GREENHOUSE GAS MITIGATION CASE STUDY 1

BOX 1 EXECUTIVE SUMMARY

Key findings

There is a large portfolio of research by CSIRO into Greenhouse Gas (GHG) mitigation. This case study has selected three projects to illustrate the work that has taken place. Those three projects have resulted in:

- A large number of significant publications and reports
- A major correction to previous estimates of GHG emissions from northern beef cattle
- New methodologies which are now the basis of carbon credits for improved savanna management
- A new animal feed supplement that reduces methane emissions from ruminant animals and increases their rate of growth
- Significant economic, social and environmental benefits
- The net present value of just these three projects is estimated to be $166 million.

Innovation impact

- New methodologies for measuring carbon sequestration and emissions reductions
- New feed supplement for ruminant animals

This case study uses the evaluation framework outlined in the CSIRO Impact Evaluation Guide. The results of applying that framework to the greenhouse gas (GHG) mitigation case study is summarised in **Figure 1.1**.

FIGURE 1.1 GHG MITIGATION CASE STUDY – IMPACT FRAMEWORK DIAGRAM

INPUTS	ACTIVITIES	OUTPUTS	OUTCOMES	IMPACTS
Investment by: – CSIRO – The Dept of Environment & Energy – Meat & Livestock Australia – Various other partners including businesses and indigenous people	Research on: – Methane emissions from cattle – Impact of emissions from variations in timing of savanna burning – Indigenous co-benefits[1] from GHG mitigation – Identification of optimum seaweed feed to reduce ruminant emissions	– Publications and reports – Improved national GHG accounting – New GHG and carbon co-benefit methodologies – New animal feed product developed	– Correct attribution of GHG emissions leading to better targeted interventions – Carbon credits for the savanna burning under new methodologies – New seaweed supply & processing businesses in the low carbon economy	– Revised accounting has helped Australia meet its GHG target – Improved savanna management with co-benefits for Indigenous and other savanna land managers – Low carbon meat will help protect social licence to operate and retain markets for Australian producers

[1] Co-benefits are the added benefits from measures to control climate change, above and beyond the direct benefits of a more stable climate. Indigenous co-benefits may involve helping to build sustainable Indigenous on-country enterprises that deliver a range of fire management services, employing local traditional owners as rangers, providing appropriate fire management regimes needed to protect threatened species, and/or enabling Traditional Owners to be on country so the younger generation can learn from their elders (see Robinson et al. 2016).

SOURCE: ACIL ALLEN

1.1 Purpose and audience for case study

This case study describes the economic, environmental and social benefits arising from CSIRO GHG mitigation projects.

This evaluation is being undertaken to assess the positive impacts arising from three GHG projects undertaken by CSIRO. The portfolio of impacts is considerably larger, but these three case studies are taken as exemplars of impact. The case study can be read as a standalone report or aggregated with other case studies to substantiate the impact and value of the CSIRO Business Units' (Land & Water (L&W), and Agriculture and Food) activities as a whole, relative to the funds invested in these activities.

This information in this case study is provided for accountability, communication and continual improvement purposes. This case study is primarily intended to be an input into the independent review of the CSIRO Business Units however other audiences for this report may include Members of Parliament, Government Departments, CSIRO and the general public.

1.2 Background

The Australian Government is committed to reducing Australia's GHG emissions by 26-28 per cent below year 2005 levels, and to achieving this reduction by 2030. The Government has adopted policies to promote technologies and practices that will help to achieve this target. In addition, Australian industry is also taking measures to meet the challenge. Agriculture and land use change are significant contributors to Australia's National Inventory of GHGs. The Carbon Farming Initiative (CFI),[2] established in 2011, enables farmers and landholder to earn credits for reducing GHGs. Approved emissions reduction projects, once implemented, receive credits which can be sold to parties wanting to offset their emissions. The Emissions Reduction Fund (ERF), with updated methodologies, has now replaced the CFI.

CSIRO has played a key role in the development of land-based GHG mitigation through the land sector. Through this role, CSIRO has helped inform the policies of multiple governments, commencing with the 'seminal' study on the potential for the land sector through research and participatory processes. CSIRO's research has underpinned the national carbon accounting system and the development of formally recognised practices and accounting, and monitoring and verification processes of use in the CFI, and now the ERF. Important also has been CSIRO's trusted advisor relationships and their role in, and contribution to, technical working groups – to design the current auction process and ensured that the national accounting system appropriately attributes and accounts for emissions.

CSIRO has worked with others to assess, define and enable the delivery of economic, social, environmental benefits to the land sector. CSIRO's work has delivered cultural and economic benefits to Indigenous land managers and assessed where there can also be benefits to biodiversity from changed burning practices.[3] Modelling work has demonstrated the synergy between soil carbon accumulation and soil productive capacity. A senior official in the Department of Environment and Energy noted that:

The research has improved our understanding of how to evaluate success in fire management and fire management partnerships across the country. It's also provided important baseline information for the National Landcare Program. This in turn has led to new work looking at identifying economic opportunities for Indigenous groups, and how to improve monitoring to provide a better platform for fire-related investments.[4]

In addition, CSIRO has enabled and supported new businesses operating in the emerging carbon market, including the partnership with CarbonLink[5] for the commercialisation of CSIRO's Soil Condition Analysis System (SCANS),[6] and the provision of sampling algorithms and approaches to Carbon Conscious (now Alterra Ltd).[7] CSIRO's work has made significant improvements to the national carbon accounting system in forests, soil carbon accounting and livestock methane.

This case study has examined three elements of CSIRO's GHG mitigation work that have taken place since the previous review of Land and Water and Sustainable Agriculture Flagship in 2013, though the research on northern beef began earlier. They are the:

- Northern beef methane emissions project
- Savanna management project,
- FutureFeed project.

[2] See http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/cfi/about accessed on 2 May 2018
[3] Robinson, CJ., James, G., PJ Whitehead, 2016. Negotiating Indigenous benefits from payment from ecosystem (PES) schemes, *Global Environmental Change* 28, 21-29
[4] Mitch Jeffery, Director, Monitoring and Reporting Team, Biodiversity Conservation Division, Department of the Environment and Energy, 2018.
[5] See http://carbonlink.com.au/ accessed on 2 May 2018
[6] SCANS is a system developed by CSIRO to monitor soil organic carbon content and other carbon parameters after changes in land use or management
[7] See http://alterra.com.au/ accessed on 2 May 2018

1.3 Impact Pathway

1.3.1 Project Inputs

The total cost for the three elements of this case study was about $3.6 million in cash and in-kind contributions (see Tables below). CSIRO contributed around $0.3 million in cash (around 0.08 per cent of the total cost). However, the northern beef methane emissions work drew on earlier research, believed to have cost millions of dollars. Other contributors were: the (now) Commonwealth Department of Environment and Energy, the Tiwi Land Council, Meat and Livestock Australia (MLA), the (now) Commonwealth Department of Agriculture and Water Resources and James Cook University.

TABLE 1.1 SUPPORT FOR THE NORTHERN BEEF METHANE EMISSIONS PROJECT

Contributor / type of support	2012-13 ($ m)	2013-14 ($ m)	2014-15 ($ m)	2015-16 ($ m)	2016-17 ($ m)	Total
Cash						
Dept of Environment		0.029				0.029
In-kind						
Total		**0.029**				**0.029**

TABLE 1.2 SUPPORT FOR THE SAVANNA MANAGEMENT PROJECT

Contributor / type of support	2012-13 ($ m)	2013-14 ($ m)	2014-15 ($ m)	2015-16 ($ m)	2016-17 ($ m)	Total ($ m)
Cash						
Dept of Environment & Energy	0.033	0.170	0.144	0.147	0.165	0.659
Tiwi Land Council		0.053	0.033	0.017	0.027	0.130
In-kind						
CSIRO	0.021	0.134	0.107	0.100	0.116	0.478
Total	**0.054**	**0.357**	**0.284**	**0.264**	**0.308**	**1.267**

TABLE 1.3 SUPPORT FOR THE FUTUREFEED PROJECT

Contributor / type of support	2012-13 ($ m)	2013-14 ($ m)	2014-15 ($ m)	2015-16 ($ m)	2016-17 ($ m)	Total ($ m)
Cash						
CSIRO					0.277	0.277
Meat & Livestock Australia	0.099			0.062	0.328	0.489
Dept Agriculture Fisheries & Forestry		0.150	0.200	0.150		0.500
In-kind						
CSIRO	0.071	0.139	0.186	0.139	0.366	0.901
James Cook University		0.127	0.031			0.158
Total	**0.170**	**0.416**	**0.417**	**0.351**	**0.971**	**2.325**

1.3.2 Project activities

Northern beef methane emissions

In 2014, CSIRO was commissioned by the Australian Department of the Environment to undertake an analysis of Australian data on methane emissions from cattle. Some 1,034 individual animal records of daily methane production were analysed to reassess the relationship between methane production, dry matter intake and gross energy intake. The revision drew on recent Australian research with both dairy and beef cattle funded through the Australian Government's carbon abatement programs and MLA.

Previous estimates had relied largely on overseas data and older methods of estimating these methane emissions. CSIRO's research was based on data collected over eight years of research into ways to reduce methane emissions in Australian livestock as part of MLA's methane abatement research programs. The size of this investment is not known but is believed to have been in the order of millions of dollars. The new analysis resulted in an adjustment to the National Greenhouse Gas Inventory reducing methane emissions from forage-fed cattle from 52 to 39 million tons/year. The contribution of northern beef cattle was found to have been over-estimated by approximately 30 per cent.[8]

Savanna management

For the past three decades CSIRO has worked with partners to better understand the management and impacts of fires that burn more than one quarter of northern Australia's savannas each year. By 2015, this work had led to the development of three versions of a Carbon Farming Methodology to produce reductions in the emissions of the important greenhouse gases, methane and nitrous oxide through improved fire management. Over the past five years, CSIRO has worked with the Department of the Environment and Energy (DoEE) and the Tiwi Land Council to develop approaches to add carbon sequestration to the emissions reduction methodologies.

For example, the Tiwi Carbon project addressed three aspects of carbon dynamics: carbon in live vegetation, in dead organic matter and in soils. Field studies were conducted within a replicated fire experiment. The project found that, while there may be opportunities for carbon offsets in live vegetation and soils, the science was not well enough developed for a robust quantification of the benefits from changing fire management. However, carbon in dead organic matter was found to increase following the same improvements to savanna fire management that were being implemented to reduce emissions of methane and nitrous oxide. An analytical solution was developed that was applicable across northern Australia's savannas and provided an integrated account of carbon dynamics in dead wood and emissions abatement under various fire management regimes.

A numerical solution for quantifying carbon in dead organic matter (DOM) was developed, which took account of fuel remaining after a fire and provided a consistent account of both emissions (methane and nitrous oxide) and carbon in the DOM pools. This was essential for consistency with the IPCC 2006 guidelines. Following the development of a numerical solution to DOM dynamics, an analytical solution was developed.

This work enabled the DoEE to develop new methodologies that included both emissions abatement and carbon sequestration, and to produce new emissions abatement methodologies based on more robust science. These methodologies were released in May 2018. Improved fire management has benefited land holders across northern Australia, particularly Indigenous land managers, ranger groups and pastoralists. This work also provided the evidence to support the case for Indigenous benefits to be considered as part of the design and evaluation of Indigenous carbon farming support programs[9]. Protocols have been developed for Indigenous fire management partners to ensure that fire activities benefit and are endorsed by local Indigenous communities.[10] The work has also provided a base against which the National Landcare Program can assess and support Indigenous fire enterprises, partnerships and activites.

FutureFeed

FutureFeed has been developed in a collaboration between CSIRO, MLA and James Cook University. Methane in the atmosphere is a potent GHG with a global warming potential 28 times that of carbon dioxide over 100 years (as published in AR5[11]). Between 2000 and 2009, agriculture and waste management accounted for 62 per cent of global anthropogenic methane emissions[12] with ruminant livestock responsible for 58 per cent of agricultural contributions[13]. In Australia, the contribution of methane from ruminant livestock is around 10 per cent of total GHG emissions.[14]

[8] Kennedy P and Charmley E 2012, Methane yields from Brahman cattle fed tropical grasses and legumes, Animal Production Science, 52(1):225-239; Charmley E, Williams SRO, Moate PJ, Hegarty RS, Herd RM, Oddy VH, Reyenga P, Staunton KM, Anderson A and Hannah MC 2016, A universal equation to predict methane production of forage-fed cattle in Australia, Animal Production Science, 2016, 56, 169–180

[9] http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/cfi/indigenous-australians/icffrd

[10] Robinson, CJ, Barber, M, Hill, R, Gerrard, E, G James 2016.Protocols for Indigenous fire management partnerships, Report to the National Environment Science Program (Northern Hub),Canberra http://www.nespnorthern.edu.au/2016/10/11/developing-protocols-indigenous-fire-management-partnerships/

[11] IPCC 2015, Climate Change 2014, RK Pachauri Chairman, accessed on 10 May 2018 at https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf

[12] Kirschke S, Bousquet P, Ciais P, Saunois M, Canadell JG, Dlugokencky EJ, Bergamaschi P, Bergmann D, Blake DR, Bruhwiler L, Cameron-Smith P *et al.* 2013, Three decades of global methane sources and sinks. Nature Geoscience 6, 813–823. doi:10.1038/ngeo1955

[13] Olivier JGJ, van Aardenne JA, Dentener FJ, Pagliari V, Ganzeveld LN, Peters JAHW 2005, Recent trends in global greenhouse gas emissions: regional trends 1970–2000 and spatial key sources in 2000, Environmental Sciences 2, 81–99. doi:10.1080/15693430500400345

[14] Henry B, Charmley E, Eckard R, Caughan JB, Hegarty R 2012, Livestock production in a changing climate: adaptation and mitigation research in Australia, Crop and Pasture Science 63, 191–202. doi:10.1071/CP11169

Laboratory research showed that adding dried seaweed to a cow's diet can reduce the amount of methane it produces by at least 99 per cent. A trial with sheep showed a 60 per cent reduction in methane emissions, even though some sheep in the trial only had 2 per cent of their diet as seaweed. These results were field tested with cattle at the CSIRO's Lansdown Research Station, in North Queensland. The seaweed supplement was mixed with barley and molasses. While it was clear that less methane was produced it was hypothesised that the energy saved would be directed to live weight gain. This has subsequently been verified. A variety of seaweed found off Central Queensland known as *Asparagopsis taxiformis* was found to be the most effective in reducing methane from cows.[15]

An additional beef cattle trial at CSIRO's Lansdown Research Station was commissioned to confirm both methane reduction and productivity benefits. As at May 2018, this trial is nearing completion and the early results are better than expected.

1.3.3 Project outputs

Northern beef methane emissions

The results of this Australian research provide an accurate dataset which clearly show that Australian cattle contribute substantially less to methane emissions than was previously believed. Overall, Australia's methane emissions from cattle were found to be 24 per cent lower than previously estimated, equivalent to reducing emissions by 12.6 million tonnes of carbon dioxide a year.

MLA General Manager, On Farm Innovation, Matthew McDonagh said the results of this Australian research provide an accurate dataset which clearly show our cattle contribute substantially less to methane emissions than previously believed. Dr McDonagh said:

This revelation clearly shows livestock-based emissions are nowhere near what they were thought to be and will help improve the accuracy of Australia's national greenhouse gas emissions estimates.

Savanna management

In collaboration with Indigenous, corporate and government leaders CSIRO has enabled Australia to design climate mitigation innovations that benefit Indigenous Australians. The Australian Government commissioned CSIRO to lead the design of Australia's Indigenous carbon co-benefit index for the Carbon Farming Initiative, which was then included in the federal regulations. Research led by CSIRO was also used to inform the Garnaut Climate Change Review in 2011, the design of the $22 million Indigenous Carbon Fund, and the design of the Indigenous Carbon Co-Benefit Assessment Framework, which was used by the Indigenous Land Corporation (ILC) to assess Indigenous carbon fire projects.

CSIRO research with collaborators has also highlighted the importance and challenges of realising multiple benefits in climate mitigation schemes and the importance of GHG project design to ensure success. We showed that only one third of the total area currently under use for on-the-ground Indigenous CFI environmental planting projects were bio-climatically suitable for sequestering carbon through native tree planting.[16] Yet marginal GHG benefits are tolerated by Indigenous groups provided these projects deliver to broader regional natural resource management and community development goals and activities. Importantly Indigenous groups do not see broader economic, social and environmental benefits as co-benefits but as core benefits that are needed for GHG in the Indigenous land sector to achieve sustainable development goals.[17]

The Tiwi Carbon Project has improved scientific knowledge in the following areas:

— Fire and soil carbon dynamics in savannas
— The dynamics of vegetation in a frequently burnt savanna with strongly seasonal rainfall
— A model of dead organic matter dynamics in the context of the 2006 IPCC guidelines
— Accounting for woody debris dynamics in the National Greenhouse Gas Inventory, and
— Development of a Mid-Infra Red spectral library for north Australian soils which will aid and reduce the cost of any future soil carbon methodologies in northern Australia.

The national Indigenous fire management and carbon-co benefit research team have

— Improved scientific and Indigenous knowledge about how to negotiate Indigenous benefits from fire management and carbon offset schemes

[15] Machado L, Magnusson M, Paul NA, Kinley R, de Nys R and Tomkins N 2016, Dose-response effects of *Asparagopsis taxiformis* and *Oedogonium sp*. on *in vitro* fermentation and methane production, Journal of Applied Phycology, 28:2, pp 1443–145, accessed on 5 May 2018 via https://link.springer.com/article/10.1007%2Fs10811-015-0639-9

[16] Robinson, CJ, A. R. Renwick, T. May., E. Gerrard, R. Foley, M. Battaglia, H. Possingham, D. Griggs, D. Walker 2016. Indigenous benefits and carbon offset schemes: an Australian case-study, Environmental Science and Policy 56, 129-134. DOI: 10.1016/j.envsci.2015.11.007.

[17] Robinson, CJ., James, G., PJ Whitehead, 2016. Negotiating Indigenous benefits from payment from ecosystem (PES) schemes, Global Environmental Change 28, 21-29.

— Developed Indigenous co-benefit principles, criteria and requirements that were used to design Australia's Indigenous Carbon Farming Fund[18]
— Improved the Landcare Program's evaluation of Indigenous fire management benefits across Australia

FutureFeed

CSIRO and the FutureFeed team:

— Have identified the best performing source of seaweed and the bioactive dose response curve
— Have developed processes for converting the seaweed into a feed supplement
— Have demonstrated the effectiveness of FutureFeed in reducing methane emissions with the additional benefit of improved live weight gains, and
— Are working with partners to develop a process of scaling the production of seaweed to meet global demands.

Publications

Northern Beef methane emissions

Charmley E, Williams SRO, Moate PJ, Hegarty RS, Herd RM, Oddy VH, Reyenga P, Staunton KM, Anderson A and Hannah MC 2016, A universal equation to predict methane production of forage-fed cattle in Australia, Animal Production Science, 56:169–180, http://dx.doi.org/10.1071/AN15365

Coates T, Flesch T, McGinn S, Charmley E and Chen D 2017, Evaluating an eddy covariance technique to estimate point-source emissions and its potential application to grazing cattle, Agricultural and Forest Meteorology, 234–235:164-171, https://doi.org/10.1016/j.agrformet.2016.12.026

Benvenutti M, Coates T, Imaz, A, Flesch T, Hill J, Charmley E *et al*. 2015, The use of image analysis to determine the number and position of cattle at a water point, Computers and Electronics in Agriculture, 118:24-27

McGinn S, Flesch T, Coates T, Charmley E, Chen D, Bai M *et al*. 2015, Evaluating dispersion modeling options to estimate methane emissions from grazing beef cattle, Journal of Environmental Quality, 44(1):97-102, https://doi.org/10.2134/jeq2014.06.0275

Tomkins N and Charmley E 2015, Herd-scale measurements of methane emissions from cattle grazing extensive sub-tropical grasslands using the open-path laser technique, Animal, 9(12 1):2029-2038, https://doi.org/10.1017/S1751731115001688

Gonzalez L, Charmley E, and Henry B 2014, Modelling methane emissions from remotely collected live weight data and faecal NIRS, Animal Production Science, 54:1980-1987

Henry B, Charmley E, Eckard R, Gaughan J and Hegarty R 2012, Livestock production in a changing climate: adaptation and mitigation research in Australia, Crop & Pasture Science, 63:191-202

Kennedy P and Charmley E 2012, Methane yields from Brahman cattle fed tropical grasses and legumes, Animal Production Science, 52(1):225-239

Savanna management

Cook GD and Meyer CPM 2017, Position paper on fuel accumulation in savannas, CSIRO, Darwin

Cook GD, Meyer CPM, Muepu M and Liedloff AC 2016, Dead organic matter and the dynamics of carbon and greenhouse gas emissions in frequently burnt savannas. International Journal of Wildland Fire 25, 1252-1263

Cook GD, Richards AE, Liedloff AC, Meyer CPM and Schatz J 2017, Carbon sequestration resulting from management of fires on the Tiwi Islands Final Report June 2017, CSIRO, Darwin

Robinson, CJ., James, G., PJ Whitehead, 2016. Negotiating Indigenous benefits from payment from ecosystem (PES) schemes, Global Environmental Change 28, 21-29

Robinson CJ, Renwick AR, May T, Gerrard E, Foley R, Battaglia M, Possingham H, Griggs D and Walker D 2016, Indigenous benefits and carbon offset schemes: an Australian case-study, Environmental Science and Policy 56, 129-134, DOI 10.1016/j.envsci.2015.11.007

[18] http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/cfi/indigenous-australians/icffrd.

FutureFeed

Machado L, Magnusson M, Paul NA, Kinley R, de Nys R and Tomkins N 2016, Dose-response effects of *Asparagopsis taxiformis* and *Oedogonium* sp. on in vitro fermentation and methane production, J Appl Phycol 28(2):1443–145, accessed on 5 May 2018 via https://link.springer.com/article/10.1007%2Fs10811-015-0639-9

Li X, Norman HC, Kinley RD, Laurence M, Wilmot M, Bender H, de Nys R and Tomkins N 2018, *Asparagopsis taxiformis* decreases enteric methane production from sheep, Animal Production Science 58, 681–688, http://dx.doi.org/10.1071/AN15883

Machado L, Magnusson M, Paul NA, Kinley R, de Nys R and Tomkins N 2016, Identification of bioactives from the red seaweed *Asparagopsis taxiformis* that promote antimethanogenic activity in vitro, J Appl Phycol 28:3117–3126, DOI 10.1007/s10811-016-0830-7

Kinley RD, de Nys R, Vucko MJ, Machado L and Tomkins NW 2016, The red macroalgae *Asparagopsis taxiformis* is a potent natural antimethanogenic that reduces methane production during in vitro fermentation with rumen fluid, Animal Production Science 56, 282–289, http://dx.doi.org/10.1071/AN15576

Kinley RD, Vucko MJ, Machado L and Tomkins NW 2016, In Vitro Evaluation of the Antimethanogenic Potency and Effects on Fermentation of Individual and Combinations of Marine Macroalgae, American Journal of Plant Sciences 7, 2038-2054, http://www.scirp.org/journal/ajps

Machado L, Kinley RD, Magnusson M, de Nys R and Tomkins NW 2015, The potential of macroalgae for beef production systems in Northern Australia, J Appl Phycol 27:2001–2005, DOI 10.1007/s10811-014-0439-7

Patents

FutureFeed

- WO2015109362 Method for reducing total gas production and/or methane production in a ruminant animal
- WO2018018062 Growth performance improvements in pasture and feedlot systems

Innovation / commercialisation

Northern Beef methane emissions

The dataset that was used to re-evaluate Australia's enteric methane emissions has been incorporated into a global database from individual beef cattle which will be published during 2018 in Global Change Biology.

Savanna management

On 1 May 2018 the Department of the Environment and Energy announced that the Minister had released two new ERF savanna fire management methods following their endorsement by the Emissions Reduction Assurance Committee. The two methodologies are linked, with the major innovation being the addition of carbon sequestration calculations to emissions avoidance calculations. This has required new science that is based on a sound understanding of fire ecology, vegetation ecology, combustion chemistry and the underlying mathematical relationships linking those processes. The new methodologies rely on algorithms developed as part of the Tiwi Carbon Project undertaken by CSIRO.

FutureFeed

CSIRO is developing a commercialisation pathway and business model with key industry partners to secure capital. This will ensure the scaling of seaweed production to deliver a cattle feed supplement to Australia and the rest of the world. FutureFeed participated in CSIRO's ON Innovation Acceleration program in 2016.

1.3.4 Project Outcomes

Northern beef methane emissions

The analysis of new data on methane emissions from forage-fed cattle led to a revision of the National Greenhouse Gas Inventory. The forage-based cattle industry has now been appropriately assessed for its share of Australian greenhouse gases, ensuring the sector is not unfairly represented in the National Inventory. The new data provides a baseline against which any future reduction in enteric emissions from cattle can be judged and will underpin future mitigation methodologies for cattle under the ERF.

Savanna management

CSIRO's savanna management work has provided the basis for a new draft carbon sequestration and emissions avoidance methodology. This methodology will have application across the northern Australian savannas. Data from the project was found to contradict a key assumption in the existing savanna burning methodology that fire patchiness is independent of fire frequency and varies only with fire timing. The two new methodologies will continue this achievement and substantially increase the benefit to landholders that take up the sequestration option.

FutureFeed

The direct outcomes from the use of FutureFeed will be a reduction in GHG (methane) emissions from cattle and higher farm productivity (because less feed will be converted to methane).

Currently red meat is losing market share to other protein inputs in developed countries. In part this is due to red meat's perceived environmental foot print. One outcome of this project may be support for retaining the current market share and retaining the red meat sector's social licence to operate.

Farmers who feed ruminant livestock with FutureFeed may become eligible for ERF credits.[19]

There are also likely to be indirect benefits, including creating employment in developing countries, and the use of seaweed to filter detrimental nutrients from rivers, or effluent from fish farms, as well the potential to support improved environmental outcomes via open ocean cultivation addressing ocean acidification.

1.3.5 Adoption

Northern beef methane emissions

The National Greenhouse Gas Inventory has been updated as a result of CSIRO work. The data provides a sound benchmark for the carbon industry, underpins the 2017 Beef Cattle Herd Management Methodology[20] and will facilitate future methodologies under the ERF.

Savanna management

The new approach to integrate emissions avoidance and carbon sequestration in a set of equations has been incorporated into the National Greenhouse Gas Inventory, supporting fulfilment of Australia's international obligations. The two new carbon farming methodologies are too recent to have been adopted by practitioners but based on previous experience should be widely taken up across northern Australia.

FutureFeed

FutureFeed is yet to be commercialised. It is anticipated that the first product will be supplied to market in 2020 with scale up to 10 per cent of Australian industry within 2 years. Parallel initiatives are anticipated in other global markets.

[19] Clean Energy Regulator undated, Reducing greenhouse gas emissions by feeding dietary additives to milking cows, accessed on 5 May 2018 at http://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Agricultural-methods/Reducing-Greenhouse-Gas-Emissions-by-Feeding-Dietary-Additives-to-Milking-Cows

[20] See http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/publications/factsheet-beef-cattle-herd-management and for the 25 May 2017 amendment see http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/methods/beef-cattle-herd-management

1.3.6 Impacts

Northern beef methane emissions

Assuming a carbon price of $13.08 (December 2017 ERF auction price) and a calculated reduction in emissions of 12.6 million tonnes, the value of this recalculation is $165 million per year which is no longer attributed to the cattle industry.

Savanna management

Savanna fire management Emissions Avoidance methods (which have drawn on earlier work by CSIRO and partners) applied in 78 project areas have led to 54 per cent of high rainfall savannas (>1000 mm rainfall) and 11 per cent of semi-arid savannas (600-1000 mm) being under carbon farming projects. The savanna zone in total comprises 15 percent of the Australian continent. The projects are making real differences to fire management in northern Australia with associated co-benefits for remote livelihoods and protection of biodiversity and infrastructure. To date over 4 million Australia Carbon Credit Units (ACCU) have been issued and 13.8 million Credit Units contracted. The issued Credits represent 9 per cent of all Carbon Credits issued under the ERF. Average prices per ACCU of about $10-$12 have created a new business opportunity for remote landholders in northern Australia. The addition of carbon sequestration to the Emissions Avoidance calculations could see a trebling in the value of this work in terms of both GHG benefit and cash value.

The Head of the Climate Change Division at the Department of Environment and Energy has commented:

I am delighted the two new Emissions Reduction Fund savanna fire management methods have been endorsed by the Minister for the Environment and Energy, the Hon Josh Frydenberg MP. The making of these methods is the culmination of many years of work.

On behalf of the Department of the Environment and Energy, I would like to sincerely thank you for your substantial contribution to the development of these methods, and in advancing our knowledge of fire behaviour and carbon accounting. Your collaboration with the Department on this work has provided an opportunity for science to be directly translated into policy. It has been a challenging environment in which to work and we appreciate this is so often the case in areas of relatively new science and innovation. These methods will make an important contribution to reducing Australia's greenhouse gas emissions and meeting our international climate change targets. They will also provide many social, cultural, economic and environmental benefits.

FutureFeed

If 10 per cent of Australia's feedlot and dairy cattle were fed this product, Australia's GHG emissions would be reduced by 3 million tons. The estimated Australian market for this product could be around $60 million. The global market is estimated to be 100 times larger than the Australian market.

1.4 Counterfactual and Attribution

1.4.1 Counterfactual

Northern beef methane emissions

If this work had not been undertaken the environmental cost (determined as the current carbon price) of methane emissions for the forage-fed cattle industries would be $680 million per year as opposed to $516 million.

Savanna management

If this work under the Tiwi Carbon Project had not been undertaken, carbon sequestration in the dead organic matter pool would not have been included in the savanna carbon farming methodologies and the National Greenhouse Gas Inventory would not have been updated to include this component. The potential for substantially increasing return for effort for remote landholders in northern Australia would not exist. The identification of an important source of additional net savings in Australia's GHG budget would not have happened.

FutureFeed

In the absence of FutureFeed, the next best methane reduction feed supplement gives a 30 to 50 per cent reduction with as-yet unquantified productivity gains at a current cost of $5 per animal per day.

1.4.2 Attribution

Northern beef methane emissions

The review of methane emissions was based on data provided by the Victoria Department of Economic Development, Jobs, Transport and Resources, the NSW Department of Primary Industries and the University of New England. The research that supported the analysis was funded through the Reducing Emissions from Livestock Research Program and National Livestock Methane Program, both coordinated by MLA and co-funded by the Australian Government and MLA. The attribution to CSIRO for the outcomes of this work is 80 per cent.

Savanna management

The work undertaken in the Tiwi Carbon Project would not have been possible without the strong support of the Tiwi Land Council, the Tiwi Land Rangers and the Tiwi Plantations Corporation. They provided strong logistic support to the implementation and maintenance of the fire experiment on the Tiwi Islands. The attribution to CSIRO of this work is 90 per cent. The work built upon an extensive body of research undertaken by CSIRO, Charles Darwin University, Northern Australian Indigenous Land and Sea Management Alliance and others.

FutureFeed

MLA supported a feeding trial. James Cook University collected seaweed for trials on a full cost recovery basis. The attribution to CSIRO for the outcome of this project is 80 per cent.

1.5 Evaluating the Impacts

1.5.1 Cost-Benefit Analysis

Costs

Based on the cost information shown in **Table 1.1**, **Table 1.2**and **Table 1.3**, the present value of the R&D costs of the Northern Beef Methane Emissions, Savanna Management and FutureFeed projects are $0.04 million, $1.49 million and $2.57 million in 2017/18 dollars respectively under a 7 per cent real discount rate.

Benefits

Northern Beef Methane Emissions

The results of this project showed that Australia methane emissions from cattle were found to be 24 per cent lower than previously estimated, equivalent to 12.6 million tonnes of carbon dioxide a year. This is a saving on paper only, as these savings would have been sought from outside the agriculture sector if the recalculation had not been undertaken, possibly at a higher resource cost to Australia. ACIL Allen does not have sufficient information to accurately estimate the net benefits from the recalculation.

Savanna Management

According to DoEE[21], 4.11 million ACCUs are expected to be issued cumulatively by the end of 2017-18 from a total of 78 savanna projects, under the *Carbon Credits (Carbon Farming Initiative) Act 2010*. On average, since 2013-14, credits associated with CO_2-e savings of 0.91 MT have been issued each year in relation to savanna management.

CSIRO researchers believe that the results of the savanna management research project will enable the number of credits issued each year to triple. This is likely lead to 1.82 MT of additional CO_2-e savings each year from 2018/19 onwards, which is worth $18.2 million a year assuming a carbon price of $10 per tonne of CO_2-e.

FutureFeed

To estimate the benefits from the FutureFeed research project, ACIL Allen has made the following assumptions / adopted the following parameter values:

- Australian lotted cattle marketings: 2.7 million heads per year
- Average duration in the feedlot: 120 days

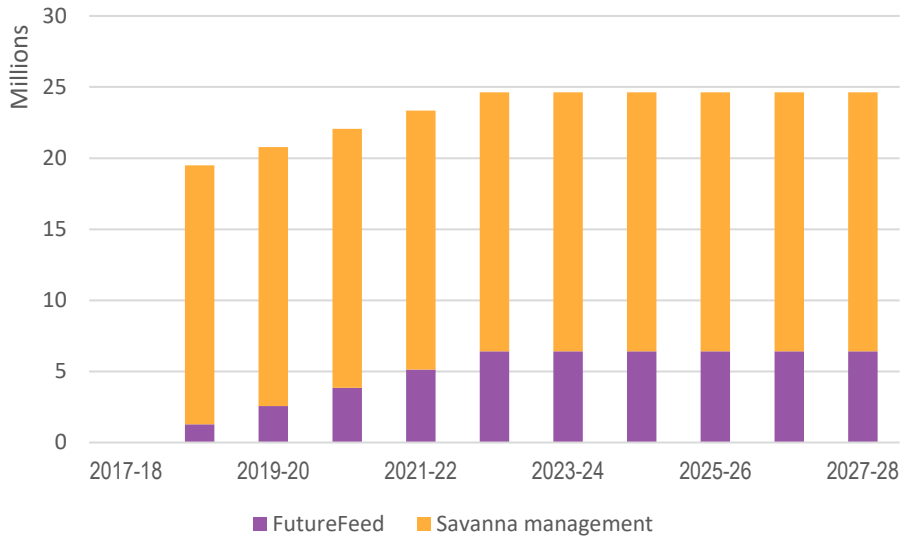
[21] See, for example, the DoEE presentation "Emissions Reduction Fund – Savanna Fire Management Determinations: Sequestration and Emissions Avoidance, and Emissions Avoidance only"

- Methane currently emitted per head of cattle at the feedlot: 118 grams per day
- Methane to CO_2-e conversion factor: 28
- Reduction in methane emission at the feedlot due to FutureFeed: 90 per cent
- Reduction in methane emission at the feedlot due to best alternative to FutureFeed: 30 per cent
- Proportion of Australian feedlots adopting FutureFeed: 20 per cent in 2018-19, 40 per cent in 2019-20, 60 per cent in 2020-21, 80 per cent in 2021-22 and 100 per cent from 2022-23 onwards
- Carbon price: $10 per tonne of CO_2-e.

A simplifying assumption is made that FutureFeed and its next best alternative are priced identically, have the same adoption rate and have the same impact on cattle growth rates. They differ only in the magnitude of methane emission reduction in feedlot cattle.

The estimated annual benefits of the Savanna Management and FutureFeed research projects are shown in **Figure 1.2**. These figures, in 2017-18 dollars are ACIL Allen estimates.

FIGURE 1.2 BENEFITS OF SAVANNA MANAGEMENT AND FUTUREFEED RESEARCH PROJECTS, 2017-18 TO 2027-28 (2017-18 DOLLARS)



SOURCE: ACIL ALLEN CONSULTING

Assessment of benefits against costs

The results of the cost-benefit analysis are summarised in **Table 1.4**.

TABLE 1.4 COST-BENEFIT ANALYSIS RESULTS

Project	PV (costs) $m	PV (benefits) ($m)	NPV $m	BCR
Northern beef methane emissions	0.04	Not quantified		
Savanna management	1.49	119.47	117.97	79.99
FutureFeed	2.67	51.38	48.71	19.24
Both projects	**4.20**	**170.85**	**166.65**	**40.66**

SOURCE: ACIL ALLEN CONSULTING

Sensitivity analysis

There are too many assumptions and potentially unknown factors involved in these projections to undertake a credible sensitivity analysis.