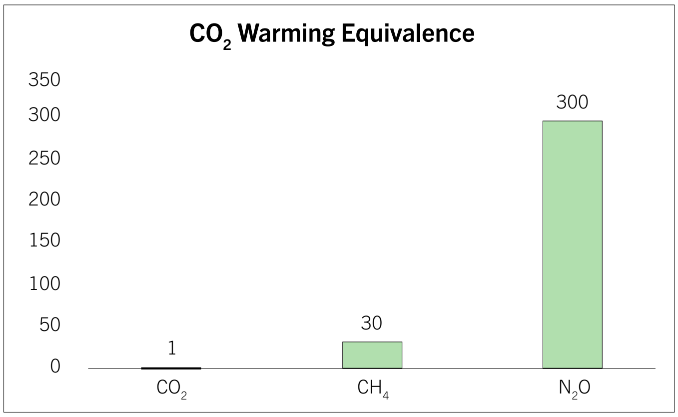
- Short-lived emissions (methane) are like a bath with the plug removed. Some water will be in the bath, but if the flow of water into the bath is not greater than how much water can be drained, then the water level will remain stable. If the taps are turned up full then the water level will get quite high.
- Long lived emissions (carbon dioxide, nitrous oxide) are like a bath with the plug in. Even if the taps are turned on low the level will continue rising until the taps are turned off completely.

This concept is explained in this video produced as part of the Basque Centre for Climate Change (BC3) contribution to the 25th United Nations Climate Change Conference (COP25) in Madrid and under the Horizon 2020 project:

Other key differences of GHGs are the atmospheric concentration and the warming potential with respect to CO_2 (as shown in the below figures).



The atmospheric concentration is measured in parts per million, parts per billion, or parts per trillion. In other words, a concentration of 1 part per billion means that there is one molecule of that gas in every billion molecules of air.



CO_2 warming equivalence is how much warming one kg of a GHG creates in terms of CO_2. For example, over 100 years one kg of methane has the atmospheric warming equivalent of releasing 30kg of CO_2.

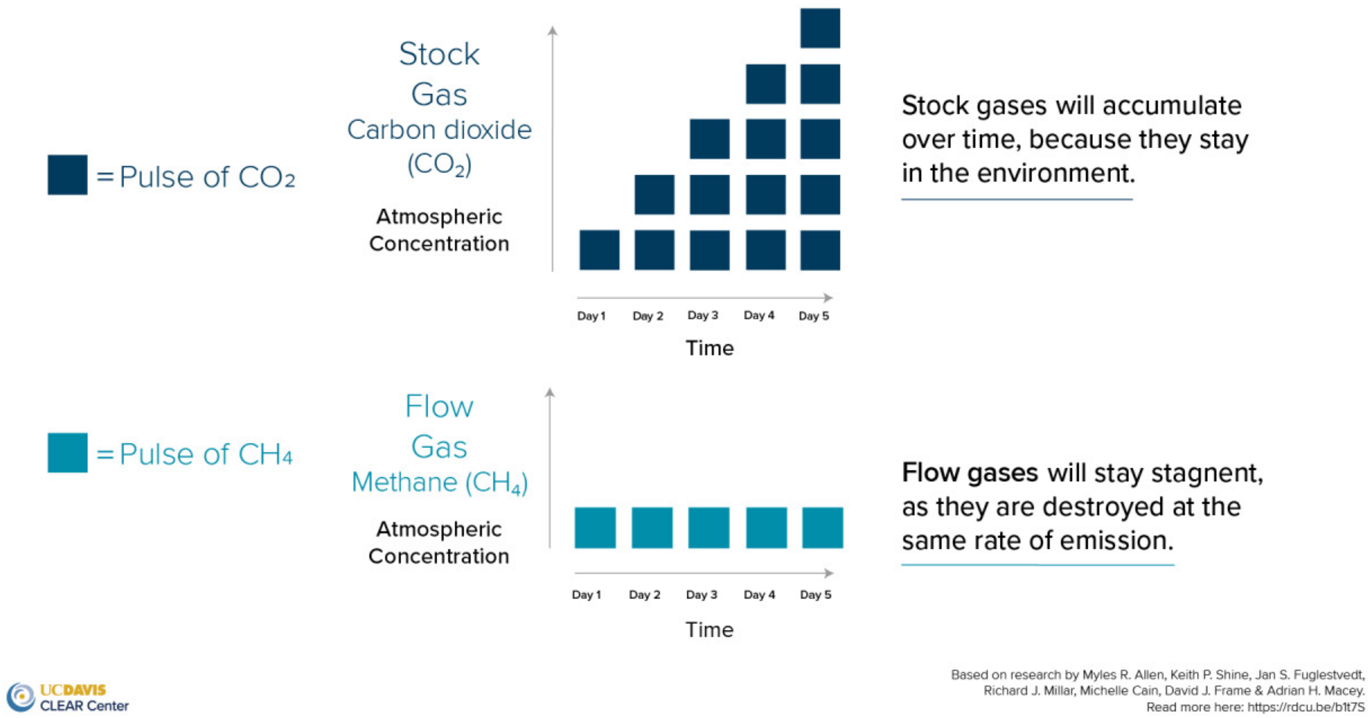
Currently, different GHGs are calculated through Global Warming Potential 100 (GWP_{100}). This method for measuring GHGs aims to compare the global warming caused by different gases over 100 years. However, the metric cannot accurately differentiate the contrasting impacts of short lived (methane) and long-lived (carbon dioxide and nitrous oxide) climate pollutants.

With reference to the above figures, GWP_{100} accounts for the variation in the figure *'CO_2 Warming Equivalence' and in the figure 'Atmospheric Concentration (parts per billion)', but does not sufficiently include differences shown in the figure 'Atmospheric Lifetime (Years)'*

To go back to the bathtub metaphor, GWP_{100} treats both long and short-lived emissions as if the impact could be compared to both having the plug in the bath. This causes the warming effect of methane to be over-reported if emissions are stable or decreasing, and to be underreported if emissions are increasing.

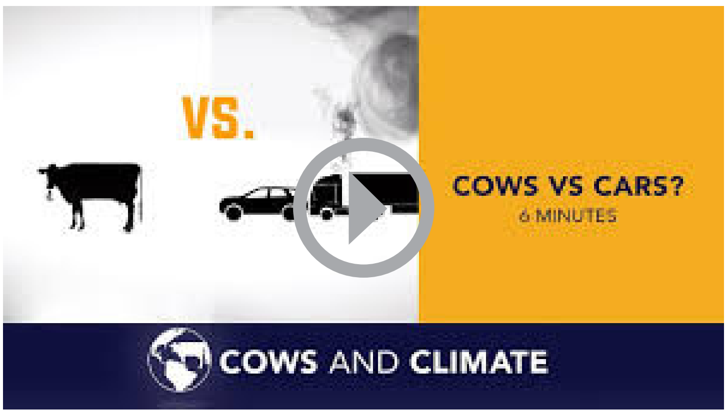
As shown in the below figure, if emissions are released at a constant rate over a long period:

- Stock gases will accumulate over time and continually add to global warming, because they persist in the environment.
- Flow gases will stay stagnant, and after the initial pulse of warming will not add to global warming, as they are destroyed at the same rate of emission.[19]



In addition to the difference of methane being a flow gas and carbon dioxide being a stock gas, methane comes from a significantly shorter carbon cycle. The majority of methane comes from ruminant animals, which is then broken down in the atmosphere to carbon dioxide, which is used by plants in photosynthesis (a cycle of 20-30 years). In contrast, the majority of CO_2 comes from carbon sinks that have been released from storage and burnt as fuel. This cycle can last anywhere from 300-1000 years.[20]

In this video, produced by Dairy Cares as a part of the Cows and Climate series, Dr Mitloehner from the University of California explains how the greenhouse gas emissions from burning fossil fuels differ from those produced by livestock.[21]



New Zealand has recognised the differences between short-lived and long-lived emissions, and has adopted two emissions targets for 2050:

- The first emissions target is to take long-lived gases, like carbon dioxide and nitrous oxide, down to 'net zero' by 2050. Every additional tonne of long-lived gas emitted builds up in the atmosphere, and we need to reduce these to net zero in order to halt global warming.
- The second target is to reduce methane emissions from livestock, but not completely. Unlike long lived gases, methane does not need to be reduced to zero in order to stop adding to global warming.[22]

The current method for comparing long and short-lived gases in carbon footprints has come under widespread scrutiny, since the first Intergovernmental Panel on Climate Change (IPCC) Assessment Reports were published in the early 1990s.[23] To address the issues with using GWP_{100} to account for the warming from methane, policy makers can either use a split-gas approach (as done by New Zealand) or use a better method for estimating the warming from methane emissions. Many alternative methods have been put forward.

One prominent alternative has been proposed by an international team of researchers which includes the Oxford Martin school in the United Kingdom and Victoria University of Wellington in New Zealand and is called 'GWP*' (or 'GWP star'). This method of calculating GHG CO_2 equivalence provides a better representation of the warming impacts of methane relative to those of carbon dioxide, as it accounts for the fact that a gas like methane has a short lifetime in the atmosphere.

This metric shows that stable agricultural methane levels in countries such as New Zealand are providing much less warming than is currently being reported. GWP* is a more fit for purpose means of estimating the warming impact of methane emissions. It is not currently used in New Zealand when discussing agriculture's contribution to the total warming from the New Zealand economy, or when discussing the emissions required to produce various food products.

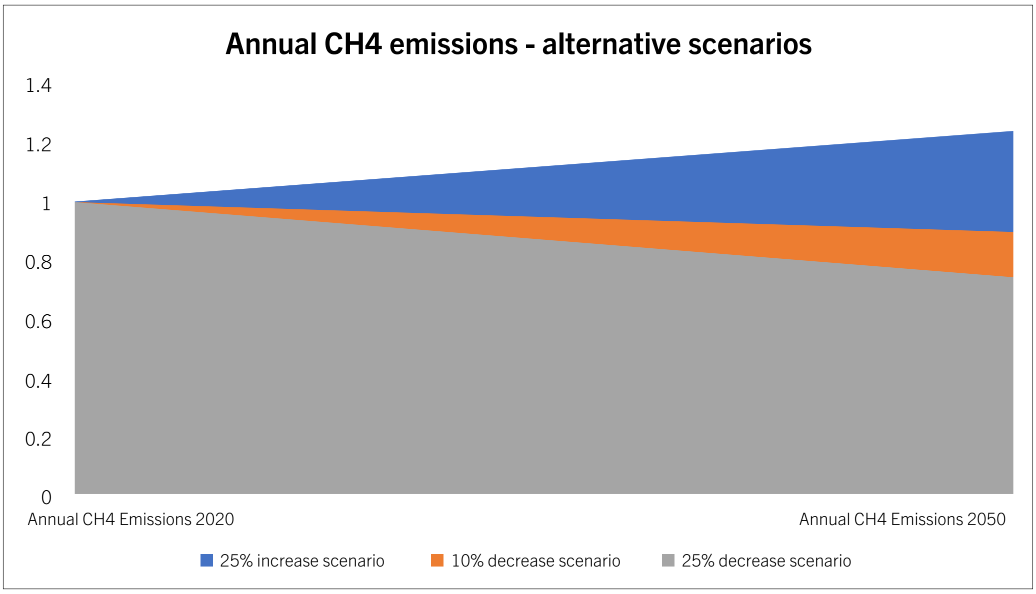
The New Zealand Productivity Commission recognised the limitations of the current metric and the improved accuracy of GWP* in its 'Low Emission Economy Report, stating:

- *"A newly-proposed metric, GWP*, is different in approach and better captures the warming effects that arise from the different dynamics of short- and long-lived gases. It can thereby help people make better decisions about mitigation."*[24]

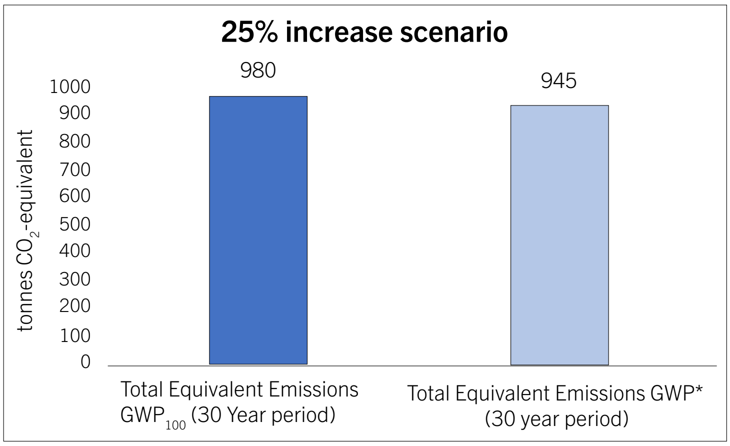
The point made by the Productivity Commission regarding GWP* helping people make better decisions about mitigation is very important. If policy makers rely on GWP_{100} there is a serious risk that this may distort mitigation pathways, as decisions will be based on inaccurate input data. This risk can be overcome by either using a split-gas approach (separating stock and flow pollutants) or by using a more fit-for-purpose metric (such as GWP*).

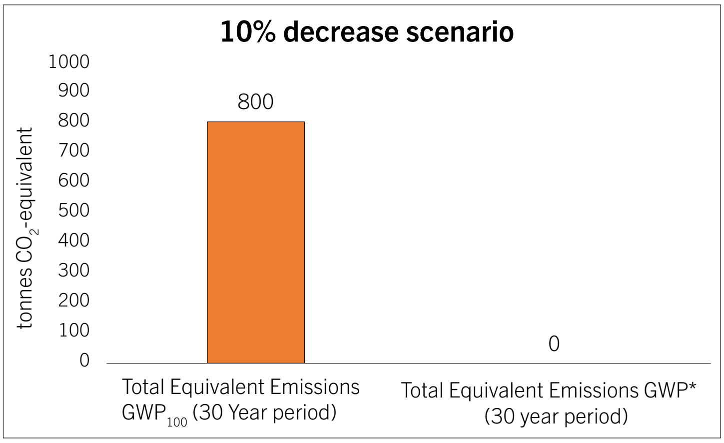
While all greenhouse gases (GHGs) have a warming effect on our planet, this warming effect is not equivalent across all GHGs. It is a challenge to compare GHGs without making assumptions or disregarding important behaviours of these gases in the atmosphere. The current international standard for reporting GHG emissions is with GWP_{100}, which does not provide accurate information on the warming impact of methane.

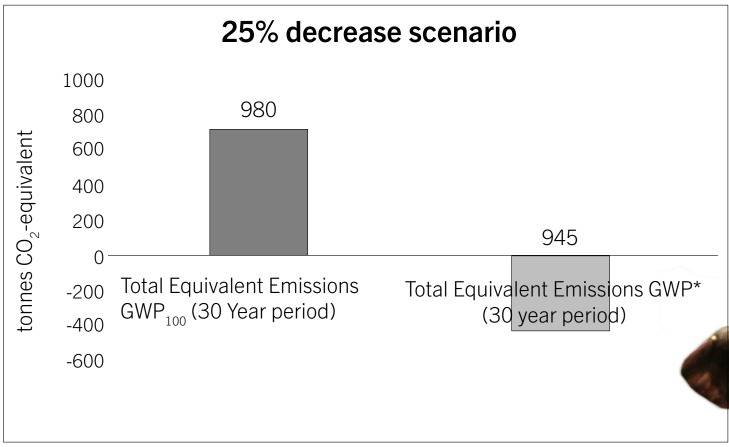
The below figure shows three scenarios, each starting from an emission rate of 1 tonne of methane per year, and either rising by 25% (blue), decreasing by 10% (orange), or decreasing by 25% (grey), over the next 30 years.



The following diagrams show the comparison of GWP_{100} and GWP* for all three of these scenarios, calculated over 30 years.







Conventional GWP_{100} ignores the impact of changing emissions rates, while GWP* takes into account the atmospheric lifespan of methane and the rate of emission. These factors account for the discrepancies seen above.

GWP_{100} can be misleading when applied to methane emissions, especially when these are being reduced. It is important for us to get the science right behind how these gases are going to affect our climate, and over what timeframe, so we can make the right choices around mitigation.[25] If we do not accurately measure the warming impacts of behaviours causing climate change, then we cannot hope to tackle the issue.

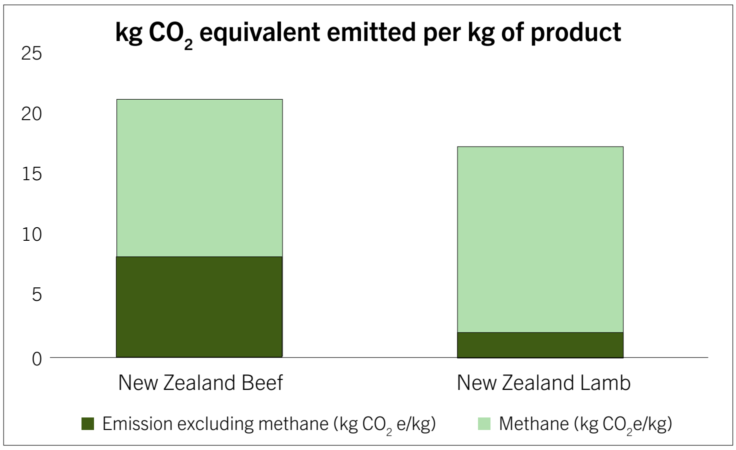
A DIFFERENT PERSPECTIVE ON THE CARBON FOOTPRINT OF FOOD

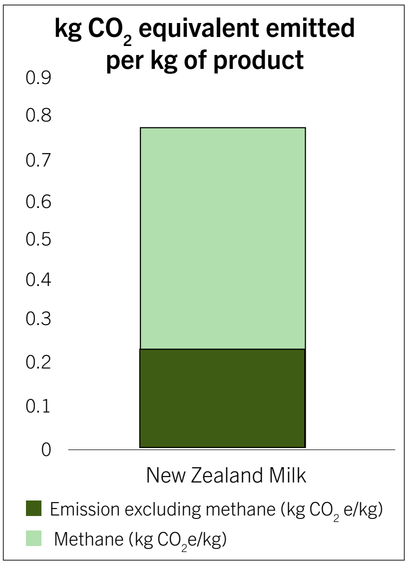
One thing to takeaway:

Assessing the sustainability of a diet is not a simple task. When doing so it is important to consider both the nutritional value of the food and the environmental impact involved in its production. It is also important to remember that not all farms are the same, and different people have different nutritional requirements.

Beef, lamb, and milk provide many of the essential nutrients for a balanced diet, in a form that your body can easily digest and absorb. These include high-quality protein, iron, zinc, vitamin B12, calcium, magnesium, selenium, and riboflavin.[26]

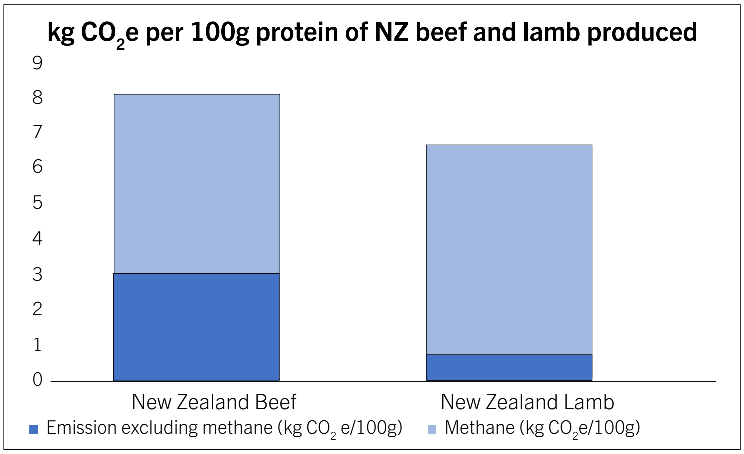
When attempting to quantify the climate footprint of food, we need to know both the nutritional value of the food and the GHGs involved in its production. As discussed in section 5, the difference between short-lived and long-lived gases is important when looking at GHG emissions. It is also important to understand the difference when looking at the carbon footprint (how many emissions are involved in production) of different food types.

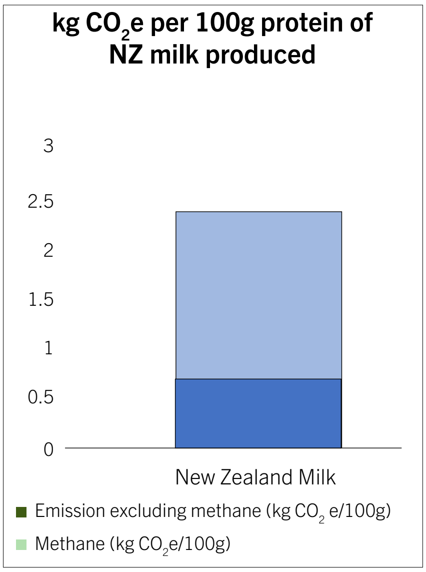


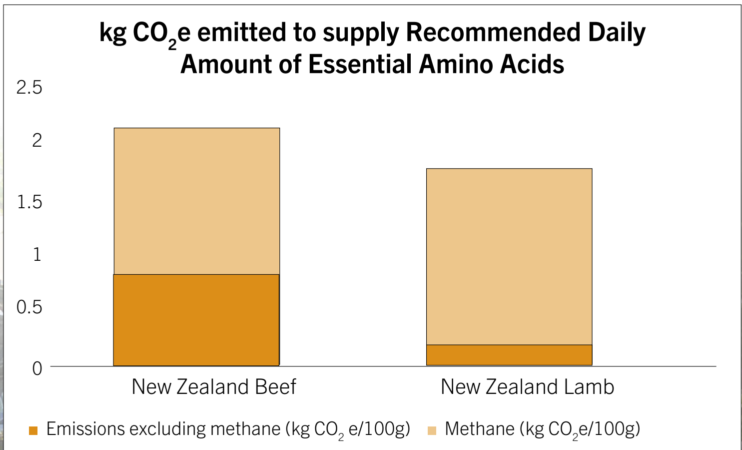


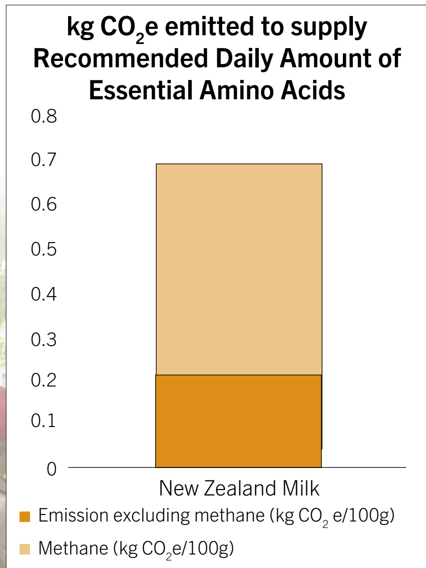
The above figures shows how much methane and other GHGs are produced during the farming of New Zealand milk, beef and lamb. As you can see, these livestock food products have carbon footprints that are dominated by methane emissions.[27] As previously discussed, the current way methane emissions are reported (GWP_{100}) can be misleading and can result in over-reporting in sectors with stable or declining emissions such as the New Zealand livestock sector.

While we all prefer to eat food that is delicious, the most important aspect of the food we produce is its nutritional value that contributes to health and well-being. We can get a different perspective on food's carbon footprint if we look at emissions based off how much protein or essential amino acids each food type provides.[28] The following figures show the amount of emissions created to produce 100g of protein or the recommended daily intake of essential amino acids (the building blocks of protein). This is instead of the traditional carbon footprint of measuring GHG emissions for the production of 1kg of product.[29]





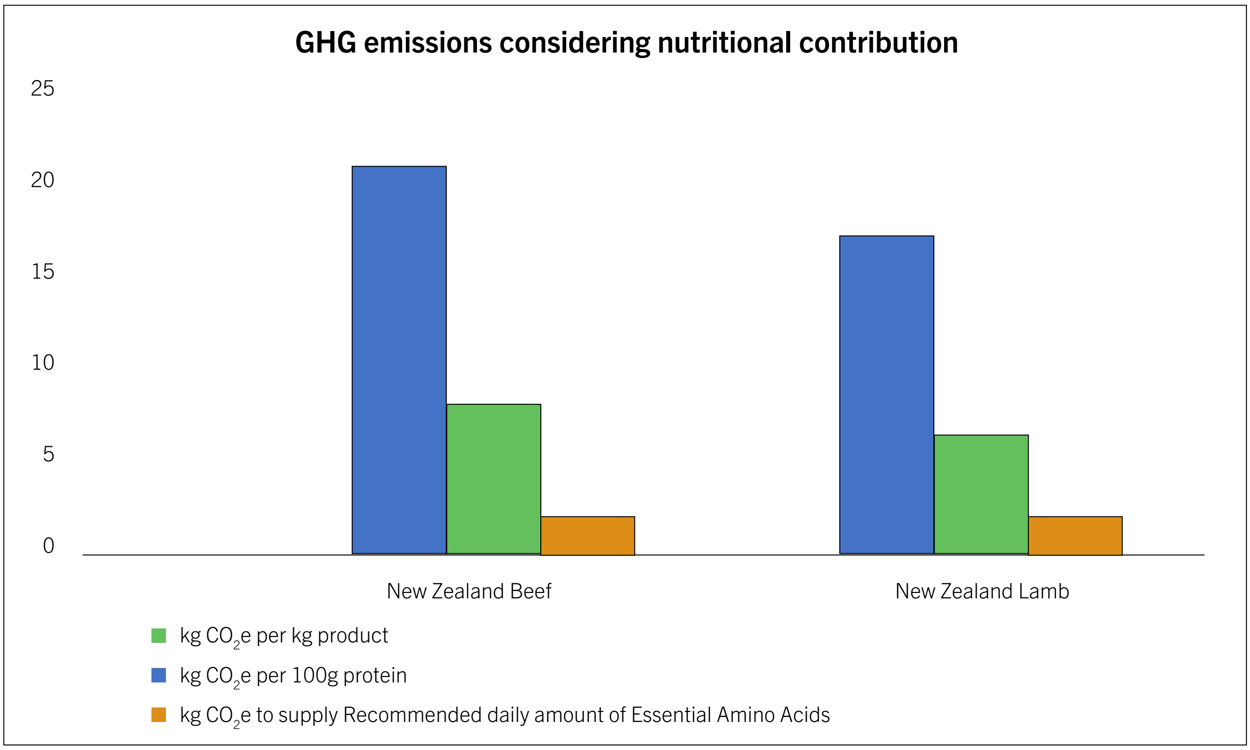


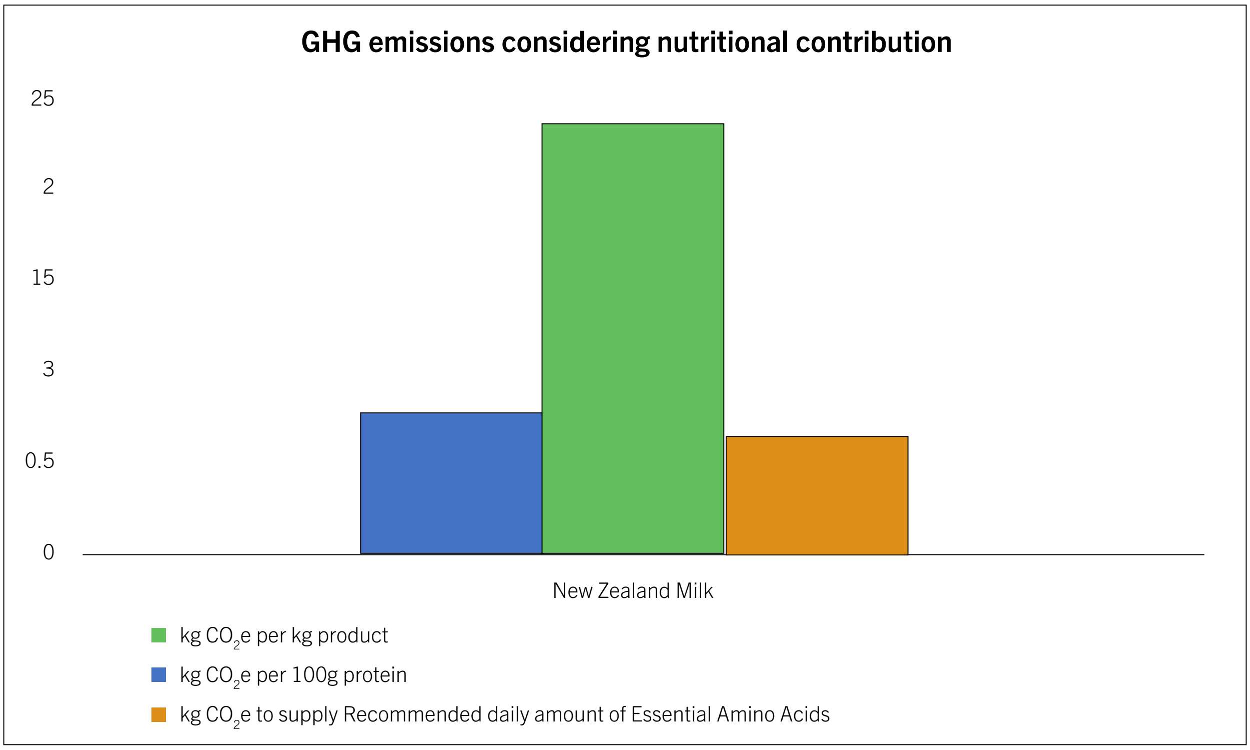


It is important to consider the nutritional density of foods alongside the environmental impact when determining a balanced and environmentally friendly diet. It is also important to keep in mind that not all farming production systems globally are the same, and different population groups and different individuals within these groups will have different nutritional requirements.

There are times during a human's life of rapid growth and development where nutrition is essential, such as the role iron has to play for brain development in babies. For example, at 7 months a baby needs more iron than their dad.[30]

The figure below summarises the comparison of different food types on both a nutritional and emissions basis.[31]





HE WAKA EKE NOA –
THE PRIMARY SECTOR CLIMATE ACTION PARTNERSHIP

One thing to takeaway:
In 2019 New Zealand farmers partnered with Government and iwi/Māori to measure, manage and reduce agricultural greenhouse gas emissions. This collaborative partnership includes the development of an appropriate pricing mechanism designed to further incentivise innovation while maintaining food production.

He Waka Eke Noa is a partnership between primary industry groups, the Government and iwi/Māori. Via He Waka Eke Noa, the New Zealand agriculture sector is working together to develop a framework by 2025 to equip farmers and growers with skills and tools to reduce on-farm agricultural greenhouse gas emissions and adapt to climate change. The He Waka Eke Noa partnership aims to enable sustainable food and fibre production for future generations.[32]

This is a new and innovative approach because farmers and growers will work alongside subject matter experts and public servants to ensure the policy and tools that are developed are fit for purpose, practical and cost-effective.

"The partnership's vision is that New Zealand farmers and growers take action on climate change to protect, restore and sustain our environment and to enhance our well-being and that of future generations. We are doing this work to enable sustainable food and fibre production for future generations and competitiveness in international markets."[33]

The Primary Sector Climate Action Partnership is committed to achieving a solution that is practical for the primary sector, rewards efforts to reduce emissions, and supports the industry's future success. This will include farmers and growers being incentivised to act through an appropriate pricing mechanism by 2025.

The Partnership will provide farmers and growers with a toolkit over the next five years, including:

- guidance on how to manage and reduce on-farm agricultural emissions.
- a farm plan module for planning the steps to be taken on the farm to reduce emissions.
- a system for measuring and reporting on-farm emissions.
- a mechanism for pricing emissions as an incentive to take action.
- guidance on maintaining or increasing long-term carbon storage (for example in trees or soil); and
- guidance on adapting to a changing climate.

The partnership is comprised of: Apiculture NZ, Beef + Lamb NZ, DairyNZ, DCANZ, Deer Industry NZ, Federation of Māori Authorities, Federated Farmers of New Zealand, Foundation for Arable Research, Horticulture NZ, Irrigation NZ, Meat Industry Association, Ministry for Primary Industries and Ministry for the Environment.

Prime Minister Jacinda Ardern announcing He Waka Eke Noa in 2019[34]

THERE IS A LARGE AMOUNT OF CARBON BEING STORED ON NEW ZEALAND FARMS, MUCH OF WHICH IS NOT BEING COUNTED

One thing to takeaway:

Kiwi farmers are investing large amounts of time, money and effort into improving the environment. All farmers in New Zealand want to leave their farm in a more sustainable state then when they began farming it, for future generations. This includes establishing vegetation and improving soil carbon stocks.

There are 2.8 million hectares of native vegetation and 1.4 million hectares of native forest on sheep and beef farms in New Zealand, second only to native forestry on public conservation land.[35] The New Zealand dairy sector is also looking after about 160,000 hectares of native forest.[36]

A 2020 study commissioned by Beef + Lamb New Zealand and led by Dr Bradley Case at Auckland University of Technology (AUT) estimates the woody vegetation on New Zealand sheep and beef farms is offsetting between 63 percent and 118 percent of their on-farm agricultural emissions.[37] This study used the GWP_{100} method for comparing the methane emitted by livestock and the carbon dioxide absorbed by vegetation and if a more accurate metric (such as the previously discussed GWP* approach) were used, the results would likely have been more impressive.

Subsequent to the release of the AUT study, the New Zealand Ministry for the Environment (MfE) released a similar study that estimated that New Zealand sheep and beef farms are offsetting from a net perspective 33% of on-farm agricultural emissions.[38] While this study used different methodologies and estimating techniques than the AUT study (including the netting off of harvesting), it also used the GWP_{100} method for comparing the methane emitted by livestock and the carbon dioxide absorbed by vegetation.

All of this vegetation is storing carbon and much of it is also regenerating and removing (sequestering)[39] additional carbon from the atmosphere. However, currently most of this carbon sequestration is not accounted for when calculating New Zealand's emission budgets or when reporting the emissions each sector is responsible for.

These statistics have a strict definition of what can be counted as 'forestry' and what can not, including shelter belts, erosion planting or riparian planting on farms - the planting of which New Zealand farmers have extensively undertaken in order to protect their animals, waterways, and the atmosphere.

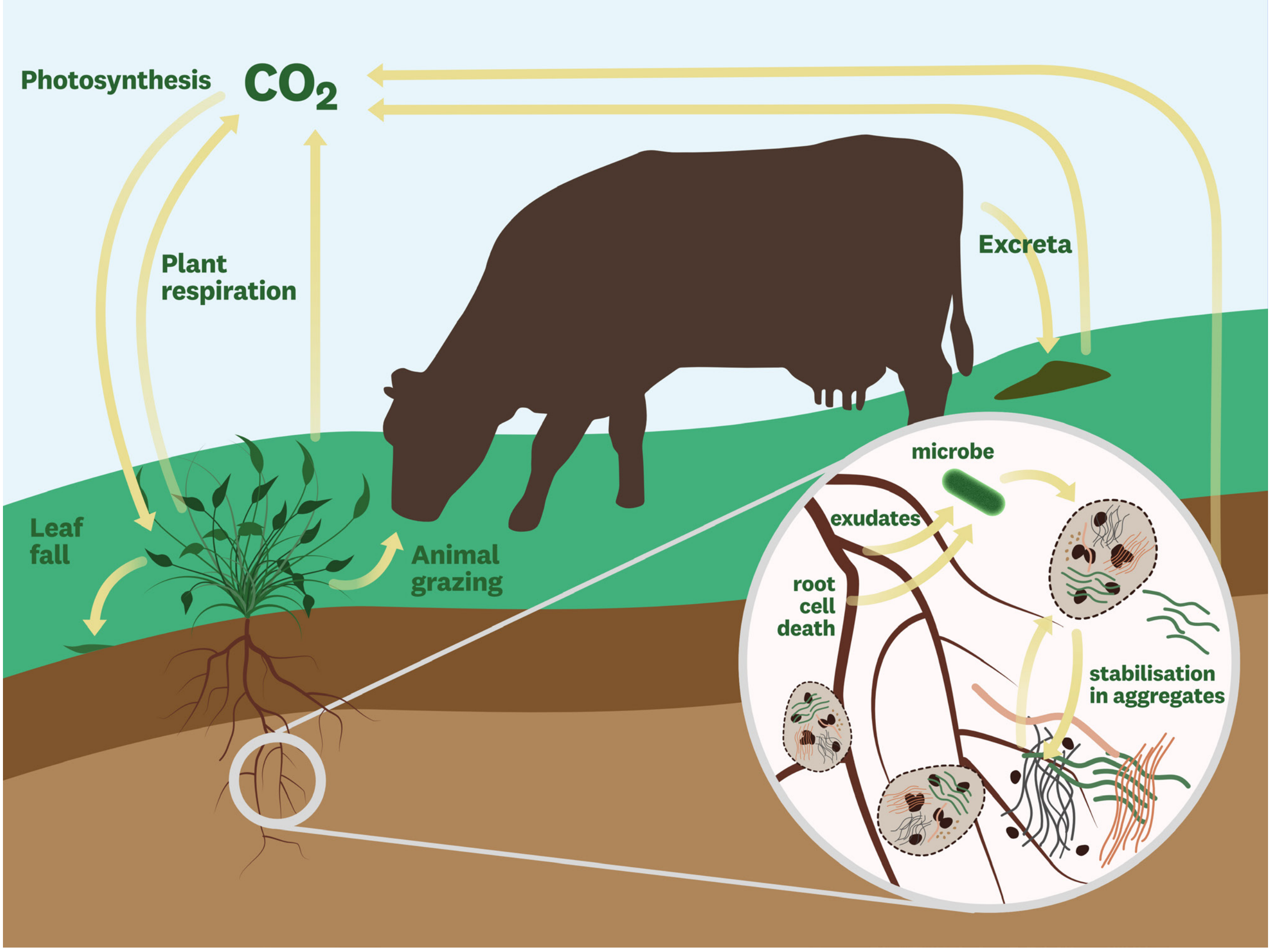
Thousands of kilometres of waterways have been fenced and millions of plants have been established along the banks of these waterways. All storing carbon while filtering water.[40]

There is also a lot happening below the surface on New Zealand farms. Carbon is constantly moving between the atmosphere, plants, and soil. Some of this carbon chemically binds to soil particles and is inaccessible to microbes. In this form, it is stable and can remain locked away for decades.[41]

The following video, produced by the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) features Professor Louis Schipper from Waikato University, explains what soil carbon is, why it matters, and why it's currently difficult for New Zealand farmers and growers to verifiably increase their soil carbon stocks.[42]

The issue is complex, and more work is needed in order to fully understand what New Zealand farmers can do. Boosting stable soil carbon levels by a small percentage has the potential to sequester very large amounts of carbon.[43] However, reducing soil carbon levels also has the potential to lose large amounts of carbon quickly.

The below diagram from AgMatters illustrates the soil carbon cycle in which livestock can add carbon to the soil.[44]



Practices that are already widespread in New Zealand farming have been financially rewarded internationally as a means of increasing soil carbon levels. Such methods include:

- Low disturbance no-tillage cropping (not disturbing the soil through digging, stirring, or overturning)
- Rotational grazing (moving livestock between pastures to maintain good soil and grass health)
- Using fertiliser and irrigation to increase pasture productivity; and
- Planting perennial pasture crops (plant varieties which can be farmed for multiple years without resowing).[45]

New Zealand is not alone in looking into how soil can store more carbon.[46] The international "4 per 1000" initiative was launched by France on 1 December 2015 at the 21st United Nations Climate Change Conference (COP 21) and consists of national governments, local and regional governments, companies, trade organisations, non-governmental organisations and research facilities.[47] The aim of the initiative is to demonstrate that agriculture, and in particular agricultural soils, can play a crucial role where food security and climate change are concerned.[48]

New Zealand organisations involved with the '4 per 1000' Initiative include the New Zealand Government, the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) and the Global Research Alliance (which was established by, and whose secretariat is hosted by New Zealand).

The program is called '4 per 1000' because an annual growth rate of 0.4% in the soil carbon stocks, or 4% per year, in the first 30-40 cm of soil, would significantly reduce the carbon dioxide concentration in the atmosphere related to human activities.

This is explained in [the following video](#).

NEW ZEALAND FARMERS ARE FUNDING RESEARCH WHICH HAS THE POTENTIAL TO REDUCE EMISSIONS GLOBALLY

One thing to takeaway:

Since 2003 New Zealand farmers have been spending millions of dollars researching innovative and exciting methods for reducing agricultural greenhouse gas emissions.

Despite already being the most climate friendly farmers in the world, New Zealand farmers are working hard to be even better. Since 2003 the Pastoral Greenhouse Gas Research Consortium (PGGRC) has directed about $75 million of industry and Crown funding to the challenge of lowering New Zealand agricultural emissions. This includes attempting to decouple the relationship between the feed consumed by a ruminant animal (animals such as cattle, sheep and goats that have four stomachs) and the methane produced.[49]

While the program has yet to be successful in discovering a breakthrough technology, valuable knowledge has been gained and exciting progress has been made in developing the following potential mitigation tools, which could be applied to not only New Zealand farms, but to all farms globally:

- Methane vaccine.
- Methane feed inhibitors.
- Low methane sheep; and
- Low nitrous feeds.[50]

New Zealand is also demonstrating leadership in coordinating efforts to reduce GHG emissions internationally. The Global Research Alliance (GRA) is an international organisation that was launched by New Zealand in 2009 and now has 62 member nations from all regions.

The GRA is focussed on research, development and extension of technologies and practices that help deliver ways to grow more food (and more climate-resilient food systems) without growing greenhouse gas emissions.[51] New Zealand continues to host the secretariat of the GRA and is also co-chairing the livestock Research Group.[52]

Sheep wearing a SF6 tracer device that is used by the PGGRC to measure the methane emissions from their low methane sheep breeds.

LIVESTOCK PLAY AN IMPORTANT ROLE IN THE GLOBAL FOOD SYSTEM

One thing to takeaway:

It is very important to global food security that New Zealand continues to promote the open trade of food, while also reducing greenhouse gas emissions. Livestock play an important role in the global food system, both in developed and developing nations.

Climate change is a global problem, and it is important that solutions take a global perspective. Climate change will affect world regions unevenly. It is already affecting vulnerable countries, and will pose a major threat to their food security.

Climate change will alter conditions for agriculture. This could lead to changes in how well different regions produce agricultural products, and consequently lead to changes in agricultural trade. Trade can help in adapting to climate change and in ensuring food security. It can support adaptation efforts by stabilising markets and reallocating food from surplus to deficit regions.[53]

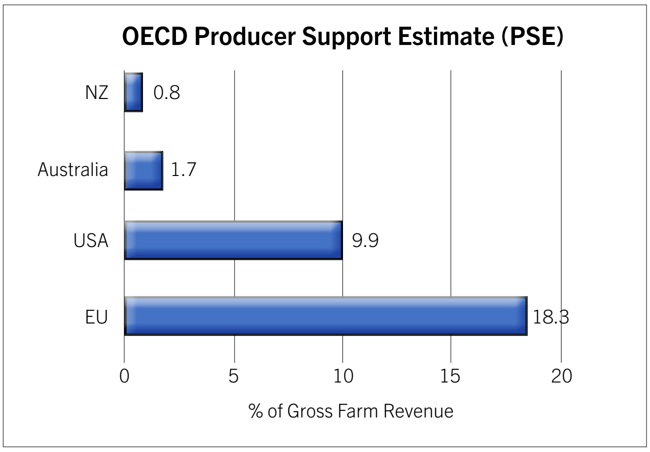
In 2050, the world will count 9.6 billion people, 70% living in cities with an average income almost twice as high as today. As a result, global demand for animal products will continue to grow and play a critical role in global food security and nutrition.[54]

New Zealand farmers efficiently produce red meat and milk without the large direct subsidies (money given by the government to help an industry or business keep the price of a product low) seen in many countries overseas. New Zealand has the lowest estimated producer support in the Organisation for Economic Cooperation and Development (OECD).[55]

The Producer Support Estimate, or "PSE" is a measure that represents policy transfers to agricultural producers, measured at the farm gate and expressed as a share of gross farm receipts. In the case of New Zealand, this would include things like public expenditure on disaster relief, biosecurity systems and industry good research. Red meat and milk production in New Zealand is economically sustainable without government support. Livestock farmers in other major dairy exporting regions such as Europe and the United States receive regular government subsidies that are particularly significant when prices are low.

In New Zealand, farmers produce food without the government distorting the market with subsidies. Since the 1984 economic reforms (when subsidies were removed), New Zealand farmers have been required to farm economically and efficiently or risk going out of business. This economic efficiency is not only good for the New Zealand economy, but also good for the atmosphere, as it is also a major reason behind the impressive emissions efficiency of New Zealand red meat and milk.

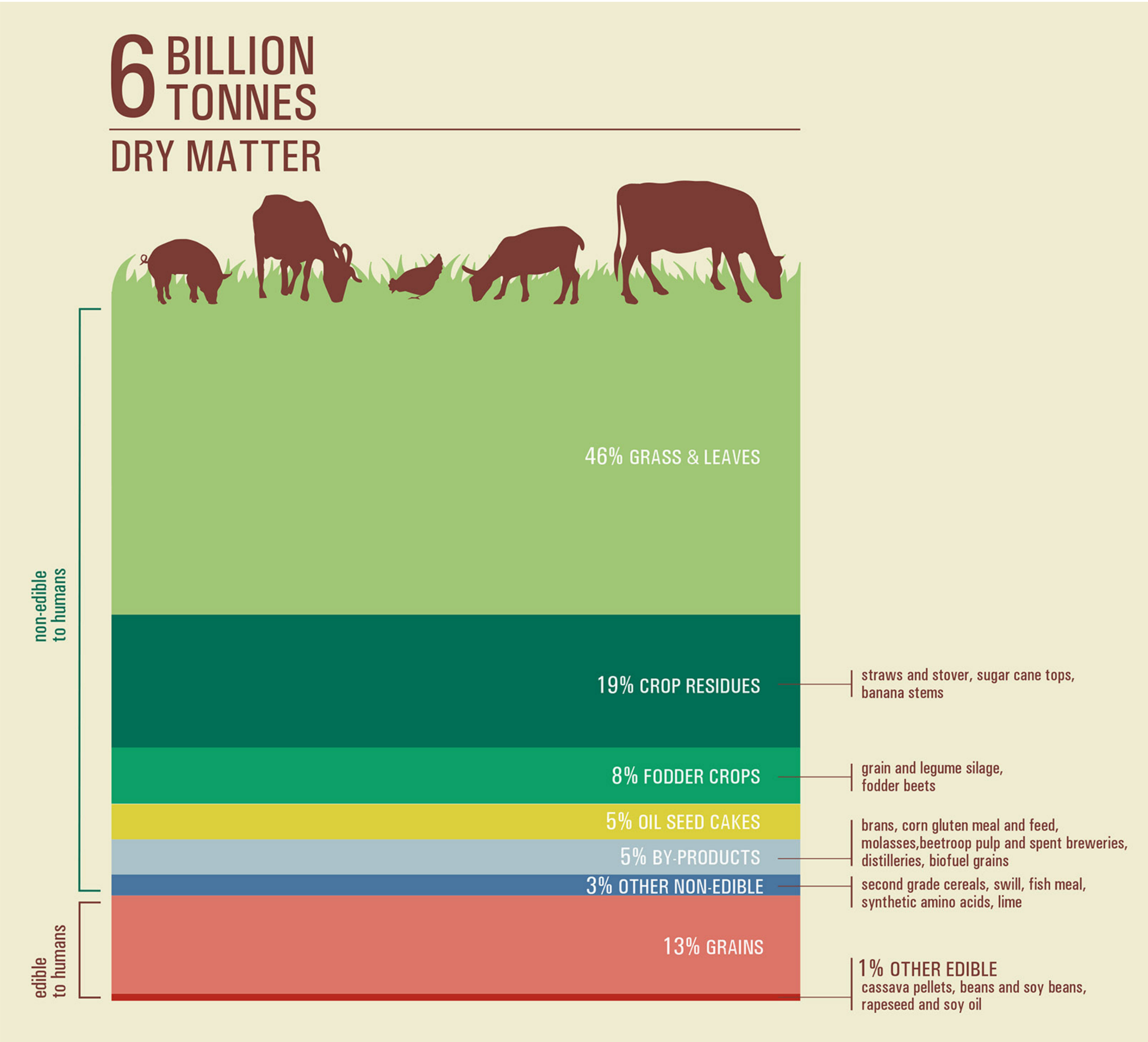
The below graph shows the PSE of New Zealand, Australia, the European Union (EU) and the United States of America (USA).



Livestock in New Zealand are not only grown without subsidies, but also play an important role in the wider food system. As simple as it sounds, we cannot simply substitute livestock production with plant production, as 86% of livestock feed is not suitable for human consumption. If not consumed by livestock, crop residues and by-products could quickly become an environmental burden as the human population grows and consumes more and more processed food. This issue is further explored in the next section.

Another critical constraint in the New Zealand context is that much of the land currently in pastoral agriculture is unsuitable for growing arable crops, fruit, and vegetables. Limitations on this land include some being too steep for farm machinery and some that would require uneconomically and unsustainably large amounts of irrigation and fertilisation.

As this graph produced by the United Nations Food and Agriculture Organisation (UN FAO) demonstrates, 86% of the feed consumed by animals globally cannot be consumed by humans.[56]



Ruminant livestock (such as sheep and cows) rely primarily on forages, crop residues and by-products that are not edible to humans. Certain livestock production systems contribute directly to global food security, as they produce more highly valuable nutrients for humans, such as proteins that ruminants efficiently upcycle from pasture, than they consume.[57]

Globally, hundreds of millions of people rely on red meat and milk for nourishment, either by farming animals, such as cows, sheep and goats, or by consuming products imported from net food exporters, such as New Zealand. Animal food sources make a vital contribution to global nutrition and are an excellent source of protein and micronutrients. Livestock products make up 18% of global calories, 34% of global protein consumption and provide essential micronutrients, such as vitamin B12, iron, zinc and calcium.[58]

Globally, animals also add to efficient agricultural production through manure production and draught power (such as ploughing, planting, weeding, water-lifting, milling, construction and transportation). Animals assist in eliminating poverty, reducing drudgery and in the creation of wealth. Livestock is particularly important for food security in smallholder farming systems, as keeping livestock provides a secure source of income for over 500 million poor people in many rural areas.[59]

Agriculture has a key role to play in addressing and responding to many global issues. This is recognised in the UN Sustainable Development Goals (SDGs) which state:

- “If done right, agriculture, forestry and fisheries can provide nutritious food for all and generate decent incomes, while supporting people-centred rural development and protecting the environment.”[60]

UNDERSTANDING SUSTAINABLE FOOD SYSTEMS AND THE DELTA MODEL

One thing to takeaway:

Sustainably feeding a growing global population is a very complex problem. A New Zealand institute has developed a model to offer insights into how this can be done. This model shows that the global food system is, and needs to be, plant-based and animal optimised.

The question of how farmers can sustainably feed a growing global population is being grappled with by New Zealand's own Sustainable Nutrition Initiative (SNI).

The SNI has developed a modelling approach to test various scenarios for a globally sustainable future food system, the DELTA Model. This model explores the ability of different food production scenarios to provide the bioavailable nutrients needed to adequately feed the global population.[61]

By using the DELTA model, people can explore the challenge of how to sustainably nourish an increasing global population without exceeding the capacity of the planet. There are many ways of approaching this question and users of the model can manipulate the major components of the food system to see the impact on the supply of key nutrients.[62]

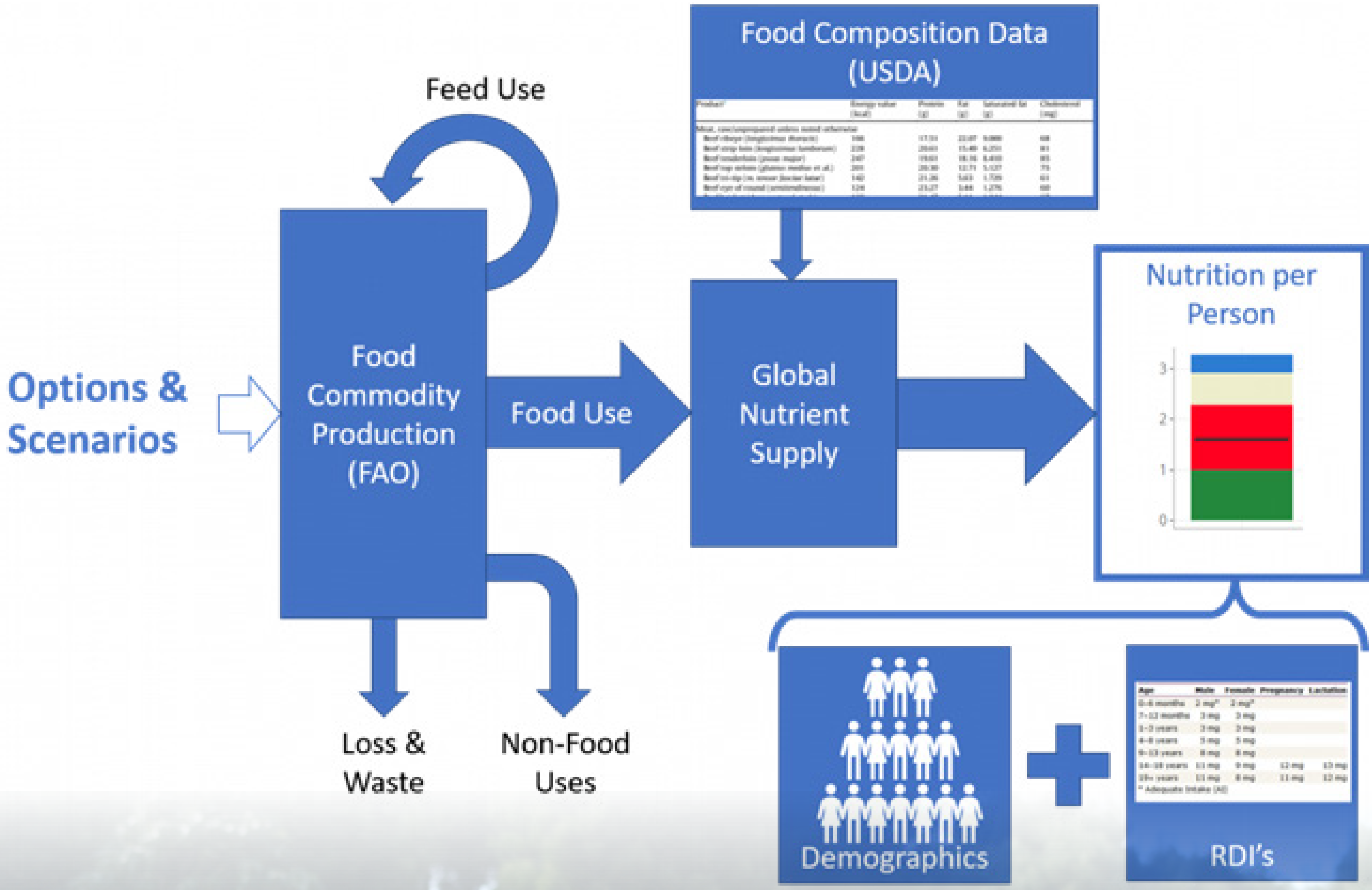
So, what insights does the DELTA Model offer? For most food production system scenarios that can be tested with the DELTA Model, it is often not the macro-nutrients (protein, fat, carbohydrate) that limit the provision of adequate nutrition. Rather, it is the micro-nutrients and trace elements. Foods rich in bioavailable nutrients are therefore required. For example, the richest and best-absorbed source of calcium is dairy products, and red meat offers bioavailable iron, both of which are also rich in other nutrients such as high-quality protein and vitamins such as B12. On the other hand, the best sources of other nutrients, for example vitamin C and fibre are plants. This is why a balanced food system with nutrient-rich animal and plant foods is important.[63]

As also noted by the SNI, diets cannot work on a global scale if there are insufficient nutrient-rich foods. For example, diets recommended by EAT-Lancet and Greenpeace suggest a reduction in animal products. While such reductions claim to be good for the planet, they do not necessarily guarantee global nourishment, particularly when it comes to micro-nutrients and trace elements like calcium, vitamin B12, zinc, iron and others. About one billion people rely on livestock for their livelihoods and research has also demonstrated that about 1.6 billion people could not afford the global diet prescribed by EAT-Lancet.[64] This is consistent with the DELTA Model, which also indicates it is not possible to meet global nutrient requirements with only plant-based sources of nutrition without supplementation and fortification, which may not be a practical or affordable solution on a global scale.[65]

This does not mean the answer to the global food system's problems is an excess of red meat and milk. While it is difficult to summarise the insights provided by the DELTA Model, two clear takeaways are that a balance and variety of food types is needed, and that the complexity of the global food system must be appreciated by policy makers.

"The current food system is plant dominant; in fact, around 85% of all biomass that leaves the world's farms is plant-based. The key is that a food system must be optimised with nutrient-rich foods to ensure global nutrient requirements are met. **In other words, the food system is, and should be, plant-based and animal optimised".**[66]

The below image visualises how the DELTA Model is able to show how adjusting the types of food produced will impact the nutrition available to the average global citizen.[67] As the image also shows, this process is very complex.



CONCLUSION

New Zealand has a unique emissions profile, and consequently has a unique challenge in reducing greenhouse gas emissions. In most developed countries, the emissions profile is mostly comprised of carbon dioxide, from sources such as the use of coal and gas for electricity generation. New Zealand is unusual in having both a large amount of renewable electricity (the majority from hydroelectricity) and a proportionately large agricultural sector.

Under the standard means of calculating the warming from different GHG emissions (GWP_{100}), almost half of the GHG emissions in New Zealand are from agriculture, with the majority of these agricultural emissions being methane, a gas that behaves very differently to carbon dioxide in the atmosphere. This difference is not fully recognised in the GWP_{100} metric. To successfully do our part in combating the wicked problem that is climate change, we must acknowledge these differences, and find a way to accurately report the impact of these gases.

As complex as the issue of climate change is, the task of reducing agricultural emissions is further complicated by the importance of the global food system. In addition to considering the environmental impact of agricultural products, we must also consider their nutritional value. As shown in section 6, it is important to consider the nutritional value of food when determining its environmental impact. As the world's population increases and climate change impacts the ability for many nations to efficiently produce nutritious food, efficiently produced red meat and dairy will become more important. New Zealand grass-fed beef, lamb, and dairy is efficiently generated, nutrient dense and provides high-quality protein and micronutrients.

As the DELTA Model shows there is an important role for red meat and milk to efficiently deliver these micronutrients to a growing global population. However, too much red meat and milk is good for neither people or the planet, but rather a balance is needed. **"In other words, the food system is, and should be, plant-based and animal optimised."**[68]

New Zealand red meat and dairy is produced with a relatively low carbon footprint when compared to other large agricultural producing countries. By exporting large amounts of red meat and milk with a world leading low carbon footprint, New Zealand is helping countries lower their GHG emissions from consuming agricultural products while also helping them deliver large amounts of macronutrient and micronutrient dense food to their people.

New Zealand farmers are keenly aware of the challenges posed by climate change. Farmers are working together to both adapt to these upcoming climatic challenges and to also reduce the on-farm GHG emissions made during food production.

Farmers are working together on getting the policy framework right with He Waka Eke Noa The Primary Sector Climate Action Partnership. Farmers are also working hard to give the scientific community the best possible chance to develop a breakthrough technology, such as a methane vaccine for livestock. New Zealand farmers have funded the PGGRC since 2003, recognising the tremendous potential a breakthrough technology represents for farmers, their animals, consumers and the environment.

New Zealand is an international trading nation, acutely aware of our place in the world, both vulnerable to risks from overseas, such as climate change, but also eager to apply a 'number eight wire' approach to tackling these global challenges. By spearheading organisations (such as the GRA) and by being an active member in organisations such as the '4 per 1000 Initiative', a scientific breakthrough developed by the PGGRC, or a collaborative policy framework for managing agricultural GHG emissions developed by He Waka Eke Noa, has the potential to improve outcomes for not only New Zealand farmers, animals, consumers and the environment but also to improve these outcomes globally.

New Zealanders should all be proud of the fact that as a nation we feed ten times our population. Proud of the fact that our farmers are able to produce this much food while competing against nations who depend on substantial direct government financial assistance. Most of all New Zealanders should be proud of the fact that Kiwi farmers are not shying away from the immense challenges posed by climate change, eager to have a challenging but fair conversation. Efficiently produced New Zealand red meat and dairy will play a key role in feeding a growing global population, but the ongoing challenge is how we can reduce our environmental impact even further, while still feeding a growing global population.

FURTHER READING

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The CLEAR Center: What is the greenhouse gas effect?
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DairyNZ's Climate Change site
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Farm Gate podcast Episode 1: Ruminant Methane, GWP* & Global Warming
https://www.faifarms.com/podcasts/ruminant-methane-gwp-global-warming/

Foodsource: Free and open resource for information on sustainable food systems. Building block: Methane and the sustainability of ruminant livestock
https://foodsource.org.uk/building-blocks/methane-and-sustainability-ruminant-livestock

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