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Managing carbon in livestock systems: modeling options for net carbon balance (UWA)

Farm Modelling for Emissions Management in WA's broadacre farming region

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Abstract

In 2009/10, four national demonstration sites were commissioned by RELRP. The main aims of these sites were to demonstrate and communicate new research on options to mitigate methane emissions from ruminant livestock. Another aim of the network of sites was to establish limited baseline data to help demonstrate impacts of abatement measures to help with this communication and to gain the acceptance by leading farmers, advisors, and agribusiness consultants will be critical to adoption of new technologies or practices, to improve the chances of adoption of new technologies and maximising uptake of emissions abatement strategies. One strategy that can help to support this goal is to demonstrate a number of mitigation or abatement options using modelling protocols that have taken their biophysical and economic inputs from actual farm sites. The four demonstration sites all have the capacity to provide the biophysical and economic inputs required to successfully model net carbon balance. Further, each of these sites may have the opportunity to develop scenarios to consider climate variability and abatement strategies. The intent of this project was to use MIDAS to model the UWA Future Farm (Pingelly) as one component of an overarching modelling report to identify key similarities/differences between different modelling approaches. More specifically, our objective was to model whole farm emissions on a farm typical of WA's broadacre farming region.

Executive summary

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 purposes 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 CO_2–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 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 CO_2-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 CO_2-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 CO_2–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 CO_2–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

Key words: climate change, emissions, farm modelling, farm business impacts

Background

Perceptions of Climate Change

Leviston and Walker (2011) surveyed 5030 Australians in July and August this year, seeking their understanding of climate change. They found 77% considered climate change was occurring. However, only between 43% to 47% of respondents, depending on how the survey question was worded, thought that climate change was happening <u>and</u> that humans were either largely causing it or contributing to it. A separate survey of Western Australian farmers by the Australian Bureau of Statistics in 2008 (ABS 2008) revealed that, apart from farmers in the northern agricultural region, just over half the respondents thought that the climate affecting their farms was changing and a slightly lesser proportion felt that this changing climate was affecting their farm business. Around 40% of respondents indicated they had changed their management practices in response to recent climate change. Hence, in spite of the widespread scientific, media and political attention surrounding climate change over the last decade, there remains a sizeable proportion of the general public and the farming community that remains unconvinced that either climate change is occurring or that human activity is contributing to climate change. One implication of the diversity of views on climate change within the Australian society is that it is likely to remain a politically divisive issue and that any effective policy response will be difficult to achieve.

In contrast to the divisive political views surrounding climate change and the diversity of views among the general public, there is a widely held consensus among climate scientists that climate change, contributed to by human activity, is highly likely. The agricultural region of the southwest of WA has been described as already probably being subject to adverse climate change (Sadler 2002, ACG 2005). In the region, declining rainfall and warmer temperatures have been observed since the mid-1970s (Foster 2004). Crop production in the region is acknowledged as exposed to the impacts of adverse climate change (ACG 2005, Hennessy and Jones 2007), although much uncertainty remains about the timing, size and variation of impacts of the climate change (Reyenga et al. 2001, Howden and Hayman 2005, Farré et al. 2007, Heyhoe et al 2007).

The Challenge of Climate Change and Variability

Although projected long term climate change is posed to potentially seriously challenge the viability of traditional agriculture in some parts of southern WA (Howden et al. 1999; Reyenga et al. 2001; John et al. 2005; Howden et al. 2007), particularly through an increased frequency of poor seasons, the more pressing business challenge for the vast majority of WA farmers is responding to current climate and price variability. By illustration the widespread drought in 2010 that followed a challenging year in 2009 has tested the financial resilience of many WA farm businesses (Planfarm-Bankwest, 2011). This year many farm businesses will be relying on their sale of wheat to fuel their business recovery. However, in spite of the prospect of above average grain yields, the wheat price has dramatically declined from a cash price of $360 per tonne in February 2011 to be only $235 per tonne in November 2011 and with heavy rains in early November at some locations, quality downgrading is likely. In short, the wheat price has fallen a third in 2011, and when combined with prospects of price downgrades due to weather damage, the projected economic recovery for many WA farms has been weakened. Hence many farmers heading into season 2012, although buoyed by favourable yields in 2011, will not have experienced a strong financial rebound and so many businesses will remain financially exposed.

The Challenge of Carbon Policy

Heading into 2012 and subsequent seasons, farmers will not only face the on-going challenge of variable prices, costs and seasons; but they will also face the consequences of the Carbon Pricing Mechanism (CPM). 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 CO_2–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. No doubt, businesses directly affected by this will investigate the feasibility of limiting their emissions. Some businesses will simply pay for their emissions and mostly pass-on those payments to their consumers, whilst others will, in combination with restricting emissions and passing on costs, also purchase credits (also known as offsets). There are 75 large emitters in WA who will face emission payments and a further 45 firms operate nationally. Among affected firms in WA are Verve Energy, Alinta Energy, Woodside Petroleum, Burrup Fertilisers, Rio Tinto, Alcoa Australia Holdings, CSBP, ERM Kwinana Holding, Fortescue Metals and the Water Corporation. Other notable national entities are Qantas, Incitec Pivot, Caltex Australia, Virgin Blue Holdings, Shell Australia, Exxonmobil Australia and BHP Billiton. Nation-wide, of the around 500 businesses initially subject to the CPM around 60 are primarily involved in electricity generation; around 100 are primarily involved in coal or other mining; around 40 are natural gas retailers; around 60 are primarily involved in industrial processes (cement, chemicals, metal); around 50 operate in a range of other fuel intensive sectors; and the remaining 190 operate in the waste disposal sector.

Note that emissions from agriculture are not subject to an emission price as set by the CPM. Farmers do not pay for the emissions from their farms; even though agriculture is responsible for around 16 per cent of the nation's greenhouse gas emissions and for the bulk of the nation's methane and nitrous oxide emissions. Farmers will be indirectly affected by the CPM, facing additional costs for some inputs and services made slightly more expensive through the incidence of the CPM. Farmers firstly will face what are known as pass-through costs, where those who directly face emission payments will recoup some of their expenditures by passing on those costs to their customers. By illustration between 2013 to 2017 wholesale electricity prices in WA are forecast to increase in real terms by 32 per cent. 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. The term price-takers is commonly used to describe the market position of farmers. Hence, the likelihood for export-oriented farmers in WA is that some of their costs will rise very slightly, as a consequence of implementing the CPM, yet virtually no price-offsetting movements in farm commodity prices will occur.

A second ramification for farmers is the possibility that some emitters may seek offset options from which some farmers may benefit. These offset options entail activities such as environmental tree plantings with the additional main benefit of carbon storage. Governments and emitters may combine to ensure some farmland is used for carbon sequestration and other environmental services and, depending on the incentives available, some farmers may financially benefit. The sorts of activities encouraged and supported by the government are outlined in the Carbon Farming Initiative (CFI) legislation (Commonwealth of Australia 2011a).

What are implications of the CPM and the CFI for WA farms?

Although adverse climate change is projected for the agricultural region of the southwest of WA, in spite of the recent experience of a worsened environment, wheat yields have trended upwards in many recent decades, although yield variability has increased greatly in the 2000s (Kingwell, 2011b). Knopke et al. (2000) and Alexander and Kokic (2005) reported annual average total factor productivity growth was highest for grain farms in WA, at around 3.5 per cent for the 21 years to 1998-99, compared with 3.2 per cent in the nation's other southern region and 3.0 per cent in its northern region. Grain yields also rose the fastest in WA over this period. Islam (2004) similarly found that the annual growth in total factor productivity for broadacre agriculture in WA was 4.8 per cent compared to the national average of 3.7 per cent over the period 1977/78 to 1999/00. These findings reveal that adverse climate change may not necessarily translate into adverse commercial or economic impacts.

Against the backdrop of a changing climate, the more immediate management issue facing WA farmers in coming years is responding to government policy decisions surrounding climate change. The two main policy announcements potentially affecting WA farmers are the Carbon Pricing mechanism (CPM) and the Carbon Farming Initiative (CFI). As yet there are no published studies of the effect of these schemes on WA farms.

A preliminary investigation by Keogh and Thompson (2008) of the Carbon Pollution Reduction Scheme (CPRS) impacts on different types of agricultural businesses in Australia concluded that "under a Medium emission price scenario2, the CPRS will potentially result in a 5–10 percent reduction in average broadacre farm cash margins relative to a business-as-usual scenario, with the impact much greater under higher emission price scenarios" (p. 25). They also forecast that if agriculture becomes covered by the CPRS then there would be a "100 percent reduction in farm cash margins relative to business-as usual even in the short term, for broadacre farm enterprises involving ruminant livestock" (p. 25).

They noted however, that if farm businesses were granted emissions intensive trade exposed status and thereby received 90 percent of required emission permits free, then the negative impact of the CPRS was substantially less, causing farm cash margins to be reduced by between 10 and 20 percent for most broadacre farm enterprises, relative to business-as-usual.

Tulloh et al. (2009) examined various CPRS scenarios for a range of Australian agricultural industries. Their analysis assumed that only electricity, fuel and freight prices would increase because of the CPRS. They did not allow for any economy-wide changes in the cost of labour or capital that may occur due to the CPRS. They estimated that at 2015, if agriculture was covered by the CPRS then farm cash incomes would reduce by between 8.5 to 13 percent for the mixed livestock-crops industry; by 5.7 to 9.3 percent for the wheat and other crops industry, and by 12.2 to 16.7 percent for the sheep industry, depending on cost pass-through assumptions. These authors did not report on the extent of profit reductions. The farm-level impacts of the CPRS they reported were greater than the impacts earlier reported by Ford et al. (2009) who suggested that 'Once agriculture is included in the CPRS, the short to medium-term (to 2020) effects of the scheme on Australian agricultural activity levels and costs are projected to be relatively small.' (p. 28).

Kingwell (2009) examined the potential impacts on a WA central wheatbelt farm business of the Mandatory Renewable Energy Targets (MRET) scheme and the former Carbon Pollution Reduction Scheme (CPRS). The latter was heavily promoted then abandoned. He found that farms, as providers of biomass for electricity generation and small users of electricity, were liable to benefit from the MRET scheme, with the extent of benefit depending on the price offered for biomass. By contrast, the CPRS was liable to more profoundly affect farming systems, especially if agriculture was included in the scheme. The impacts of the CPRS on agriculture were mostly conditional on: the amount of free permits allocated to agriculture (if agriculture was included in the scheme), the value of trees as carbon sinks, the size of CPRS-related costs passed through to farmers, and emission permit prices.

Dependent on these factors, farm profits were projected to increase by up to 20 percent or decrease by over 30 percent, relative to the ‘no CPRS’ or ‘business-as-usual’ case. If agriculture was covered by the CPRS, and emission permits and tree growth rates were sufficiently high then optimal farm plans typically involved a combination of reduced livestock numbers, the planting of permanent stands of trees on marginal farmland and other changes to the enterprise mix on farms that reduced emissions. At the more likely prices for permits ($25 per tonne CO_2-e), and assuming agriculture was exempt from the scheme, then the modelled farm’s profit was about 4 percent less under the CPRS.

Petersen et al. (2003a,b) used a version of the MIDAS model to examine greenhouse gas emissions from livestock dominant farming systems in the high rainfall great southern area of WA. A farming enterprise of 1000 hectares, with 15 percent of land cropped, emitted 1745 tonnes of CO_2-e annually, of which the vast majority came from sheep. Flugge and Schilizzi (2005) also estimated emissions from the same region and found that the average farm emitted 1762 tonnes of CO_2-e annually. Flugge and Schilizzi (2005) also estimated emissions from a typical farming system in the low rainfall eastern wheatbelt of WA to be 1930 tonnes of CO_2-e. The amount of emissions from these farming systems in different regions are about the same, however emission estimates in this study of a medium rainfall region (~400 mm of annual rainfall) are slightly lower. This is principally due to more crop dominant farm plans currently being optimal in this region, given the greater relative profitability of grain production.

This handful of studies of emissions from WA farms have, of course, not been able to consider the ramifications of the recently announced policies of the CPM and CFI. Hence, the purpose of this report is to address this lack. The next section outlines the modelling approach, followed by a discussion of modelling results and the implications of those findings. A final section provides some concluding remarks.

Modelling Approach

This research uses a version of the whole-farm bioeconomic model MIDAS (Model of an Integrated Dryland Agricultural System) that has been tailored to describe the West Pingelly farm ("Ridgefield") where methanogenic shrubs are being trialled, tree planting experiments are occurring and *in situ* measurement of methane emissions from grazing sheep are recorded. Originally developed in the mid-1980s (Kingwell and Pannell 1987), but subsequently revised and applied to other farming regions, (Kingwell 2002; O'Connell et al. 2006; Gibson et al. 2008; Kopke et al. 2008) MIDAS utilises mathematical programming to determine profit-maximising strategies for management of farming enterprises.

Mathematical programming models have three components (i) an objective function (ii) alternative activities for attaining the objective and (iii) activity constraints (Kingwell and Pannell 1987). MIDAS is a steady-state optimisation model that assumes an average weather-year, with the model's objective function being maximisation of the net return to capital and management invested in the farming enterprise. Net return is attained by deducting all operating costs, overhead costs, depreciation and opportunity costs associated with farm assets (exclusive of land) from production receipts. For the West Pingelly farm (see Figure 1), the several hundred activities in MIDAS include alternative rotations on each of four soil classes, crop sowing opportunities, feed supply and feed utilisation by different sheep classes, yield penalties for delays to sowing, cash flow recording, and machinery and overhead expenditures. Constraints include resource restrictions such as availability of land, labour and capital plus various logical constraints and transfer rows. The model jointly takes into account the biological, managerial, financial and technical aspects of the mixed enterprise farming system.

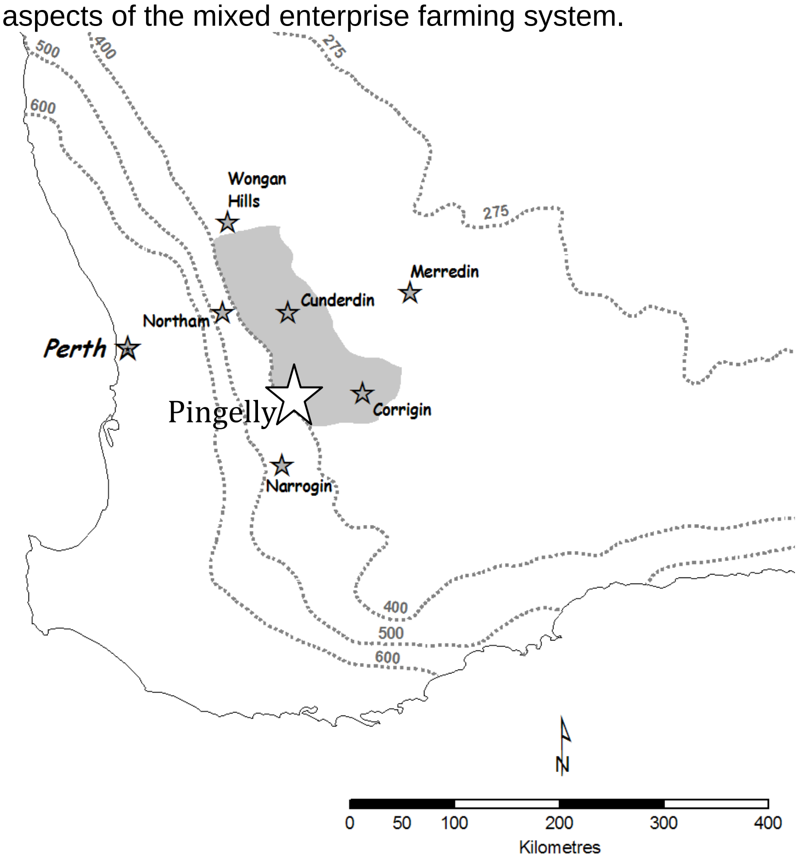

Figure 1. Location of west Pingelly

One of the major strengths of MIDAS is its ability to address a range of whole-farm issues (Pannell 1996). The MIDAS model used in this paper represents a 1620 hectare farm in West Pingelly (UWA Future Farm). The farming region receives annual rainfall averaging around 440 mm (see Figure 2), although over the last two decades annual rainfall has averaged around 400 mm. The majority of rain falls over Winter/Spring (May to October). The weather is characteristic of a Mediterranean climate with long, hot and dry summers and cool, wet winters. The break of season in the region occurs in early May.

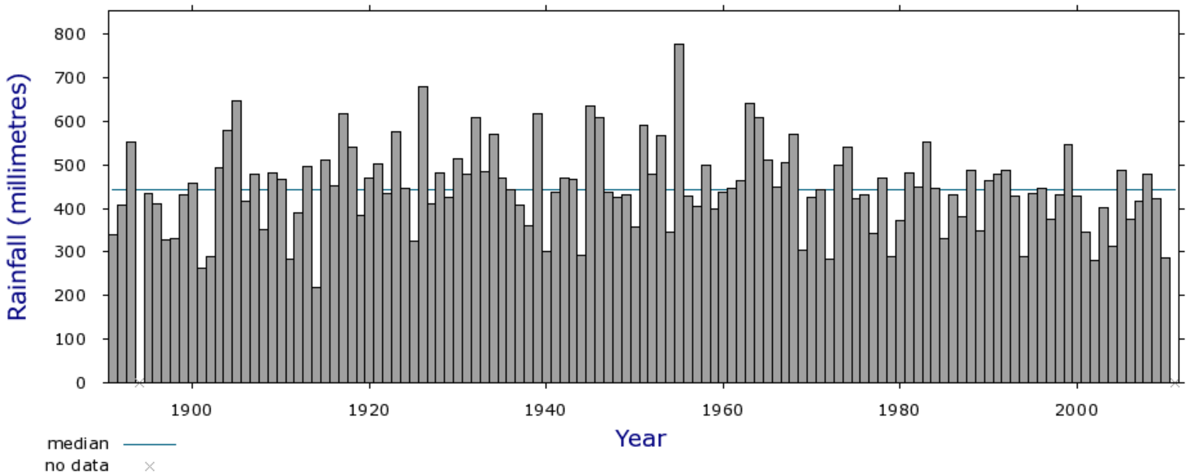

Figure 2. Rainfall history for the shire of Pingelly

Typically the farming system in the Pingelly region entails a mix of crop and sheep enterprises. Crops mainly grown include wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), canola (*Brassica napus*) and oats (*Avena sativa*). These are grown mostly in crop sequences interspersed with pasture phases and there are parts of the farm that are in more or less permanent pasture. Sheep on the farm are mostly Merino ewes retained for crossbred lamb production and wool production.

For further detail of the MIDAS model the reader is referred to Kingwell and Pannell (1987), who describe the first version of the MIDAS model. Later versions were developed for different regions as well, and are described by Kingwell et al. (1995), Kingwell (2002), O'Connell et al. (2006), Kopke et al. (2008), Gibson et al. (2008) and Doole et al. (2009).

The most recent version of the central wheatbelt MIDAS as updated in August 2011 was further amended to consider farm cost structures as outlined by the lessee of the farm. Greenhouse gas emissions from farm activities and carbon storage options were included as were the CPM cost pass-through factors for various farm overhead costs, service costs and input costs. Greenhouse gas emissions from farm activities were also included: those generated by livestock through enteric fermentation and animal waste; fertiliser emissions; nitrogen fixing crop emissions and crop residue emissions. Fuel emissions were not included as they are not part of the initial scope of the CPM. All farm-level emissions were expressed as carbon dioxide equivalents (CO_2-e) and were based on Australia's National Greenhouse Accounting equations, adjusted where warranted for regionally-specific, scientifically verified differences. For example, Biswas et al. (2008) used field experimentation and compiled data for nitrous oxide emissions near the model farm and showed these emissions were appreciably different from international default values.

Carbon storage options encompassed the growing of non-commercial trees on the different soil classes. Currently trees are the only carbon storage option in MIDAS because they meet the Kyoto Protocol standard for environmental integrity; representing abatement that is additional, permanent, measurable and verifiable (Department of Prime Minister and Cabinet 2007).

The revenue calculations in MIDAS regarding the value of sequestered carbon initially assume tree growth is a non-symmetrical sigmoidal growth pattern, estimated following Yin et al. (2003) and drawing on tree growth data at a site near the study region (Justin Jonson, *pers comm*.). Stored carbon is also alternatively valued, not based on regional *in situ* measurements, but on the more conservative estimates generated by NCAT (National Carbon Accounting Tool). Currently, the CPM uses NCAT as the accepted measurement tool for sequestration, although work is underway to improve NCAT's representation of tree growth (Department of Climate Change 2009).

In the south-west region of WA where adverse climate change is projected there are few studies of potential tree growth. Battaglia et al (2009) reviewed studies on tree growth and climate change impacts. They concluded that there was a high degree of interaction between factors and responses to climate change that varied depending on the site and climate characteristics. They acknowledged that knowledge of the effects of elevated CO_2 on Australian plantation species was poor. They also noted that besides the direct effects of climate change on plantation production, there were likely to be important indirect effects through changes in pest distribution and host-pest dynamics. Also changes in fire frequency and severity could be important. They ran over a million climate simulations for different forest regions of Australia. Overall, for the south-west of WA their modelling suggests that outside the high rainfall (>1000 mm of annual rainfall) zone, wood production is likely to be reduced by climate change, in spite of adaptation and fertilisation effects. Moreover, many risks and uncertainties surround these production projections.

Regarding questions over which inputs and farm services could be affected by the CPM, presently all passenger and light commercial vehicles, all vehicles engaged in agriculture and fishing, and all vehicles using LPG and natural gas are excluded from carbon pricing impacts. All other long haulage road freight are to be included from 2014-15. (p. 130, Commonwealth of Australia 2011b).

The Nature of the Carbon Farming Initiative (CFI)

Legislation underpinning the Carbon Farming Initiative (CFI) was passed by the Federal Parliament on 23 August 2011 and on 15 September 2011 the Carbon Credits (Carbon Farming Initiative) 2011 (CFI Act) received royal assent. The CFI aims to help Australia meet its international greenhouse gas obligations by creating incentives for people to undertake land sector abatement projects. These projects are also expected to assist with the protection of the natural environment and improve resilience to the impact of climate change.

CFI projects can generate saleable Australian carbon credit units (ACCUs) that are tradable either internationally (Kyoto compliant) or nationally (non-Kyoto compliant). The creation of ACCUs provides opportunities for agricultural sector abatement projects. Eligible abatement activities can be split into two groups: Kyoto-recognised abatement and non-Kyoto abatement.

Kyoto abatement includes emission reductions from livestock digestion, fertilisers, manure management, stubble and agricultural crop residues, rice cultivation and landfill, and carbon storage through reforestation and avoided emissions through prevented deforestation.

Non-Kyoto abatement projects include revegetation, improved forest management, better management of agricultural soils (soil carbon) and feral animal management, thereby lessening their emissions.

Examples of agricultural practices and technologies that may be considered by the CFI include:

- Split application of fertiliser
- Slow release fertiliser or the use of nitrification inhibitors
- Improved feed quality
- Effluent/methane capture systems in intensive livestock systems
- Improved/managed savanna burning practices
- Minimum tillage
- Application of biochar
- Rotational grazing in the rangelands

The integrity of the offsets will be assessed according to internationally recognised standards to verify abatement. The standards include requirements for additionality (projects that would not have happened if the offsets market was not available), permanency (maintained store for 100 years) and accounting for leakage (emissions from elsewhere that nullify abatement must be accounted for). Changes to emissions and storage of carbon must be measureable, auditable, conservatively measured, use internationally consistent measurement methods or, if locally derived, a measurement method should be supported by peer reviewed science. An independent expert committee, the Domestic Offsets Integrity Committee, has been established to assess offset methodologies proposed under the scheme. The Committee will ensure that methodologies are rigorous and lead to real abatement. The Committee will provide recommendations to the Minister for Climate Change and Energy Efficiency to approve or reject particular proposed methodologies.

There has been some discussion over the rigour with which the additionality and leakage tests will apply to CFI projects. There is a suggestion that weaker criteria will apply in order to facilitate the establishment of initial projects. Moreover, it is likely that additional funds will be available to support carbon sequestration projects that offer other benefits such as biodiversity, salinity management and habitat protection or creation.

Results and Discussion

Emission Profiles

The west Pingelly UWA Future Farm that is the focus of this study is in WA’s central wheatbelt. In this region farms are typically mixed enterprise businesses. The modelled farm, if constrained to represent different farming systems from less to more crop dominance, then its emission levels decline (see Figure 3). Pasture dominant farming systems that carry thousands of sheep have much higher emissions than crop dominant farming systems. A farming system based on 30% of the farm area being devoted to cropping generates around 2500 tonnes of CO_2-e. By contrast when 60% of the farm area comprises crops then around 2000 tonnes of CO_2-e are generated.

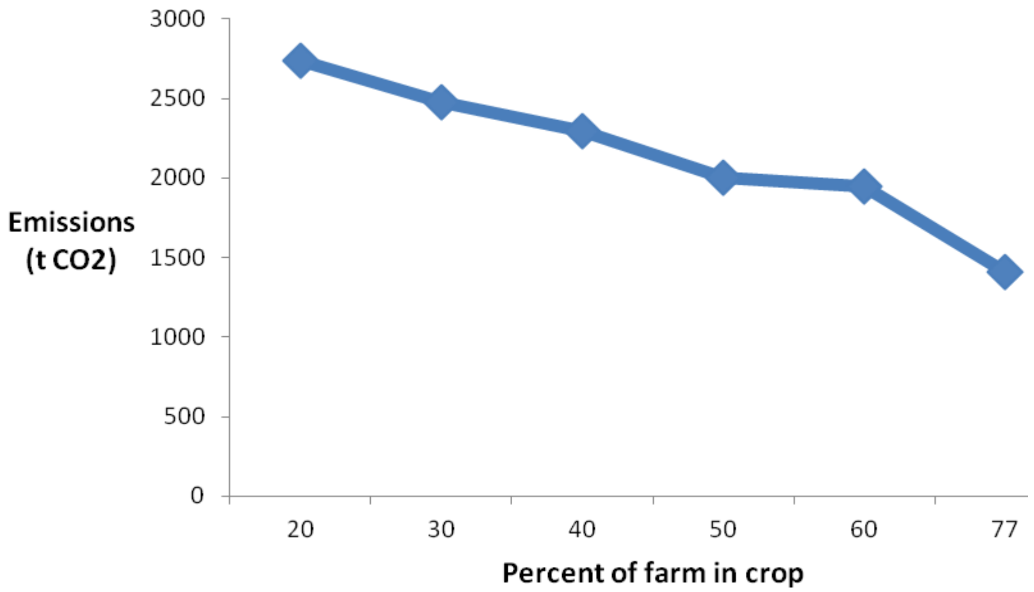

Figure 3. Emissions from different farming systems for the modelled farm

As shown in Figure 4, the major source of emissions are sheep and nitrogen-fixing pastures. By contrast the cropping enterprises are a relatively minor source of emissions. Around 90 per cent of the farm's emissions stem from the sheep and pasture enterprises. Hence emissions from the farming system mostly depend on the relative size of the sheep enterprise

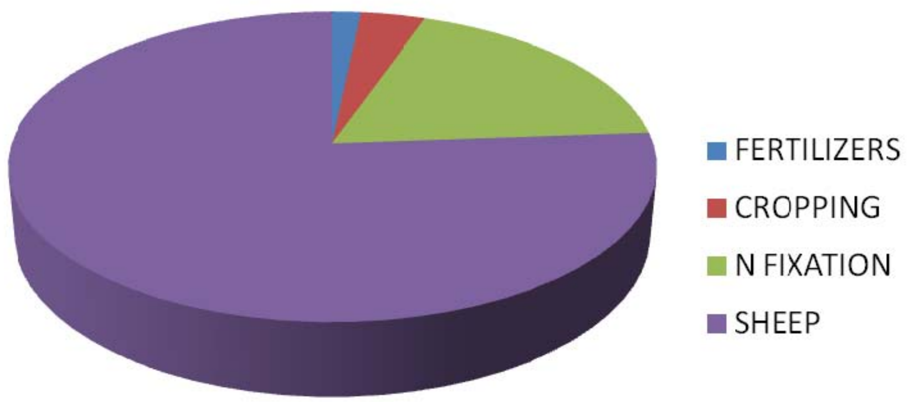

Figure 4. Emissions from different components of the farming system

Emissions and Farm Profits
Although Figure 3 shows the emission profiles of different possible farming systems that range from pasture dominance through to crop dominance, it does not reveal the profitability of the different systems. However, Figure 5 does show the profitability of the different farming systems and their emissions. The profitabilities of the various farming systems are not closely correlated to the level of emissions. This is because farm emissions are not part of the CPM, insofar as farmers do not have to pay for

their emissions nor offset those emissions through sequestration or abatement activity. Hence, emissions are a costless by-product of each type of farming system. The profit-maximizing decision does not need to account for emission levels and they attract no cost penalty. As shown in Figure 6 the most profitable farming system is one that uses about 40 per cent of the farm's area for cropping and the remainder for pasture production. The farm's net return is around $85K. Shifting away from that percentage of the farm in crop lowers net returns. The reasons for optimal profit being generated at that point are many and varied; but principally are due to the relative returns for sheep and wool production, the unsuitability of parts of the farm's landscape for cropping and the synergies between grain and sheep production.
As the farming system shifts away from 40 per cent of the farm area being in crop towards a greater emphasis on cropping then net returns diminish but so do emissions. By contrast, if the farming system shifts towards a greater emphasis on sheep and pasture production then net returns diminish, yet emissions increase. Hence for a farming system that is highly livestock and pasture dominant there is the possibility that by moving towards a slightly more crop dominant farming system and thereby reducing pasture area and livestock numbers that farm profit may actually increase and emissions decrease.

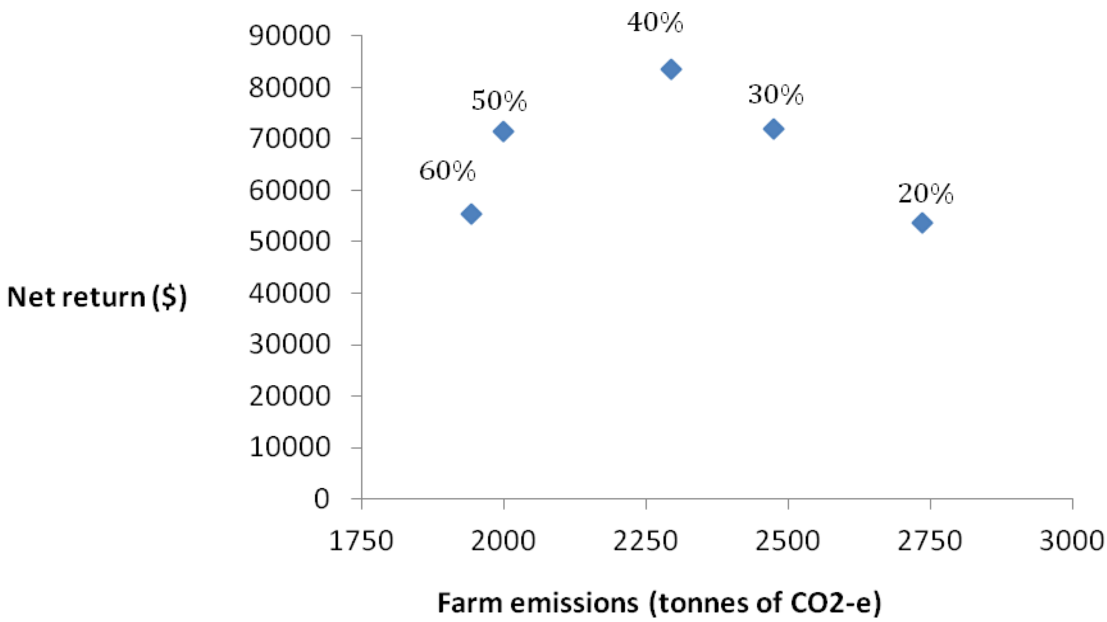

Figure 5. Emissions and profits from different farming systems

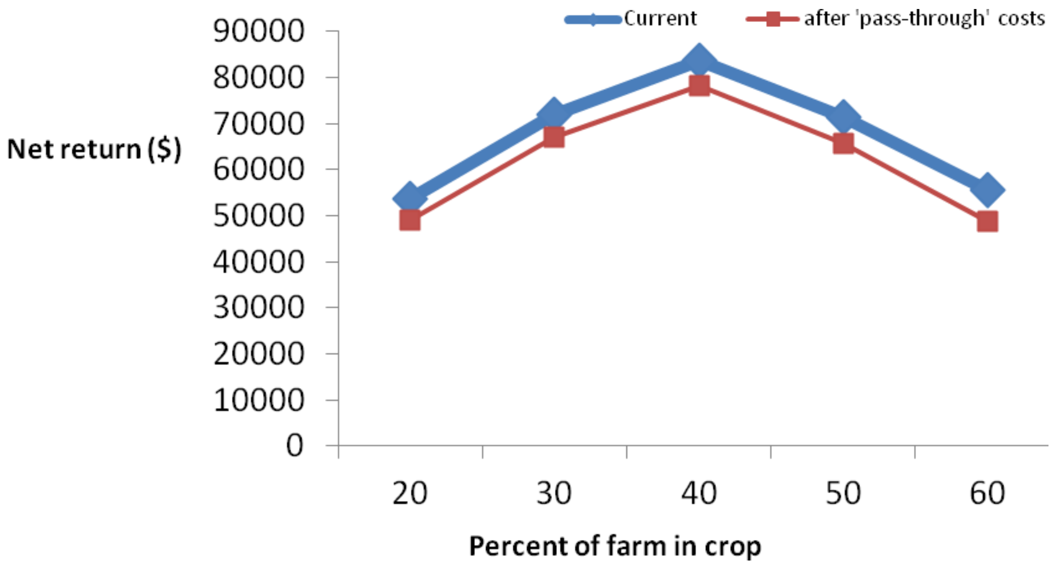

Figure 6. Net returns from different farming systems with and without the CPM and CFI

The two curves in Figure 6 represent farm profitability in the presence and absence of the CPM and CFI. When these policies are assumed to be absent then farm profit is higher. The effect of the CPM is to make some inputs that are subject to emissions pricing (e.g. electricity, energy and some types of fertilisers and eventually heavy road haulage) potentially increasingly more expensive. Further there are a range of other product inputs and services that indirectly are likely to be become slightly more expensive. These pass-through costs raise a farmer's costs of production and lessen their profits, especially as a farmer is unlikely to be able to pass on these higher costs. 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.

A separate analysis by Davison and Keogh (2011a) using a different approach has found very similar impacts for some WA farms. For an average WA grain farm they found that the CPM would cause farm costs after 5 years to be 2.6 per cent higher and farm net income to be 8.6 per cent lower. In another study Davison and Keogh (2011b) examined average Australian wheat-sheep farms and found the impacts of the CPM depended on the size of the farm, with smaller farms being worse affected in percentage terms. The range of impacts of the CPM after 5 years were for wheat-sheep farm costs to increase by between 1.7 to 2 per cent and net incomes to decline by between 7.6 and 16.3 per cent. The lower end of these ranges is more likely to be applicable to WA farms as they are typically larger in physical size and turnover compared to their counterparts in other States.

The export oriented nature of mixed enterprise farm businesses in WA causes those businesses to have a limited ability to pass on any additional indirect costs to their predominately overseas customers. With no price cushioning, farmers will mostly bear the additional small increases in direct and indirect costs, leading to an erosion of their profit margins. Depending on what economists call the incidence of the tax on inputs affected by the CPM (e.g. electricity), a range of farm overhead and variable cost items may slightly increase. The end result is a possible reduction in farm profit by between 6 to 8 percent, after road haulage emissions are brought into the CPM. Although this reduction may seem minor, it comes in the aftermath of a series of problematic production years for many WA farm businesses in 2009 and 2010. Even in the absence of the CPM some farm businesses are currently financially vulnerable. Hence any additional cost impost that is unable to be offset further weakens the recovery of these businesses. In the particular case of the UWA Future Farm Ridgefield, it is already in a sound financial position so the profit reduction attributable to the CPM will only slightly erode that financial strength.

Regarding the Carbon Farming Initiative (CFI) that is supported by both sides of the political divide, some policy commentators believe this will be a boon to farmers and will redress any financial disadvantages associated with the CPM. However, when the most likely applicable option of environmental plantings is included in the MIDAS analyses, it is only economically attractive at very high prices for emission permits. These prices are much higher than those currently projected. For the particular west Pingelly farm, carbon permit prices greater than $60 per tonne of CO_2-e are required before environmental plantings for carbon sequestration are attractive. The expense of farmland and the relative advantage of retaining land in agricultural production makes tree planting only preferred when very high prices for carbon permits persist. If very high prices for sequestration offsets are available over the next two or three decades then the use of farmland as carbon sinks becomes more attractive. However, there is a low likelihood of such high prices being sustained whilst access to international offsets remains feasible. These international offsets are liable to be a preferred cost-effective option for many businesses.

To make environmental carbon plantings more attractive in Australia may require complementary payments for biodiversity or wildlife habitat creation. Even revised Australian Treasury modelling is now less optimistic about the role of carbon sequestration by tree planting. They say:

> “The forestry abatement estimates are lower than the previous modelling estimates as they now incorporate a broader range of factors such as water interception and pricing, estimation of Kyoto compliant land, environmental restrictions and the risk of reversal buffer under the CFI policy.” (p. 79, Commonwealth of Australia (2011b))

Treasury admit that avoided deforestation, rather than aforestation, is particularly important in contributing to land-based abatement. They say:

> “Avoided deforestation and managed regrowth provide a significant share of the abatement from the CFI. Abatement from these land-use change activities is constrained by permanence requirements and strong growth in agricultural commodity prices which results in rising opportunity costs of avoided deforestation.” (p. 79, Commonwealth of Australia (2011b))

Moreover, the nature of WA soils and the projected adverse change in climate in coming decades in south west WA suggests that the other often-mentioned option of carbon storage in soils may also 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.

Reduction in methane output from sheep is currently problematic; with much of the research into sheep genetics regarding emissions and the scope for use of anti-methanogenic shrubs being in its infancy. It is likely that it will be some years before genetic solutions are identified and are widely accessible, but there is some chance that in the shorter term emissions intensity on farm may be reduced through the selection of more efficient genotypes and/or animals that are more efficient for traits genetically correlated to methane production. Also the efficacy and economic merit of growing and feeding anti-methanogenic shrubs need to be more widely assessed and proven.

Concluding Remarks

The principal findings of this study are that, although farm emissions are not subject to emission payments under the CPM, nonetheless the CPM will cause some higher costs to farmers through the pass-through cost consequences of the policy. Initially farm costs will slightly increase, typically by less than 1.5 per cent. However, 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, for the farming systems considered in this report.

Whether these initial reductions in profits persist will depend on many considerations, but especially how the economy-wide impacts of the CPM affect the Australian exchange rate. If the dollar depreciates due to the impacts of the policy, as forecast by the Australian Treasury, then farmers will not be disadvantaged to the extent suggested by the short term initial impacts. The effect of the lower Australian dollar would benefit export-oriented farming systems, such as those in broadacre WA. The farm-gate prices they would receive for their exported products would be higher, in Australian dollar terms, due to the depreciated Australian currency. Hence, the 6 to 8 per cent decline in farm profit is the upper bound of impacts and over time, if the exchange rate effects occur, then the decline in profit will lessen.

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, in this study, we found that these options were economically attractive only at very high prices for emission permits, for the particular case study farming systems we investigated. 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 CO_2–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 CO_2–e.

The reduction in methane output from sheep remains a possibility rather than a reliable actuality. Because the practices and technologies that might allow reductions in methane output remain under development, the economic merits of these options have not been appraised. When their technical efficacy is assured then their economic worth can also be assessed.

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Collaboration with other projects within RELRP

The most significant collaboration with other projects within RELRP has been with the coordinators of the other modeling projects but information has been drawn from BCCH1015, BCCH1012 as well as BCCH1031 to complete this modeling exercise. At this stage the interaction amongst the modeling projects is being coordinated by Hutton Oddy and Doug Alcock. A meeting was held on November 15, 2011 and a follow up meeting is expected to occur on February 22, 2012. A summary of the summary of the data we have collected, the modelling we have done and a draft of a report has been sent to Hutton and both he and Doug will look across sites to establish the degree to which the data and models used are able to inform across site modelling.

Communication of information

Dr Kingwell presented this work as a keynote speaker at the UWA Future Farm field day on October 18, 2011. He was one of three keynote speakers on the day. The other two were David Cattanach, the first farmer to undertake a C audit of his farm, and Dean Revell, who spoke about the DAFF project he manages at the farm entitled 'Drought-hardy, C-conscious grazing systems'. MIDAS was also used in the shrub work to model the value of incorporating perennial shrubs that remain green through summer and autumn into sheep grazing systems. The expectation is that Ross Kingwell will publish the work reported here as a peer reviewed paper and that the work will be communicated more widely once the final report has been accepted and approved by DAFF and MLA.