DISCUSSION PAPER #9:
Understanding the drivers of climate change – part two.

Solar panels on agricultural property, Griffith, NSW, May 2019 (not an RFF asset).

AGRICULTURE'S ROLE IN REDUCING EMISSIONS

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Introduction

The previous edition of this newsletter (December 2018) discussed climate change and humanity's emission of gases causing this problem. The article used the term *radiator gases*, rather than the more common term, greenhouse gases, as a more accurate description of the process that is warming our planet. This is because the additional gases now residing in our atmosphere behave like a giant radiator, rather than a greenhouse. Since the beginning of the industrial revolution, humanity's pollution has installed an additional 2,000 billion tonnes of gas molecules in our atmosphere[1]. These molecules, or radiator gases (RGs) are emitting infrared radiation, day and night, and it is the heat from this radiation that is warming our planet.

Despite sustaining humankind for the past 10,000 years, the agricultural industry has been criticised in recent years for the impact it has on the environment. It is the largest user of land, the cause of much deforestation, the largest consumer of water and one of the largest polluters of our atmosphere through emission of RGs. Some would say that this is to be expected, given the task of feeding seven billion people. However, if the industry is to provide sustenance to a projected 10 billion people by the year 2050, it is necessary to ask how things can be done better.

Globally, the agricultural industry contributes 11% of total RG emissions, with emissions amounting to 5.4 gigatonnes (Gt) per annum[1]. In Australia, the agricultural industry is responsible for 13% of total emissions, or 0.07 Gt per annum.

Each of the RGs has different radiative power, and differing residence time in the atmosphere. Given the need to quantify emissions, scientists have standardised the radiative power of each gas to carbon dioxide (CO_2) equivalent, as set out in **Figure 1**.

The purpose of this article is to identify the RGs emitted by the agricultural sector, quantify them, and examine the means by which they can be reduced. For this reason, each major source of RG emissions will be explained and explored, with particular reference to the agricultural sectors relevant to the Rural Funds Group (RFF) and other entities operated by Rural Funds Management (RFM).

Figure 1 – Radiator gases (RG) standard radiation potential[2]

Radiator Gas (RG)	Lifetime	CO_2 equivalent over 100 years
Carbon dioxide (CO_2)	Up to 30,000 years[3]	1
Methane (CH_4)	12 years	28
Nitrous oxide (N_2O)	121 years	265

1. Jenkins et al "Framing Climate Goals in Terms of Cumulative CO2-Forcing-Equivalent Emissions", *Geophysical Research Letters*, 45 (2018), 2795-2804.
2. Pachauri et al, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, (2014).
3. Archer, "Fate of fossil fuel CO2 in geologic time", *Journal of Geophysical research*, 110 (2005).

“Permanently reducing CH_4 emissions would cause an immediate and significant reduction to the amount of radiation coming from our atmosphere.”

Methane (CH_4)

CH_4 constitutes 16% of global RG emissions and 21% of Australia’s emissions. It is the primary form of RG emissions from agriculture[4]. **Figure 1** notes that the radiative power of CH_4 is 28 times that of CO_2 standardised over 100 years (as set out by the Intergovernmental Panel on Climate Change). However, CH_4 only has a residence time of 12 years[5], as it is broken down in the lower atmosphere and converted to ozone[6]. For this reason, permanently reducing CH_4 emissions would cause an immediate and significant reduction to the amount of radiation coming from our atmosphere.

One of the main sources of CH_4 emissions in agriculture is ruminant digestion. Ruminants such as sheep and cattle break down fibrous material like grasses with the aid of microorganisms in the rumen. These microorganisms produce digestible molecules such as protein while producing CH_4 as a by-product.

RFF owns nine grazing properties and three feedlots, and is awaiting settlement of a further two feedlots. These assets are collectively capable of carrying 220,000 head of cattle. While all these properties are leased to entities who operate cattle businesses, it is estimated that the combined emissions from these farms is approximately 13,200 tonnes of CH_4 per annum, or approximately 369,600 tonnes of CO_2 equivalent measured over a 100-year time frame. This is estimated to be the largest source of RG emissions from the assets owned by RFF.

Given the large quantity of emissions and the fact that reducing CH_4 emissions has a larger immediate benefit, it makes sense to prioritise the reduction of these emissions where possible. For these reasons RFM is in the process of engaging experts who will more accurately calculate emissions for all RGs from our cattle enterprises over the past three years, then provide a list of steps that can be taken to reduce them.

An effective solution relating to reducing CH_4 emissions is to use natural feed additives to alter the fermentation process occurring in the rumen. An added benefit of this approach is feed conversion becomes more efficient as the energy rich CH_4 emissions are prevented and instead utilised by the animal. Trials conducted by the CSIRO have reduced CH_4 emissions by more than 80% using a common seaweed called Asparagopsis taxiformis supplied as a feed additive at less than 2% of total dietary intake[7]. While these results are very promising, commercialisation of the technology and cultivation of large quantities of seaweed will take years.

Cattle are grazed on an oats crop to increase daily weight gain. Rewan, Rolleston, central Qld, August 2018.

4. Edenhofer et.al. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment. Report of the Intergovernmental Panel on Climate Change*, IPCC (2014).
5. Pachauri et al, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, (2014).
6. Saunois et. al. "The global methane budget 2000–2012", *Earth System Science Data*, 8 (2016), 697-751.
7. Li et. al. "Asparagopsis taxiformis decreases enteric methane production from sheep", *Animal Production Science*, 58 (2018), 681–688.

There is possibly a parallel between the livestock industries and motor vehicle industry, where steady improvements in fuel efficiency have been utilised as a pathway to reduce emissions while zero emissions technologies such as electric vehicles are being developed. In the cattle industry it is possible to reduce CH_4 emissions by improving daily weight gain from higher quality pastures while dietary supplements to eliminate emissions are developed[8].

Previous editions of this newsletter have discussed pasture improvements being made to RFF assets and given their added benefit of lowering CH_4 emissions, these programs will be pursued, quantified and documented. To achieve this RFM will conduct trials using equipment (see GreenFeed on page 7) that can directly measure CH_4 emissions such as those depicted in **Figures 2** and **3**.

Nitrous oxide (NO_2)

NO_2 emissions are the second largest form of RGs emitted by agriculture. Globally the sector contributes around 60% of total NO_2 output[9]. The main causes of these emissions are the application of nitrogen fertilisers and manure management in intensive livestock industries.

NO_2 can be released into the atmosphere when excessive amounts of nitrogen-based fertilisers are applied, or during water-logging caused by excessive irrigation. These are issues that best management practice avoids on RFF's cotton and almond properties, but nevertheless will be the subject of future review and measurement.

Carbon dioxide (CO_2)

CO_2 emissions are the next most significant form of RGs contributed by agriculture, accounting for less than 1% of Australia's CO_2 emissions[10]. Two activities commonly associated with CO_2 emissions are land clearing and energy consumption in the forms of electricity and diesel.

Land clearing

Land clearing creates RG emissions as carbon-rich forests are replaced with grasslands or fields that are harvested annually. Prior to the period of industrialisation fuelled by the oil and gas industries, land clearing was the largest man-made source of RG emissions[11]. It is estimated that since 1850, 160 billion metric tons of carbon from forests and soils have been emitted worldwide as a consequence of land use and land use changes[12].

Land clearing is no longer a significant source of

Figure 2 – RG emissions from Australian agriculture (Gt)[13]

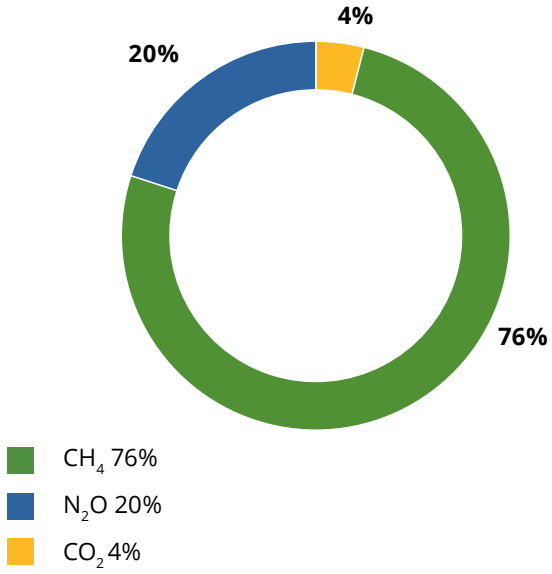
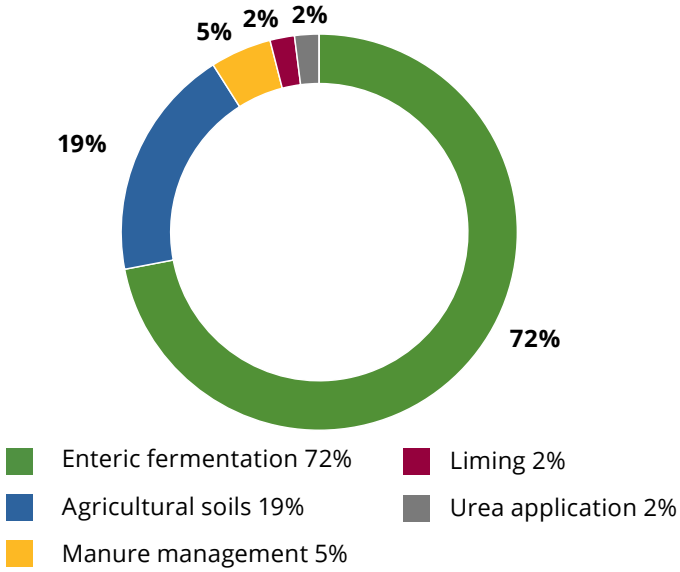


Figure 3 – RG emissions from Australian agriculture by source (Gt)[13]



8. Ibqual et. al. "Mitigation of ruminant methane production: current strategies, constraints and future options", *World J Microbiol Biotechnol*, 24 (2008), 2747–2755.
9. Reay et. al. " Global agriculture and nitrous oxide emissions", *Nature Climate Change*, 2 (2012), 410-416.
10. Commonwealth of Australia, *National Inventory Report 2016*, Volume 1, (2018).
11. Kammen and Marino, "On the origin and magnitude of pre-industrial anthropogenic CO2 and CH4 emissions", *Chemosphere*, 26 (1993), 69-86.
12. Paustian et.al., *Agriculture's role in greenhouse gas mitigation*, Pew Centre on global climate change, (2006).
13. Commonwealth of Australia, *National Inventory Report 2016*, Volume 1, (2018).

The GreenFeed

The GreenFeed is an automated RG emission measuring tool made by C-lock[14]. When cattle place their head in the hopper to feed, a fan draws the animal's breath through sensors which analyse the CO_2 and CH_4 content. An integrated radio-frequency identification scanner reads each animal's ear tag, recording the animal's ID number with the emissions data. In this way, the emissions output of each animal can be monitored for use in selective breeding, or for calculating total herd emissions. See **Figure 4**.

Figure 4 – Green Feed[15]

emissions from Australian agriculture because it was reduced in the years leading up to Australia's commitment to the Kyoto emissions target, and largely banned nationally afterwards. The current debate about the utilisation of credits created because of bettering the Kyoto target is a result of this. During the negotiation of the Kyoto agreement Australia insisted at the last minute on the inclusion of credits for the avoidance of land clearing, in what became known as "the Australia clause", creating credits for a practice that had largely ceased.

No clearing of remnant vegetation occurs on RFF farms, because it has already been done and it is now illegal. More positively, best management practice through minimum tillage makes it possible to increase soil carbon, thereby creating a carbon sink[16]. Quantification of the gains from this practice will also occur in the studies to be conducted on RFF farms.

Energy

Energy consumption in the form of electricity and particularly diesel fuel is a major source of carbon emissions in Australian agriculture. Energy production contributes 53% of national emissions and 35% globally[17]. On RFF-owned cotton and almond orchards, electricity and diesel consumed for pumping water is one of the largest operating costs and the largest single source of RG emissions from these particular assets.

RFM has been working with electrical engineers to quantify the cost and carbon reductions that could be achieved through the installation of reasonably large-scale solar energy systems that can be used to drive pumps. This analysis includes calculations of the many variables that can affect the financial returns on these investments, such as scaling the systems to match the seasonal demands of the crops' water requirements, options for selling electricity into the grid, and utilisation of battery storage. The cost of solar electricity systems has reduced tenfold over the past two decades, and it is likely that the installation of a system will begin on at least one of RFF's almond orchards in the coming year.

Conclusion

In recent years, community expectations regarding the environmental impact of industries have become more focused. Consumers are demonstrating preferences for products that have less impact on the environment, businesses are working to reduce their carbon footprints and governments around the world are legislating to reduce national emissions to meet emissions reduction targets. Until now, agriculture has largely been excluded from these programs, but this will not continue.

RFM is working with experts in a number of fields to quantify the emissions from assets owned by RFF and where farming enterprises are operated by RFM, it is developing measures to reduce these emissions. Once baseline emissions have been quantified, step by step trials will be measured and the knowledge gained from these initiatives will then be deployed more widely, so that RFF assets and hopefully the wider industry can play its part in reducing our nation's RG emissions.

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14. GreenFeed - Large Animals: Description, C-lock <https://www.c-lockinc.com/shop/automated-emissions-measurement/greenfeed-large-animals> [accessed 23 May 2019].
15. Image courtesy of C-Lock Inc. Used with permission.
16. West and Post, "Soil organic carbon sequestration rates by tillage and crop rotation", *Soil Science Society of America Journal*, 66 (2002), 1930-1946.
17. Edenhofer et.al. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment. Report of the Intergovernmental Panel on Climate Change*, IPCC (2014).