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Demonstration projects for on-farm practical methane management strategies: UWA Ridgefield

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Abstract:

There has been considerable investment nationally and internationally in research to reduce methane emissions from livestock. Until the late 1990s this has largely been directed at incremental increases in productivity, recognising that methane essentially represents energy lost from production systems, and adoption has been market-driven. However there has been no large breakthrough and there are currently no practical, cost-effective technologies or practices that give a substantial reduction in emissions while maintaining productivity. The Reducing Emissions from Livestock Research Program aims, through an integrated Research, Development and Demonstration program, to achieve the Australia's Farming Future outcome: Primary producers are equipped with the knowledge, tools and strategies to manage their emissions including the ability to respond to the commercial imperatives arising from emissions trading. In order for the Program to show that research outcomes can be developed for commercial applications, and to promote uptake by the industry, demonstration sites have been used to engage with livestock producers and ensure that the research is directed to practical on-farm practices and measures. Livestock production systems in Australia are highly varied and the most effective abatement measures will likely vary between different production systems. UWA Future Farm, Ridgefield, was one of the regional sites established as part of the Program to ensure commercial applications and to promote farmer acceptance and adoption. We held two key field days during the programme and engaged with producers through key State Agricultural field days, university open days and local producer groups. We also ensured that some of the research activities within the Program were being undertaken on the Future Farm to make the field days relevant.

Executive summary:

General background

UWA's future farm

At the beginning of 2009, UWA purchased 'Ridgefield', a farm near Pingelly in WA. Ridgefield is located 25 km north-west of Pingelly, itself 158 km south-east of Perth. Pingelly is on the western edge of the Central Wheatbelt and is a region of mixed farming enterprises (average annual rainfall = 450 mm). It also borders Boyagin Rock, a large native natural reserve. UWA commenced developing Ridgefield into a research facility with a difference from the time of purchase and the entire farm is being treated as a project. The vision is to take a multidisciplinary approach to its development with a view to establishing a farm according to what is likely to suit the needs in 2050. UWA Future Farm is run for non-profit purposes but it is financially independent, including management of salaries and the costs of maintenance, with income streams generated from on-farm enterprises: crop production, animal production, carbon sequestration and the provision of resources for scientific research. It also serves as a major link between research and industry and between UWA and the rural community (local, Australia-wide, international). Management decisions about production, natural resources and infrastructure are based on best-practice principles and the infrastructure, wherever possible, incorporates the latest in designs and materials, within budget constraints. As such, UWA Future Farm provides a site for monitoring the flow-on effects of innovative farm design and practises on the environment, biodiversity and productivity. All of the animal production research undertaken in the School of Animal Biology falls under the *Clean, Green and Ethical* banner and this banner has been extended to cover all on-farm activities, including design of farm buildings, energy and water usage, animal and crop production, and landscape and fringe ecology. In order to realise this vision, we have enlisted the collaboration of a number of experts from a range of Faculties on campus (e.g Architecture, Electrical and Environmental Engineering, Natural and Agricultural Sciences) as well as outside (DAFWA, CSIRO, DEC).

The opportunity for RELRP

One of the key reasons for purchasing the property was to enable us to look at farming systems and support systems-based research. We started with a blank page which gave us the opportunity to benchmark the farm (after >50 years of traditional farming practice) and then monitor the effect of changing management practices over time (toward 2050). The changing management practices stem from the results of our research on the farm as well as changes in thinking nationally and internationally about livestock/cropping systems, land use, and biodiversity in the face of consumer pressures and climate change. Carbon is the overarching factor that links all of the enterprises and activities on the Future Farm Project and our mechanism for benchmarking and monitoring change over time. Flow/cycles of other nutrients (and water) on the farm will also be monitored over time but the whole farm C budget will be a driving factor for change and assessment. As such, The UWA Future Farm 'Ridgefield' offered a unique site to demonstrate to producers, advisors and other scientists where the DAFF-MLA research programme fits into the bigger picture around the Carbon Farming Initiative.

As a demonstration site, UWA Future Farm 'Ridgefield' offered an ideal platform to use general farm field days and specific project field days to provide information and demonstrate options for producers to integrate the various mitigation and adaptation strategies that fell under the Climate Change Reduction Programme and, in particular, RELRP. It was not possible to have every research project under the MLA_DAFF umbrella represented at UWA Future Farm (eg. cattle work), but information from the national RELRP

programme and the other demonstration sites could still be presented at the field days. This report covers the communication events that took place by year during the project, the research programmes within RELRP that had physical representation at the demonstration site as well as non-RELRP projects that were related to DAFF goals around methane mitigation and adaptation to climate change, and the media coverage the site attracted during the

Section 1. Field days coordinated at UWA Future Farm Ridgefield

(Link to Appendix 1 – 7, 13, 14)

The two most significant field day events we held during the project were at UWA Future Farm Ridgefield. We held one in October, 2010 “Coping with Climate Change” and another in October 2011 “Whole-farm Carbon Emissions”. A summary of these events is provided below with more comprehensive reports provided in Appendices 1 and 2.

“Coping with Climate Change” Field Day 2010 (Appendix 1)

We organised the “Coping with Climate Change” field day at the Ridgefield demonstration site in Pingelly on October 1, 2010. This was the first major field day organised for the demonstration site. The objective of the field day was to showcase the Reducing Emissions from Livestock Research Program (RELRP) as part of DAFF’s Climate Change Research Program, which was the obvious focus for the day. However, we took the opportunity to link to a number of other projects that have been initiated at Ridgefield that were also funded through Australia’s Farming Future Climate Change Research programme; for example, increasing soil carbon and decreasing nitrous oxide, as well as the projects funded under the Phase II DAFF program (C-conscious, drought-hardy fodder shrubs and NAMI projects), the reforestation project for the farm’s non-arable land (Men of the trees) at Ridgefield and the DAFWA Centre of Excellence program developing sheep that are more resilient and can adapt to climate change. In addition, ‘ALVA House’, a newly designed house with a vision for energy efficiency for the farm infrastructure by UWA’s Faculty of Architecture, Landscape Architecture and Visual Arts (ALVA), through the Advanced Timber Concepts Research Centre, in collaboration with Optimum Resource Architects and the UWA School of Electronic & Computer Engineering was also presented on the day.

The field day was advertised widely on Rural Radio Program (Albany) and newspapers (Farm Weekly, Countryman, Narrogin Observer and local newspapers, Pingelly Times and Brookton Telegraph), along with a programme and flyer (Appendix 3) that was sent to funding bodies involved in the various projects that have been initiated (DAFF, DAFWA, GRDC, NAMI, MLA), as well as farmer groups including the following; Grower Group Alliance, Facey group, Kondinin Group and Rural advisors (Landmark, Elders, Farmworks, PlanFarm, Farmanco, Consult Ag) and other researchers. Representatives of each of these organisations were present at the field day.

The Institute of Agriculture (IOA), UWA organized the ‘opening’ of the day. Professor Robyn Owens (The Deputy Vice Chancellor of UWA) and the Honorable Philip Gardiner (MP) opened the day and expressed the commitment of the University and state government to the initiatives at Ridgefield. Assoc. Professor Vercoe introduced the main aim of the day as well as an overview of the RELRP program and the various activities that have been initiated at Ridgefield and that are linked to RELRP and more generally to the CCRP.

In summary, over 83 people attended the field day (not everyone filed through the registration desk), which could be ‘broken down’ further into the following categories:

VIP guest & External Advisory Board of IOA	13
Grower/producer	19
Funding bodies (GRDC, DAFF, FFI CRC, State Gov)	8

Scientist (CSIRO, DAFWA)	34
Student	7
Journalist	2
Total	83

The results from the surveys that were handed to the participants on the day are provided in Appendix 1. Photos of the day are provided in Appendix 13 and the field day was written up in the Institute of Agriculture Newsletter (see [Appendix 14](#)).

“Whole-farm Carbon Emissions” Field day 2011 - (Appendix 2)

The objective of the day was to showcase the Reducing Emissions from Livestock Research Program (RELRP) and share the results from UWA research projects that are related to green house gas mitigation and adaptation. The focus of the day was whole-farm carbon emissions and their measurements. The programme for the day was advertised widely in rural newspapers and using the same networks as we reported above (field day in 2010; Appendix 4), but we focused on trying to get as much radio coverage as possible, based on comments and feedback we had received from the first field day. We also linked it to an RELRP technical meeting so that other members of the RELRP team could be on hand to interact with WA producers. Over 150 people attended the field day.

Assoc. Professor Vercoe outlined the carbon emission programs in place at the UWA Future Farm “Ridgefield” and provided an overview of the day, which featured eight presentations and the visit to 2 demonstration sites. A number of presentations were given in Avery shearing shed and some others were given ‘on site’ demonstrations and presentations about the latest technology and findings about reduction and measurement of on-farm emissions at specific locations around Ridgefield. This format allowed attendees to chat with the researchers in smaller groups. The day finished with brief summary and BBQ to allow further discussion amongst attendees.

The main presenters at this field day were:

- 1) Professor Ross Kingwell (Chief Economist DAFWA/UWA) who has been involved in the development and delivery of farm modelling at UWA Ridgefield farm. He showed the results from his work on the modelling, carbon markets; emissions trading and how a carbon price would affect farm profitability.
- 2) Mr David Cattanach (a Nuffield Scholar from NSW) who was the first farmer to audit carbon emissions on a whole-farm scale. He is currently part of the Climate and Primary Industries working group in NSW and a participant in the Climate champions programme. He shared his experiences with measuring carbon emissions on his farm that have been a useful tool for him to identify areas of inefficiency and have pointed the way on how to improve them.
- 3) Dr Frances Philips (Wollongong University) who has been involved in the latest methods of in-field methane direct measurement from sheep and benchmarking at the Ridgefield farm. Dr Phillips and her team demonstrated the latest practical technology of in-field measurements of methane production from sheep using OPFTIR.
- 4) Dr Dean Revell (Principle Scientist, CSIRO Floreat) discussed drought-hardy carbon conscious grazing systems. He urged farmers to have a better look at better stock feeding systems during the challenge of variable climate that has had a large impact on WA crop and animal production.
- 5) Associate Professor Andrew Thompson (DAFWA & Murdoch University) who manages several projects within the Sheep CRC to better understand the

interactions between genetics and the production system. He talked about improving the efficiency and resilience of sheep through genetic selection and flock management.

- 6) Assistant Professor Ken Flower (the no-till project, UWA) spoke on the comparison of soil water and nitrous oxide emissions after different crop sequences.
- 7) Dr Michael Perring (Ecosystem Restoration and Intervention Ecology Research Group, UWA) who is conducting a long-term and large-scale field experiment at Ridgefield farm, looking at how different species mixtures may affect ecosystem function and services such as carbon storage, nutrient cycling, invasion resistance and prevention of soil erosion at UWA Future Farm Ridgefield. He talked about (re-)storing carbon and other ecosystem services through planting native species.
- 8) Mrs Laura Fagan and her team (IPMS group, UWA) talked about integrated pest management (IPM) in Australian grains.

The powerpoint slides presented on the day and the speaker notes handed out on the day are provided in Appendices 5 and 6.

150* registered participants can be broken down into the following groups;

Farmer	40
Industry/government partner (RELRP, Farm Advisory Board, FFI CRC, GRDC, State Gov)	34
Researcher (CSIRO, DAFWA, UWA, other institutions)	40
Ag consultant/educator/journalist/commercial sector	15
Student	10
Speakers & organizers	11

*these are the official numbers but there were a number of people who did not register officially on the day.

Organisation/concept

RELRP and the UWA Institute of Agriculture (IOA) issued invitations to a range of producers, Industry/government partners, researchers and non-commercial people that they felt would be interested in the issue of "Whole-farm carbon emission" at Ridgefield. We were also conscious that the people we invited were aware of carbon emission issues.

Judging from the responses to the survey (see below), the participants were particularly grateful for this opportunity to participate in a program – and at no cost to them other than their time. The day engaged producers, academics and consultants in the agriculture industry in the issue of carbon emissions on farm, as a whole. It helped demonstrate impacts of abatement measures and gave producers ways that could reduce the greenhouse gas emissions and improve their farm efficiency. This field day was indeed extended national awareness of the research activities of RELRP.

The engagement of local community groups to manage the catering was also an important consideration, as it increased the understanding and interest of the program within the shire.

Survey

A survey was conducted at the end of the day. The data presented in this report is extracted from the survey returns. The full survey including the demographics of questionnaire respondents and recommendations about how to improve the day is provided in the complete report provided in **Appendix 7:**

In Summary

We had very positive feedback from the attendees at the field day. There was double the number of attendees compared to the field day we held in 2010, which we feel reflects the changes we made based on feedback from the first field day, the timing of the day, as well as the interest generated from the first field day stimulating conversations and interest around the shire.

People commented on the informative and useful information supplied. The variety of topics and the level of engagement were high and all speakers of the field day were praised (average score of how informative the presentations were: 3.7 out of 5). The overall rate of satisfaction with the field day was high, average score of 7.6 out of 10 (range 2 -10). When the rating scores for each issue were broken down we found that:

- 90% of respondents rated the usefulness of information supplied was high, average score of 7.6 (range 5-10)
- 50% of respondents rated the topics discussed on the day as highly relevant to the farm business, average score of 7.6 (range 6-10).
- 66 % of respondents rated the information received on the field day and answering the questions about whole-farm carbon emission was high, average score of 7 (range 2-10).
- 86 % of respondents rated the overall benefit of the field day as high or very high, average score of 8 (range from 5-10).
- 80 % of respondents rated the management of the field day as good, average of 7.6 (range 2-10).

Among all participants, the producers acknowledged the day had been highly relevant to their farm business with an average score of 8.4 and highly beneficial with an average score of 8.1 (out of 10; range from 6-10). Other participants found the field day great and interesting, although it was rushed due to a late start and having too many presentations in half a day. Almost 50% of respondents suggested that time management could be improved. The project leader takes full responsibility of this problem and was in fact one of the main contributors to running over time.

The UWA Future Farm itself lifted the interest/curiosity from locals and regional community. The local community supported the day and the style of bringing information to them was certainly appreciated. The attendees were particularly grateful for this opportunity to participate in the field day – and at no cost to them other than their time.

Section 2. Dowerin field days – August 2010 and 2011

(Link to Appendix [8, 9, 14](#))

Dowerin Field Day, August 25 and 26, 2010 (Appendix 8)

The Dowerin Field Day is one of the biggest Agricultural field days in Australia and is held in August each year. We targeted the Dowerin Field Day for engaging with the community about RELRP and the demonstration site because it attracts over 40,000 producers/advisors/grower groups over the two days and over 500 exhibitors, ranging from farm machinery companies to exhibits that are specifically targeted towards educating primary and secondary school students from country schools about current issues facing agriculture and employment/career opportunities in agriculture. In both 2010 and 2011 we were part of the DAFWA station that included a variety of DAFWA initiatives as well as other groups, for example, Landcare, the Institute of Agriculture UWA and our own exhibit of the DAFF-CCRP program. Our booth contained posters of the RELRP program, a display of rumen microbes, both 'live' under the microscope and as a video display in the background, a display of *Eremophila glabra* seedlings to advertise the 'bioactive' project and the field site that is being established at Pingelly, as well as information and displays about the soil carbon and nitrous oxide programs that are also funded through the Australia's Farming Future Climate Change Research Programme. We scheduled the field days at the demonstration site at the UWA Future Farm Ridgefield in October of each year and used the Dowering field day as a platform for publicising the event.

We did not conduct our own survey for feedback on the display because DAFWA had a generic survey about their exhibit. A full evaluation and feedback report about the exhibit compiled by the DAFWA coordinating group is provided in Appendix 8 (2010) and 9 (2011). Both surveys reflected the general positive interaction we had with a number of producers over the two days.

In 2010, it was stated that our exhibit was popular because we had set it up to invite the public to walk into areas through interactive displays (ie. a display of live rumen microbes on microscopes, DVDs were played non-stop and *Eremophila glabra* seedling samples were on display). Briefly, on average, 76 visitors were in the DAFWA Shed at any one time over the two days (around 35 visitors were at the RELRP booth). About 30% said their awareness of the diversity in the agricultural/ food sectors had increased, and almost 60% had an increased awareness of new and improved agricultural technologies and/or regulations. About 30% said their awareness of the diversity in the agricultural/ food sectors had increased, and almost 60% had an increased awareness of new and improved agricultural technologies and/or regulations. Looking and learning about climate and weather predictions and being able to discuss the type of research that was being done were among things mentioned most by visitors as being 'what they liked most about their visit'. This indicated to us that we had engaged successfully with the focus audience at this field day.

A similar survey was undertaken in 2011 and a summary of that report is provided below. The full report is provided in Appendix 8 (prepared by Rebecca Heath, DAFWA) and any media releases are provided in Appendix 14.

The message the Department of Agriculture was trying to deliver was 'Futures in Agriculture' (3-year theme since 2009). After visiting the DAFWA display at the Dowerin Field Day, the target audiences reported that they had greater awareness of:

1. the agriculture and food sector, and its diversity;
2. careers in the agriculture and food sector; and

3. new and improved agricultural technologies and regulations.

Within the DAFWA 'shed' there were 15 Department exhibits and 7 external exhibits of which one was of the RELRP and the demonstration site. Over 70% of the visitors to the DAFWA exhibit spent more than 10 minutes in the DAFWA shed, and more than 50% of these people spent more than 15 minutes within the shed. Ninety-seven percent of the respondents enjoyed their visit to the DAFWA exhibit (3% were 'unsure'). On average, more than half the visitors that were at a display were in discussion with exhibitors at any one time and more than one third of the questionnaire respondents had learnt something new from visiting the DAFWA exhibit. Of these, three-quarters indicated that the new learnings were relevant to

them. Almost 70% of respondents indicated that their awareness of the diversity in the agricultural/food sectors had increased (compared to 10% in 2009; 30% in 2010). Almost 70% of respondents had an increased awareness of new and improved agricultural technologies and/or regulations. Just under 60% of respondents indicated an increased awareness of the potential agricultural/food careers after visiting the DAFWA exhibit (20% in 2010). About 60% of the respondents made the effort to specifically visit the DAFWA exhibit because they either wanted information on a specific topic or wanted to see what was going on at the Department. The majority (80%) felt the broad range of information and the great learning environment was what they liked best about the DAFWA exhibit. The DAFWA exhibit was unanimously well received by the 268 questionnaire respondents.

Section 3. Other engagement with producers, regional groups, young scientists and farmers

(Link to Appendix 10 & 14)

UWA Open Day and Parents Welcome

The RELRP research projects and UWA Future Farm demonstration site were key displays within the Faculty of Natural and Agricultural Science exhibits at the University of Western Australia, Open Day on August 19 (media releases, Appendix 14).

Presentations to catchment councils, regional groups, policy makers and young scientists

The project leader has been invited to give presentations about RELRP and the RELRP demonstration site at Ridgefield at a 'Carbon workshop' organised by the Northern Agriculture Catchment Council (March 2011, in Moora, WA). The other speakers included Euan Beamont who spoke about the Carbon Farming Initiative, and Ben Keogh from Australian Carbon Traders, who spoke about the carbon market. Dr Vercoe also gave a presentation about the demonstration site at the government/industry event held in Canberra in March 2011.

As part of the initiative to get greater interaction between the demonstration sites within the national programme, the project leader attended the field day that was held at the Lansdown demonstration site in Townsville in May 2011 and provided posters about the Ridgefield site and RELRP projects for that day. He also participated in the field day held at the Hamilton demonstration site in Victoria, in October 2011. The field day focussed on the role of efficiency in mitigating methane and Dr Vercoe presented a talk on 'Reducing emissions from livestock: it's all about efficiency'. A report on the success of both the Lansdown and Hamilton field days will be provided in the final report for those projects (media releases, Appendix 13 and in final reports for the other demonstration sites).

Farmer forum 'Roadshow' (Appendix 10)

Vercoe participated in a farmer forum 'roadshow' that ran during March and April (WA, NSW, SA). His role in the roadshow was to introduce the RELRP program and then talk more specifically about the antimethanogenic bioactivity work of RELRP and the demonstration site. A total of 6 forums were held (2 in WA, 1 in NSW and 3 in SA) between March 7 and April 9, 2011. A final summary of the feedback surveys that were handed out at each forum is provided in Appendix 10. We spoke to over 120 attendees during the roadshow of which 70% were producers. The survey used a scale of 1-6, with 1 representing 'not beneficial' and 6 representing 'highly beneficial'. Judging from the feedback, the forums that were held were successful and the response to the section on RELRP/bioactive plants was very positive.

Section 4. RELRP activities at UWA Future Farm 'Ridgefield'

([Link to Appendix 11 & 12](#))

The Ridgefield demonstration site has had a direct link to four key RELRP programs: BCCH1012, BCCH1015, BCCH1036 and BCCH1080.

Understanding the mechanism behind the antimethanogenic bioactivity of Australian plants in grazing systems (BCCH1012 and BCCH1036)

The aim of this project is to investigate the antimethanogenic properties of particular native species of shrubs. We planted 1200 seedlings of *Eremophila* at the demonstration site at Ridgefield in August 2010 to produce enough biomass for testing the plant *in vivo* in an animal house experiment in 2012 (December milestone report, 2010). Although the shrubs are drought tolerant, we had to set up dripper irrigation for the plants because Pingelly, like most of south west of WA, had one of its driest seasons with record periods of continuous days over 30°C. We monitored and nursed these plants through this period. We also wanted the plants to grow as rapidly as possible so there would be sufficient biomass for experiments scheduled for later in the project. We conducted measurements to determine the duration and timing of irrigation that would be most water-use efficient. The bulk density and moisture holding capacity of the soil was calculated and collated into a moisture retention curve. This curve was used to match the water holding capacity of the soil to the permanent wilting point of the plants. Using this information we determined that shrubs needed to be watered weekly during summer because of high evaporation rates and low water holding capacity of the soil. Rabbit-proof fencing was erected around the site to minimise the likelihood of damage to the seedlings through grazing.

We harvested the *E. glabra* for the *in vivo* chamber experiment when we estimated that there was enough biomass to do the chamber study. The plants were air-dried and are currently being fed to sheep in the animal house and methane measurements are being made. A full report of the outcomes from this work is presented in the final report for BCCH1012. Photos of the plants from planting through to harvest are provided in [Appendix 11](#).

Breeding for low methane emitting sheep (BCCH1015 and BCCH1036)

Over 2500 sheep were screened to estimate genetic parameters for methane production within the BCCH1015 project 'Breeding for low methane emitting sheep and elucidating the underlying biology'. One hundred and fifty of the highest and lowest emitting sheep from the 1500 that were screened for methane production using the short-term booth method in the first year of the project were kept at 'Ridgefield'. These animals had also been screened for Net Feed Intake. The animals were kept at Ridgefield because we wanted to use them to examine in more detail the underlying biology behind the high and low emitting animals as well as in grazing experiments to measure methane in-field using the OPFTIR ([Appendix 12](#)). Some rams were kept from those screened to initiate high and low methane lines of animals on the farm.

A grazing experiment was established in 2011 with the aim of confirming the results from some of our *in vitro* data by quantifying methane emissions from sheep grazing a range of pastures selected as high and low methanogenic potential based on the *in vitro* results. We (Durmic *et al.*) identified a 40 to 50% range in the methanogenic potential between 15 commercially available pasture species (preliminary screen *in vitro*). For these *in vitro* differences in methanogenic potential to translate to benefits at a farm-scale, the consumption of these pastures by grazing livestock must lead to measurable reductions in

methane production. We used the 150 animals from BCCH1015 to graze pastures of 4 commercially available species we had established in autumn/winter (Bladder clover, Biserrula, Subclover, French serradella). We grazed them in spring and measured daily methane production using the off-pasture, portable accumulation chambers on all 5 species and OPFTIR on one of the five species as well as the control or 'standard' Ridgefield pasture for comparison. A preliminary analysis indicated that methane production from Bisserrulla was 25% lower than subclover, but that this was probably due to differences in intake as there were no differences in methane production per kg liveweight change between pasture types. We have food-on-offer and nutritive value data that we are currently incorporating into the analysis. There was still a range of more than 30% in methane production per kg liveweight gain for sheep grazing different annual legumes. It is clear that significant potential exists to reduce total methane production by 20% or more by grazing different legume pastures, but the impacts on animal production and whole farm profit need to be determined to inform development of CFI methodologies based on changing pasture type. The data from the OPFTIR campaign will be reported in the final report for **BCCH1036** (Dr Frances Phillips).

Modelling C in livestock systems: modelling options for net carbon balance (BCCH1080)

A modelling initiative was initiated across all of the demonstration sites in the RELRP program. Professor Ross Kingwell modelled Ridgefield using the MIDAS model. A full report on the modelling exercise is available in the final report for BCCH1080. The executive summary is provided below.

Precautionary principles suggest that lessening global emissions of greenhouse gases is necessary if projected adverse impacts of human-induced climate change are to be lessened or avoided. In support of such precaution the Australian Government has introduced two policy initiatives known as the Carbon Pricing Mechanism (CPM) and the Carbon Farming Initiative (CFI). The joint purpose of these policies is to use a market-based mechanism to price and limit greenhouse gas emissions in Australia and to encourage activities that abate or sequester emissions.

Both policies will generate a range of economic impacts, including impacts on farming systems and land use in rural regions. This study uses representative farm-modelling to investigate how typical mixed enterprise farming systems in the central wheatbelt of Western Australia (WA) may be affected by the CPM and CFI policies.

Under the CPM, Australia's 500 or so biggest emitters will have to pay for their emissions. The emissions price will be \$23 per tonne of CO₂-e, starting 1 July 2012, and increasing by 2.5 per cent in real terms per year until 2015 when a market-based floating price commences. There are 75 large emitters in WA who will face emission payments and a further 45 firms operate nationally. To varying degrees these firms will pass on the costs of their emission payments to the users of their products and services.

A proportion of these customers in turn will pass those costs further along their particular business supply chains. Often farmers are residual claimants, being in a weak bargaining position where they are unable to pass-on much of their higher costs of production to purchasers of their products. As price-takers farmers will pay slightly more for producing their commodities, yet have no price-offsetting movements in the prices they receive, at least in the short-term.

Another ramification for farmers, arising from implementation of the CFI, is the possibility that some large emitters may seek offset options from which some farmers may benefit. These offset options entail activities such as tree plantings that sequester carbon. Farmers will be paid either through undertaking these abatement options themselves or through provision of their farmland for sequestration projects.

Emissions of mixed enterprise farming systems in WA's central wheatbelt depend principally on the number of sheep carried and the area of nitrogen-fixing pastures that underpin the farming system. A case study west Pingelly farm of 1305 hectares that allocates 20 per cent of its area to crops annually generates around 2750 tonnes of CO₂-e. Around 90 per cent of its emissions come from its sheep and nitrogen-fixing pastures. By contrast if three-quarters of the farm area is devoted to crops then annual emissions are only 1500 tonnes of CO₂-e. However, farm emissions are not subject to emission payments under the CPM.

The CPM nonetheless does introduce additional costs to farmers through the pass-through cost consequences of the policy. The impact of the direct and indirect costs associated with the CPM is to initially slightly increase farm costs (typically by less than 1.5 per cent) and, after heavy road haulage forms part of the CPM from July 2014, then farm costs are liable to increase by around 3 per cent leading to a decrease in farm profit by 6 to 8 per cent.

Regarding the CFI, its initial possible impact on farm businesses is liable to be through use of farmland for carbon storage through plantation forestry and environmental plantings. However, these options are found to be economically attractive only at very high prices for emission permits for the particular case study farming systems investigated in this report. Use of farmland for agriculture is found to be the preferred and most profitable competitive use of the land in the region examined. For returns from carbon storage in tree plantings to match those from farming requires prices for carbon credits to be consistently above \$60 per tonne of CO₂-e. Or additional payments to farmers for related services associated with environmental plantings such as biodiversity and habitat creation need to be provided that equate to a carbon credit price consistently above \$60 per tonne of CO₂-e.

The nature of WA soils and the projected adverse change in climate in coming decades in south-west WA suggests that carbon storage in soils may remain a technical and economic challenge. Ensuring the permanence of any build-up in soil carbon is a challenge in a warming and potentially drying environment.

The reduction in methane output from sheep remains a possibility rather than a reliable actuality. Much of the research into sheep genetics regarding emissions and the scope for use of anti-methanogenic shrubs remains in its infancy

A list of other activities related to methane mitigation and adaptation:

- The other DAFF activities (the reforestation project for the farm's non-arable land and a second DAFF project, the National Adaptation and Mitigation Initiative (NAMI) drought-hardy carbon-conscious grazing systems (DAFF Phase 2)) are ongoing programs on Ridgefield.
- NAMI project (DAFF, GRDC and DAFWA) - in 2010 plots included the various rotation/crop sequence options for wheat and canola, and in the second year (2011) only wheat will be sown on all plots and two nitrogen rates applied as subplots. So, wheat and canola from last year have been harvested and wheat only will be sown in May, 2 different rates of N fertiliser will be applied (at 0 kg N ha⁻¹ & 60-80 kg N ha⁻¹). Soil mineral nitrogen (from soil cores) prior to sowing and post harvest and plan to do nitrous oxide measurement on selected treatments.

- The WA State Centre of Excellence for Innovative Technologies and Capacity for Sheep Industry Development in Western Australian (DAFWA/Murdoch) initiated their Resilient Sheep Production Systems program at UWA Future Farm. The project is linked closely to the work on breeding for lower methane emitting sheep (BCCH1015). The DAFWA work has a particular focus on improving the efficiency and resilience of sheep through genetic selection and flock management and the role it may play in reducing emissions intensity.
- A weather station was also installed and is operational.
- Soil mapping and GIS mapping of the farm has commenced and our benchmarking related to the flow in nutrients was initiated through this project

Section 5. Media coverage

The demonstration site and the associated RELRP programme attracted a lot of media attention during the project. A compilation of the media coverage for this project, as well as the banners and posters that were made to publicise the site and the research programmes is provided in Appendices 14 and 15.

Section 6. List of appendices (list is filenames)

- Appendix 1. Feedback report on Coping with Climate Change field day 2010
- Appendix 2. Feedback report on Whole-farm carbon emission field day 2011
- Appendix 3. Program and map 'Coping with Climate Change' field day 2010
- Appendix 4. Appendix 4 Program Whole-farm Carbon Emissions field day 2011
- Appendix 5. Powerpoint presentations Whole-farm C Emissions field day 2011
- Appendix 6. Speaker's notes FD 2011
- Appendix 7. Feedback FD_2011
- Appendix 8. DMFD Eval report 2010 DAFWA
- Appendix 9. DMFD Eval report FD 2011 DAFWA
- Appendix 10. Farmer forum roadshow 2011
- Appendix 11. Photos E. glabra plot
- Appendix 12. Photos Open-path FTIR @ Ridgefield
- Appendix 13. Photos Demo site & Field Days
- Appendix 14. Media
- Appendix 15. Banner&Poster