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Potential impact of a carbon charge on profit of a Western District cropping and grazing farm

By

Sunday McKay, Peter Small and Bill Malcolm

Department of Agriculture and Food Systems

University Of Melbourne

Abstract

One policy response to climate change in Australia is to create a price for carbon to reduce emissions through the introduction of a policy of emissions trading. The federal government indicated that agriculture would not initially be covered by an emissions trading scheme (ETS), however, it is the sector would be affected indirectly by an ETS even if it was not covered by such a scheme. This report examines the impacts an ETS and associated climatic changes may have on a mixed farming enterprise's operating profit. Using a case study farm in the Western District of Victoria, the impacts of an ETS and climatic change on the profitability of the enterprise are modelled under twelve scenarios. These scenarios were constructed using: various emission prices; climatic changes; changes to enterprise mixes; and degrees to which free emissions permits are allocated. The report illustrates that farm productivity growth is crucial for the future viability of the farm enterprise. It also demonstrates the complexities around reducing emissions whilst continuing to meet world food demand.

Introduction

Climate change and governmental responses to it may fundamentally alter the Australian agricultural industry. This could ultimately change the social and environmental landscapes and may impact greatly on our water supplies and the broader agricultural sector. The agricultural industry is the second largest emitter of greenhouse gases in Australia, contributing 16 percent to the economy's total emissions. It is increasingly likely that the agricultural industry will play a key role in reducing Australia's emissions.

One proposed policy response to climate change in Australia is to reduce emissions via an Emissions Trading Scheme (ETS). The ETS that was proposed had two distinct elements; a cap on emissions and a trade scheme. A cap achieves the environmental outcome of reducing emissions through creating a limit and therefore imposes a cost on carbon emitters. A trade scheme enables emissions to be reduced at the lowest cost. The government has indicated that agriculture will not initially be covered in the scheme but its position could be reviewed for inclusion. Therefore it is possible that the sector could become a direct participant in the scheme. Regardless of whether agriculture becomes a participant the industry will face higher input costs due to the impact of carbon pricing on other industries such as energy and farm supply providers. Keogh and Thompson (2008) have claimed

'*farmers who use inputs whose prices are raised through the operation of the Carbon Pollution reduction Scheme will face higher costs of production and potentially lesser profits.'*

The purpose of this report is to understand how a farm could be financially affected through an ETS and how climatic impacts may further influence this. This report examines the opportunities for a mixed farming enterprise to adapt to a changing climate and the implications of an ETS. The first section of this report sets out research aims and questions to be addressed. Section two outlines current thoughts on the impact of an ETS on the Australian agricultural industry. Section three outlines the report's modelling approach. In section four, the results of the modelling and their implications for farmers are considered. In the final section conclusions are presented.

Research Questions

The aim of this research is to understand and illustrate the impact an ETS and climatic change may have on a mixed enterprise's farm operating profit. This report considers how a mixed farming enterprise might reduce its emissions in response to an ETS and how farm profits may be adversely affected in these circumstances. The impacts of climatic change and an ETS on farm productivity are also considered.

It has been commonly observed that farmers typically select their enterprise mix in response to changes in environment. The additional pressures of climate change and the proposed ETS are likely to influence farm enterprise mixes. Profits of Australian farms are expected to decline as a result of the implementation of an ETS but the size of this impact will vary widely. This research aims to examine closely a mixed farming enterprise in Western Victoria as a case study to consider potential impacts of both an ETS and climatic change.

Key issues to be considered include:

- How does an ETS affect the operating profit of a farm?
- How will climatic changes affect operating profits?
- How does an ETS and climatic impacts affect operating profits?
- Do changes in the enterprise mix impact on the operating profit of a farm?
- How sensitive are enterprise operating profits to changes in emission prices?

Literature Review

The current literature has provided a broad indication of the pressures the industry may face due to an ETS. The research conducted to date provides vital information that will assist industry and policy makers in the future.

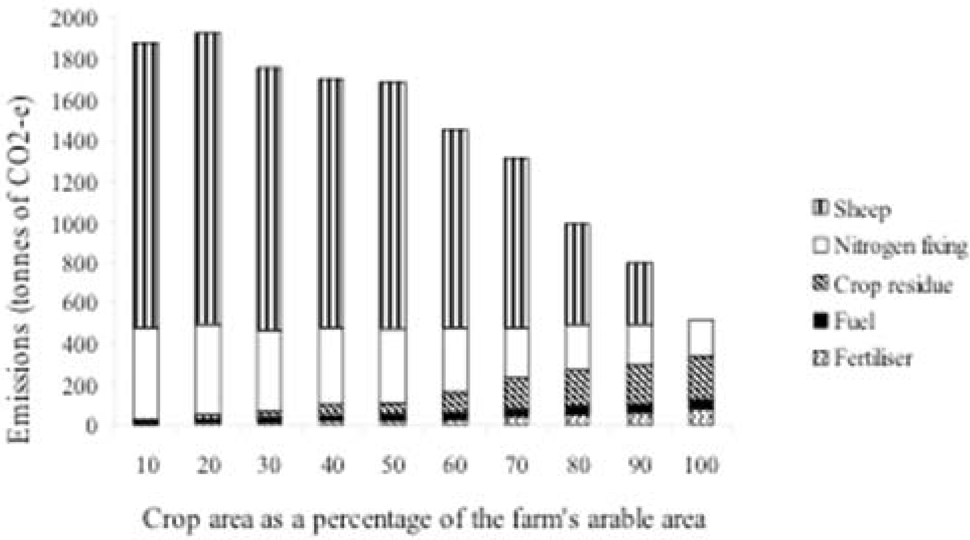
Keogh and Thompson (2008) modelled the impacts of an ETS on Australian farm input prices and profits based on the framework as outlined by the Government's Green Paper. Their objective was to inform policy makers as to whether to include the agricultural industry in an ETS. Their modelling indicated that increases in farm input costs caused by an ETS have the potential to reduce average farm cash margins in 2016 by '*between 3-9% in comparison with a business as usual scenario.*' Their report outlines the direct and indirect costs associated with a carbon tax and concludes that the greatest impacts will fall to farms which have relatively higher levels of emissions. Hence beef-sheep enterprises are projected to be the most heavily impacted, since they are higher emitters than cropping enterprises. The modelling also suggested that farm cash margins are very sensitive to higher emission prices, irrespective of whether or not the agricultural sector is itself included in the ETS. The modelling indicates that farm productivity growth will be crucial for the viability of Australian farm businesses. However, the modelling fails to address the potential longer-term responses by farmers to the impacts of an ETS. That is, the authors have assumed that no enterprise or land use substitution is undertaken by farmers, nor is there significant mitigation. This is an unlikely scenario given the projected increase in emission prices. Hence the report may have overestimated the likely impact of an ETS.

Commonwealth of Australia (2008b) modelled the economics of climate change mitigation and concluded in all scenarios, that sheep and cattle farms are likely to achieve smaller gross output levels by 2050 compared with the reference case. These declines become more significant as the ETS becomes more ambitious. However, like Keogh and Thompson (2008) this report also assumes that current trends in economic activity continue and that mitigation measures are not implemented. The results of the modelling are projected through to 2050, which provides a useful measure of the likely impacts of ETS policies. However, the modelling of ETS projections and the reference case do not include the physical effects of climate change. If these effects were included the report would have provided more realistic projections of the costs of an ETS on the industry. Hence the results from this modelling may have inaccurately estimated the costs of an ETS.

The Centre for International Economics (2009) report on the impacts on agriculture of an Australian ETS adopted a conservative scenario. The report predicts that, by 2030, emission permit costs are projected to account for 25 percent of farm gate prices for wool, 22 percent for that of beef, 16.5 percent for sheep meat, 10 percent for dairy, 5.5 percent for pork, 3.5 percent for poultry and 1-2 percent for grain crops and cotton. The results presented in this report are designed to examine the impact of one factor, an ETS on agriculture. Hence the report assumes that no climate change occurs in the base case scenario, and farmers do not undertake any adaptation measures in response. These assumptions mean that the economic benefits of mitigation under an ETS are not measured and the analysis is partially static. These shortcomings have been noted by Mitchell (2009).

Kingwell (2009) states that farmers whose inputs are raised through the ETS will face higher costs of production and potentially lower profits. Thus, should agriculture become covered by the scheme and thereby need to account for its emissions, farmers would consequently consider switching to lower emission production systems and offsetting emissions. Kingwell (2009) indicates that the ETS will potentially result in a 5-10 percent reduction in cash margins for the average broadacre farm. It is noted that the impact becomes much greater under higher emission price scenarios. It develops the analysis of Keogh and Thompson (2008), since their analysis excluded the possibility of on farm carbon sequestration, alteration of the enterprise mix, input uses or production technologies. Kingwell's (2009) report explores how mixed enterprise operations might reduce and/or offset their emissions in response to an ETS. Figure 1 illustrates, that as the proportion of land allocated to cropping activities relative to running livestock increases, the quantity of emissions decreases.

Figure 1: Annual emissions (tonnes of CO2 –e) arising from farming systems depending on the precentage of arable farmland allocated to cropping (Kingwell 2009)



Hence the Kingwell (2009) modelling indicates that the introduction of an ETS is likely to result in changes in the composition of crops and the number of livestock held on farm.

The Rural Industries Research and Development Corporation (2009) report, like Kingwell (2009), included adjustment on the part of the farm enterprise. The outcomes in this paper assume the main adjustment farms make in response to an ETS is reducing outputs. Hence there is an estimation of the adjustment pressures facing producers. The outcomes presented are therefore not forecasts but measures of the sorts of economic pressures farmers will need to respond to in the future. It focuses on average farm level impacts rather than broad sectoral or industry impacts, which were focused on by Keogh and Thompson (2008) and Commonwealth of Australia (2008b). The RIRDC report states that

'*the ETS will affect agriculture both directly and indirectly. Direct emissions are projected to account for over 60 percent of the additional costs when agriculture is included in the ETS. For an average sheep/beef farm it is estimated as over 85 percent.*'

Australian agriculture is an emissions intensive sector; hence it is likely that it will be hardest hit under an ETS. On-farm analysis showed that farm cash margins would fall by 90 percent for the average beef-sheep farm if the carbon price were $50 per tonne of CO2. Hence, the modelling concludes that farm businesses are likely to see a decrease in their business profits as a result of the implementation of an ETS.

It can been seen that the literature to date focuses predominately on the industry level impacts and presents base case scenarios that assume that farmers do nothing over time to adapt to the new cost structure. Little allowance has been made for the ability of farmers to adjust to and mitigate these new cost structures. Nor is any allowance made for advances in abatement technology. Additionally, the modelling fails to consider the physical effects of climate change on agriculture. The reference cases and projections presented include neither the impact of climate change on the economy nor the physical changes. Accordingly, there is a need for additional research that better describes the responses of farm businesses to an ETS and how climatic impacts may further influence this. This report aims to address and examine how a mixed farm enterprise may adapt to a changing climate and the implications of an ETS. The free allocation of emission permits that industry receives is also examined. This will help to further the debate on the impacts an ETS will have on the Australian agricultural industry.

Methods

Introduction to the case study farm

The case study farm is based in Western Victoria with an annual mean rainfall of 680 millimetres (27 inches), with the majority of rainfall experienced over the winter and spring period. The weather is characterised by warm summers and cold winters. Recently autumns have become increasingly drier, which has resulted in a reduction of stock numbers over this period. The autumn break in the season usually occurs in early March. The farm is situated in glacier land and is characterised by table land sandy soils. Sandy clay is found on the hills of the country whereas heavy clad is restricted to the low-lying flats of the property. A typical farm in the area operates a mixture of cropping and livestock activities. Crops grown in the area range from canola to wheat and oats and are most often grown in rotation with various pasture species. However the case study farm engages in the production of first cross lambs and Wagyu cattle, with no cropping operations. The sheep on the property are mostly merino breed that are predominately used for meat (crossed with a terminal sire) and wool. The cattle run on the property are Angus breed crossed with Wagyu bulls. The livestock operation is a non self-replacing system, with annual purchases of livestock occurring to maintain stock numbers.

The case study farm runs 5794 sheep and 393 cattle on 890 hectares. For the purpose of this study, actual market prices received by the case study were used for the 2008 time period only. Fertiliser prices for the 2008 operating year were above average and industry figures were used to determine the appropriate labour wage costs to the farm business. Return on capital figures were based on an assumption that land values within the area remain around $5000 per hectare, plant and equipment assets are valued at $400,000 and that total livestock value remains within current market values. Hence this case study is indicative only of a year's profile of profit.

Method

To determine how a farm system could be financially affected through an ETS and how climatic impacts may further influence this, a simple budget analysis was undertaken. The data were obtained through the collaboration of industry and farm case study figures. This is a static approach to estimating the on-farm economic impacts of an ETS and climatic impacts; hence it does not provide a pathway to the impact estimates over a period of time, as the sectoral models do.

This study investigates the financial implications of an ETS together with consideration of how changing climatic conditions will impact and influence an enterprise's operating profit. Crosthwaite (1997) recommends case study methods for the purpose of researching farming systems that are complex, influenced by many purposive and ad hoc management decisions which occur with a context of ill-defined feedback loops and uncertainty. Several factors influence the profitability and productivity of farm systems; hence the use of a case study methodology enables a greater understanding of these effects. Case study methods allow for a deeper understanding and exploration of how an ETS and climatic conditions will financially influence and impact a farm business.

The analysis of a farm budget requires either detailed projections into the future or an assumption that recent budgets are a reasonable indication of future outcomes. This project has adopted the latter approach. This is a limitation of the research, however, it still enables appropriate analysis of the combined effects of an ETS and climatic aspects to be addressed and understood. At this stage, the precise way in which agriculture will participate in an ETS is still unclear, however, as it is a highly emission intensive industry it is increasingly likely that the agricultural industry will play an important role in reducing Australia's emission levels. The future price pattern of emission prices is unknown; hence this research focuses on the modeling undertaken by Kingwell (2009) of an emission price pattern of $20, $40 and $60 per tonne of CO2. The point of obligation for the industry has also not been decided, thus for the purposes of this report it has been assumed that producers will be required to purchase emission permits and account for the emissions that they incur on-farm. The report has not made provisions for macroeconomic effects such as exchange rates, the provision for an international emission trading agreement, the flow on impact of farm output prices from increased costs at the processor level, the potential use of forestry as an offset, the flow on effects that will result from a carbon price and the use of emission reduction technologies. A number of scenarios were considered to assess the impacts on an enterprise's operating profit of an ETS as well as climatic implications and how these impacts translate through the farm enterprise. Twelve scenarios were considered, as detailed below.

1. Steady state scenario

In order to provide a base case that illustrates the pressures that the enterprise is likely to face, the initial assumption was made that there were to be no changes made to the enterprise mix. This is an unrealistic assumption, however, it provides a general foundation of the current efficiency of the farming operation as well as the future impacts of an ETS and climatic changes.

2. Steady state with indirect carbon costs scenario

The indirect carbon costs were estimated based on a flow-on cost factor table as established by Keogh and Thompson (2008). The table set out below is based on the changes in fuel prices.

This is an assumed flow-on cost factor based chiefly on fuel costs. For example, this report assumed that fuel prices would increase by 20 percent; hence the flow on cost factor for chemicals would be 50 percent of 20 percent (the assumed increase in fuel costs) resulting in an expected increase in chemical costs of 10 percent, and so on for the other farm inputs relevant to the case study.

Table 1 The flow-on cost factors for various farm inputs (based on Keogh and Thompson 2008)

Farm Input	Flow-on cost factor
Chemical	0.50
Contract harvesting	0.50
Contract seeding	0.50
Electricity	1
Fertiliser (Nitrogen)	0.75
Fertiliser (Other)	0.25
Fuel	1
Grain handling	0.30
Hired labour	0.20
Professional fees	0.10
Repairs and maintenance	0.20
Shearing	0.20
Sheep work	0.20
Shire rates	0.10
Transport	0.25

3. Steady state with indirect and direct carbon costs - no free allocation of permits scenario

The direct emission factor for each agricultural activity is based on table 2.

In order to determine the emission intensity of the case study farm, the emission factors (as presented above) were multiplied by the level of production for example, the number of sheep/cattle/tonnes of wheat produced by the farm. To determine the cost associated with purchasing the required permits, the calculated emissions for each production activity was then multiplied by the three permit prices as determined by Kingwell (2009), namely $20, $40 and $60. These figures were then added together to determine the appropriate direct emission costs for the case study farm. The indirect emission costs were based on the methodology and assumptions in scenario 2.

Table 2 Greenhouse Gas Emissions Per Animal or Per Ton of Production 2006

Annual emissions (ton CO2 –e)				
Animals or crop		**Enteric fermentation**	**Other**	**Total**
Dairy cattle	Per animal	2.38	0.84	3.22
Grain fed beef cattle	Per animal	1.49	1.18	2.67
Grazing beef cattle	Per animal	1.51	0.15	1.66
Sheep	Per animal	0.14	0.03	0.17
Pigs	Per animal	0.03	0.56	0.59
Poultry	Per 1000 birds		10.35	10.35
Wheat	Per ton			0.17
Barley	Per ton			0.11
Other coarse grain	Per ton			0.12

Source: CIE estimates based on emissions factors from the Department of Climate Change.

4. Steady state with indirect and direct carbon costs and 90 percent free allocation of emission permits scenario

It is possible that the agricultural industry will be under an ETS, but it may also be considered to be Emission Intensive and Trade Exposed (EITE). This is a result of the Green Paper proposing that on the basis of the emissions intensity of the broadacre livestock sectors, farm businesses engaged in these enterprises would be eligible for 90 percent of required permits free of charge. It is important to analyse how this would financially impact a farm business. The assumptions and methodology for scenario 2 and 3 have also assisted in the construction of this scenario.

5. Steady state and change to enterprise mix. Introduction of 20 percent cropping combined with indirect and direct carbon costs scenario

a. No free allocation of emission permits

b. 90 percent free allocation of emission permits

Consideration was then given to one adjustment option available to the farm system - a change in enterprise mix in order to reduce the impacts of a carbon price and thus minimise the effects on profitability. A change in the production mix towards cropping, away from the most emission intensive activities, sheep and cattle, is one method of mitigation. This was achieved through allocating 20 percent of the farm to cropping. It is assumed that a contractor does not undertake cropping and the gross margin from cropping is $450 per hectare, depreciation amounts to $10,000 and three tonnes of wheat is produced to the hectare. The assumptions and methodology for scenario 2, 3 and 4 have also assisted in the construction of this scenario.

6. Steady state and change to enterprise mix. Introduction of 40 percent cropping combined with indirect and direct carbon costs scenario

a. No free allocation of emission permits

b. 90 percent free allocation of emission permits

Consideration was then given to allocating 40 percent of the farm to a cropping enterprise. The assumptions and methodology for scenario 2, 3, 4 and 5 have also assisted in the construction of this scenario.

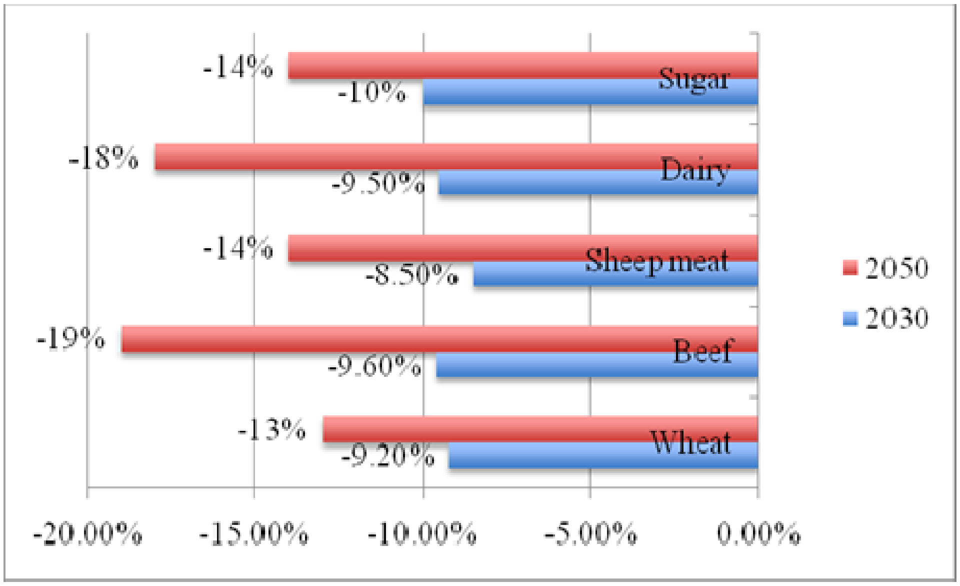
7. Climate change impacts introduced - decline in sheep production of 8.5 percent, decline in cattle production of 9.6 percent scenario

Climate change is likely to impact on water availability and heavily influence agricultural productivity. Hence it is necessary to consider closely how the changing climate will financially impact a farm enterprise. ABARE (2007) predicts that in Australia, higher temperatures and lower rainfall are expected to reduce agricultural production relative to what would otherwise be the 'reference case.' Cline (2007) projects that

'*future potential climate changes could lower agricultural productivity in Australia by 27 percent (without carbon fertilisation) and by 16 percent (with carbon fertilisation) by 2080*.'

Gunasekera (2007) indicates that, with potential climate changes, Australia's production of key agricultural products is likely to decline relative to what it would otherwise be (see figure 3).

Figure 3: Percent change in Australian agricultural production as a result of climate change impacts, relative to what would otherwise be. Gunnaseker (2007)



This report has assumed the 2030 levels of declines, namely wheat by an estimated 9.2 percent, beef by 9.6 percent and sheep meat by 8.5 percent, and altered the partial budget accordingly.

8. Climate change impacts with indirect carbon costs scenario

The methodology and assumptions for scenario 2 and 7 have assisted also in the construction of this scenario.

9. Climate change impacts with indirect and direct carbon costs but no free allocation of emission permits scenario

The methodology and assumptions from scenario 3, 7 and 8 have also assisted in the construction of this scenario

10. Climate change impacts with indirect and direct carbon costs and 90 percent free allocation of emission permits scenario

The methodology and assumption from scenario 4, 7, 8 and 9 have also assisted in the construction of this scenario.

11. Climate change impacts and change to enterprise mix. Introduction of 20 percent cropping combined with indirect and direct carbon costs scenario

a. **No free allocation of emission permits**

b. **90 percent free allocation of emission permits**

The modelling undertaken by Gunaskera (2007) assumes no planned adaptation or mitigation is undertaken to minimise the scale and scope of the adverse production impacts. Hence, in introducing changes to the enterprise mix, a more comprehensive analysis of climatic impacts and the ETS is understood. The methodology and assumptions from scenario 5, 7, 8, 9 and 10 have also assisted in the construction of this scenario.

12. Climate change impacts and change to enterprise mix. Introduction of 40 percent cropping combined with indirect and direct carbon costs scenario

a. **No free allocation of emission permits**

b. **90 percent free allocation of emission permits**

Consideration was then given to allocating 40 percent of the farm to a cropping enterprise. The methodology and assumptions from scenario 6, 7, 8, 9, 10 and 11 have also assisted in the construction of this scenario.

Results

Throughout this report the key results from the twelve scenarios are presented and compared as a change from the steady state- reference case scenario. Scenarios 1-6 reflect changes to operating profit without climatic impacts.

Table 3: Changes in operating profit without climatic impacts

Scenario	Carbon price	Percentage allocation of free emission permits	Operating profit	Decrease in operating profit from reference case	Return on capital
1: Steady state- reference case	NA	NA	$182,728	NA	3.3%
2: Indirect carbon costs	NA	NA	$159,755	-$22,973	2.9%
3: Indirect and direct carbon costs. No free allocation of emission permits	$20	0%	$127,028	-$55,700	2.2%
	$40	0%	$94,281	-$88,447	1.6%
	$60	0%	$61,534	-$121,194	1.0%
4: Indirect and direct carbon costs. 90% free allocation of emission permits	$20	90%	$156,501	-$26,227	2.9%
	$40	90%	$153,226	-$29,502	2.8%
	$60	90%	$149,951	-$32,777	2.7%
5a: Change in enterprise mix-20% cropping. No free allocation	$20	0%	$130,135	-$52,593	2.4%
	$40	0%	$102,122	-$80,606	1.9%
	$60	0%	$74,108	-$108,620	1.4%
5b: Change in enterprise mix-20% cropping. 90% free allocation	$20	90%	$155,347	-$27,381	2.9%
	$40	90%	$152,546	-$30,182	2.8%
	$60	90%	$149,744	-$32,984	2.8%
6a: Change in enterprise mix- 40% cropping. No free allocation	$20	0%	$148,635	-$34,093	2.8%
	$40	0%	$125,356	-$57,372	2.4%
	$60	0%	$102,076	-$80,652	1.9%
6b: Change in enterprise mix- 40% cropping. 90% free allocation	$20	90%	$169,587	-$13,141	3.2%
	$40	90%	$167,259	-$15,469	3.15%
	$60	90%	$164,931	-$17,797	3.1%

<u>Steady state results</u>:

Scenario 1: Reflects the business as usual operating profit of the case study. It is the reference point in which it assumes that no ETS is introduced or climatic changes have occurred. It is the reference point to future scenarios.

Scenario 2: There are two ways in which an ETS can impact an enterprise's profitability. Firstly through the indirect costs associated with the scheme and second through the direct on-farm liability for the emissions attributed to their business. The indirect costs alone would see a reduction in farm profit of ($22,973) per annum.

Scenario 3: The second way in which farm profitability will be affected through the commencement of an ETS is the direct costs incurred through the on-farm liabilities for the emissions attributed to their business. With no free allocation of carbon permits, the implications of the indirect and direct costs would see a significant adverse profit change that heavily impacts the viability of the farm business. It is clear that farm profit margins are highly sensitive to changes in carbon prices. An increase of carbon prices from $20 to $60, would halve the farm's operating profit.

Scenario 4: A 90 percent free allocation of the direct on-farm emissions would significantly reduce the burden of an ETS on the enterprise's operating profit. The operating profit would remain in the range similar to that experienced with only indirect carbon costs, however, it would include the costs associated with both direct and indirect carbon costs.

Scenario 5a and 5b: If the farm enterprise mix were altered to introduce 20 percent cropping, the changes in operating profit are slight in comparison with the previous scenarios. However, there is a larger impact if there were no 'free' allocation of carbon permits.

Scenario 6a and 6b: If the enterprise mix were altered significantly through the introduction of 40 percent cropping, then there would be a substantial change in operating profit figures. Whether or not there is a free allocation of carbon permits, the percentage profit declines would be reduced by over half. It is notable that at an emission price of $20 and a 90 percent free allocation of carbon permits, the operating profit is the closest to the business as usual/steady state of all the above scenarios. The return on capital is also nearly equivalent to the steady state scenario.

Steady state with climatic impacts:

Scenarios 7-12 reflect changes to operating profit with climatic impacts explicitly included (Table 4).

Scenarios 7 and 8: When climatic conditions are accounted for as an estimated 8.5 percent decline in sheep production and a 9.6 percent decline in cattle production, the farm enterprise becomes significantly more stressed. The variability of the farm enterprise at the steady state is questionable without consideration of an ETS. There is a ($60,000) profit decline and a one percent decline on return on capital from the business as usual scenario to the steady state level when climatic changes are considered. Hence climatic changes will impact the farm enterprise greatly (see Appendix B).

Scenario 9: When the direct and indirect implications of an ETS are combined with the production declines in relation to climate change, the farm enterprise becomes unviable. Profit levels fall substantially, and returns on capital are minimal.

Scenario 10: A 90 percent free allocation of carbon permits significantly alters the financials of a farming enterprise. However, it is interesting to note that the profit levels predicted under this scenario even with a 90 percent free allocation are significantly lower than the profit levels predicted from other scenarios.

Scenarios 11a and 11b: A change in the enterprise mix by introducing 20 percent cropping only marginally improves the profit levels if there is a 90 percent free allocation of carbon permits. In contrast it is interesting to note that if there were to be no free allocation of permits, then introducing 20 percent cropping into the enterprise improves the profit margins to a greater degree as the price of permits increases.

Scenarios 12a and 12b: Increasing the cropping component of the farm enterprise to 40 percent significantly improves the profit profile of the business. As in scenario 6, the introduction of 40 percent cropping under a 90 percent free allocation at $20 per tonne of CO2 enables profit levels to be maintained at similar levels to its steady state level. Hence the introduction of 40 percent cropping will help to mitigate both the costs of an ETS and will assist the farm enterprise in adapting to climatic changes

Table 4: Changes to operating profit with climatic impacts

Scenario	Carbon price	Percentage allocation of free emission permits	Operating profit	Decrease in operating profit from reference case	Return on capital
7: Steady state with climatic impacts	NA	NA	$122,888	NA	2.2%
8: Indirect carbon costs with climatic impacts	NA	NA	$99,935	-$22,953	1.8%
9: Indirect and direct carbon costs with climatic impacts; no free allocation of emission permits	$20	0%	$70,115	-$52,773	1.3%
	$40	0%	$40,295	-$82,593	0.7%
	$60	0%	$10,725	-$112,413	0.2%
10: Indirect and direct carbon costs with climatic impacts. 90% free allocation of emission permits	$20	90%	$96,953	-$25,935	1.7%
	$40	90%	$93,971	-$28,917	1.67%
	$60	90%	$90,989	-$31,899	1.6%
11a: Change in enterprise mix; 20% cropping with climatic impacts; no free allocation of emission permits	$20	0%	$79,271	-$43,617	1.4%
	$40	0%	$54,715	-$68,173	1.0%
	$60	0%	$30,168	-$92,730	0.55%
11b: Change in enterprise mix; 20% cropping with climatic impacts; 90% free allocation of emission permits	$20	90%	$101,371	-$21,517	1.9%
	$40	90%	$98,916	-$23,972	1.8%
	$60	90%	$96,460	-$26,428	1.76%
12a: Change in enterprise mix; 40% cropping with climatic impacts; no free allocation of emission permits	$20	0%	$103,626	-$19,262	2.0%
	$40	0%	$85,060	-$37,828	1.6%
	$60	0%	$66,494	-$56,394	1.3%
12b: Change in enterprise mix; 40% cropping with climatic impacts; 90% free allocation of emission permits	$20	90%	$120,336	-$2,552	2.3%
	$40	90%	$118,479	-$4,409	2.2%
	$60	90%	$116,622	-$6,266	2.2%

Discussion; implications of results

While a decision on the agricultural industry's inclusion in an ETS has been made, the White Paper in 2009 indicated that the Commonwealth Government was

'disposed to include agriculture emissions in a scheme by 2015. Commencing 2009, the Government will undertake a work program in consultation with the agricultural industry to enable a decision in 2013 on coverage of agricultural emissions in 2015.'

If an ETS has already been implemented, how should a farm enterprise best respond to the requirement to lower its emissions, while maintaining sustainable levels of profit and output to meet the growing demand for food production? Farmers could lower their emissions in three ways. Firstly they could reduce their emissions through making changes to their enterprise mix, thereby reducing the emissions intensive proportions of their farm, i.e. livestock. Secondly they could abate emissions through using offsets available like planting trees or applying new technologies to their production system. Or, thirdly, they could purchase the required emission permits to maintain the enterprise's current activities. The following discussion draws upon the costs involved in purchasing the required emission permits to sustain the business while addressing how changes to the enterprise mix could reduce the emission liabilities faced into the further. Complementing this will be discussion on the challenges and implications that an ETS presents in meeting increasing world food demands, whilst ensuring there is a reduction in agricultural emissions.

Steady state:

Changes to the composition of the enterprise mix and the extent to which the industry is granted free permits heavily influences the optimal plan of the enterprise and emission profile of the business. Table 5, illustrates the percentage profit declines in operating profit as a consequence of the direct and indirect cost implications of an ETS.

Table 5: Percentage change in operating profit as a result of indirect and direct costs of an ETS: steady state used as the base model

Emission Price	'Free' allocation of emission permits	Status quo	20% cropping	40% cropping
$20	0%	-30%	-29%	-19%
	90%	-14%	-15%	-7%
$40	0%	-48%	-44%	-31%
	90%	-16%	-17%	-8%
$60	0%	-66%	-59%	-44%
	90%	-18%	-18%	-10%

When fewer free permits are allocated, it is more likely that a change in the enterprise mix will occur. In the situation where farmers are only accountable for 10 percent of their emissions (receiving a 90 percent free allocation), the least cost strategy for dealing with their emissions is to make relatively small changes to the enterprise mix.

a) No free allocation of emission permits:

At an emission price of $20 per tonne of CO2, no free allocation of emission permits whilst at the status quo; the case study farm would see an operating profit decline of ($55,700). At $40 per tonne, operating profit declines by almost half and at $60 per tonne profit declines by 66 percent which equates to a decline of ($61,534). Hence it could be assumed that if the agricultural industry were to receive no 'free' allocation of permits that the farming system would become unviable and that significant deceases in profit as indicated above would cause alteration in the enterprise mix of the farm business.

If the enterprise aimed to alter its mix and introduced 20 percent cropping, under no free allocation one would see minimal changes in operating profits. The change would be a $3000 profit improvement at $20 per tonne, which is relatively insignificant. Even when the emission price increases to $60 per tonne the farm business is only 7 percent better off, which equates to $12,574. Is this profit differential enough to introduce 20 percent cropping into the enterprise mix? The introduction of cropping makes a slight difference to the overall burden of the enterprise's emission profile, however, it is likely that increases in livestock prices may compensate for the differential of maintaining the status quo over the introduction of 20 percent cropping. This outcome will be particularly likely if offshore producers are also subject to an emissions tax. A possible reason as to why there are not greater returns for introducing 20 percent cropping into the mix is that the energy intensity of cropping outweighs the emission reductions that are gained due to the small-scale nature of only 20 percent cropping. Also the expense involved in purchasing the required cropping machinery for such a small-scaled operation.

If 40 percent cropping were introduced into the enterprise mix, then there would be significant decreases in the overall burden of an emissions tax, compared with the status quo. At $60 per tonne, operating profit improves by 22 percent, equating to a $40,542 increase in profit. Thus, the introduction of 40 percent cropping into the enterprise mix would reduce the ETS burden more significantly than if 20 percent cropping was introduced. If the agricultural industry were to receive no free allocation of emission permits, then the farm system would be better off, all else remaining equal, implementing a change in the enterprise mix to introduce 40 percent cropping.

b) 90 percent free allocation of emission permits:

The allocation of free permits helps to cushion the agricultural industry from the impact of an ETS. The question arises; would this approach still provide the right incentives for producers to reduce their emissions profile and alter their production systems? If there were a 90 percent free allocation at $20 per tonne, there would be a 14 percent reduction in farm profits that equates to a ($26,228) decline in operating profit. This may be a significantly adverse profit change, however, when the emission price is increased to $60, operating profit would only further decline by ($6,500), being a further 8 percent. This is a comparatively small profit decline as against to the situation where there were no free allocations of emission permits.

When 20 percent cropping is introduced into the enterprise mix, minor changes to operating profit are experienced. At $20 per tonne and 20 percent cropping, the profit differential is ($13,086). When the emission price increases to $60 per tonne, the profit differential is ($14,986). Hence the free allocation of permits would provide less incentive for a producer to change their enterprise mix. At the other extreme, with an emission price of $60 and 40 percent cropping, profit margins would only improve by 8 percent. It is most probable that increases in livestock prices would compensate for these profit differentials.

Thus the fewer free emission permits allocated, the more likely it is that a substantial change in the enterprise mix will occur.

Steady state with climatic changes:

Table 6 illustrates percentage declines in operating profit with the impacts of an ETS and climatic changes combined. The farm enterprise is significantly more stressed when climatic impacts are addressed as per Gunnaskera (2007).

Table 6: Percentage change in operating profit with combined climatic impacts and the indirect and direct costs of an ETS. Climate change steady state used as the base model

Emission Price	'Free' allocation of emission permits	Status quo	20% cropping	40% cropping
$20	0%	-43%	-35%	-16%
	90%	-21%	-18%	-2%
$40	0%	-67%	-55%	-31%
	90%	-24%	-20%	-4%
$60	0%	-91%	-75%	-46%
	90%	-26%	-22%	-5%

a) No 'free' allocation of emission permits:

When climatic impacts are included in the analysis, introducing cropping has a significant impact on the enterprise's operating profits. At $20 per tonne, introducing 40 percent cropping improves profits by 27 percent, which equates to a $33,511 increase in profit margins. When the emission price increases to $60 per tonne, profits improve by $56,019; an increase of 45 percent. These are significant changes to profit margins. The introduction of 40 percent cropping into the enterprise mix improves the profit profile of the business by nearly 50 percent. Hence, when considering the impact of climatic changes and the costs associated with an ETS, significant changes in the composition of the enterprise mix would need to occur to ensure that the farming system maintains at least existing levels of profitability.

b) 90 percent free allocation of emission permits:

Again, the allocation of 90 percent free emission permits helps to cushion the impact of an ETS on the farm system even if there are additional climatic impacts. At the status quo level the free allocation of permits significantly reduces the adverse profit declines by halving the percent decline in profits to a difference that equates to $26,838. The introduction of 20 percent cropping to the enterprise mix presents more favorable profit, however, it is again the introduction of 40 percent cropping that significantly alters the farming system. At $20 per tonne and with 40 percent cropping, operating profit figures are ($2,552) worse off when climatic impacts are factored. At $60 per tonne and under 40 percent cropping, profit figures improve by 21 percent; that is equivalent to a $25,633 increase. Hence, regardless of whether or not the agricultural industry is granted a free allocation of emission permits, an alteration in the enterprise mix to include 40 percent cropping will significantly reduce the farming system's emission costs. This is particularly the case when climatic impacts are included in the modeling.

What are the operating profit differentials between the steady state and the steady state with climatic impacts?

Table 7 outlines the operating profit differentials to a farming system with and without climatic changes for different emission prices and enterprise mixes. Table 7 clearly demonstrates that climatic impacts significantly influence the profit profile of a farming system. These profit differential figures reinforce the findings stated earlier in the report that through significant changes in the enterprise mix the profit declines are significantly reduced. Hence a significant decrease in the profit differential is seen when 40 percent cropping is undertaken. As stated previously where there is no free allocation of permits and emission prices are higher, engaging in cropping has a greater impact on the profitability of the farm business. It is also clear that engaging in a more significant proportion of cropping i.e. 40 percent rather than 20 percent improves the profit differential more significantly.

Table 7 Operating profit differentials with climatic impacts compared to base case without climatic changes; steady state scenarios versus climate change scenario; what is the profit difference?

Emission Price	'Free' allocation of emission permits	No cropping	20% cropping	40% cropping
$20	0%	-$56,913	-$50,864	-$45,009
	90%	-$59,547	-$53,976	-$49,251
$40	0%	-$53,986	-$47,407	-$40,296
	90%	-$59,255	-$53,630	-$48,780
$60	0%	-$51,059	-$43,950	-$35,582
	90%	-$58,962	-$54,284	-$48,308

Table 8 is a comparison of the operating profits with climatic changes to the reference base case of no climatic impacts for a range of emission prices and enterprise mixes. These figures represent a direct comparison between steady state profit figures and steady state profit figures with climatic impacts. The figures clearly illustrate the percentage profit changes when climatic changes are factored into the enterprise. For example, with an emission price of $40, under a no cropping scenario, with no free allocation of emission permits, an enterprise's operating profit is 57 percent lower when climatic impacts are included, as opposed to the model which does not include such impacts.

The below percentages reinforce the severity which climatic changes are likely to have on the farming system and thus ultimately on an enterprise's operating profit. Under no cropping, with an emission price of $60 and no free allocation of permits, an enterprise's profit would be 83 percent worse off when consideration of climate impacts are combined with the impacts of an ETS. The figures above signal adverse changes in operating profits that would result in unviable farming operations and present clear challenges to the future profitability of a farming enterprise, and also Australia's ability to continue to contribute to meeting the world's growing demand for food.

Table 8: Comparison of operating profits between scenarios with climate change and scenarios without climate change; steady state of scenarios without climate change used as the base model

Emission Price	'Free' allocation of emission permits	No cropping	20% cropping	40% cropping
$20	0%	-45%	-39%	-30%
	90%	-38%	-35%	-29%
$40	0%	-57%	-46%	-32%
	90%	-39%	-35%	-29%
$60	0%	-83%	-59%	-35%
	90%	-39%	-36%	-29%

There are, however, other changes that have not been included in this analysis, namely the influences of CO2 and productivity growth. This report primarily addresses implications in relation to productivity growth, however consideration is briefly given to the impacts of CO2. Eckard (2007, 2009) modelled the impact of increases in CO2 on pasture growth for a number of sites in Victoria. In relation to the Hamilton area they predicted that when CO2 was included in the simulation, under a low 2030 climate change scenario, pasture growth showed anticipated increases of up to 12 percent in annual production, but under a 2070 high climate change scenario, pasture production declines of up to 15 percent were predicted.

Implications for required productivity growth:

a) Steady State:

Table 9 illustrates the annual productivity gains that would be required to ensure that the percentage changes in operating profits outlined in Table 5 are recovered per annum. That is, at an emission price of $60, under no cropping with no free allocation of emission permits; productivity would have to grow annually by 2.5 percent to compensate for the expected 66 percent decline in operating profit. Under the scenario of no free allocation of emission permits, productivity would need to grow between 1.3 percent and 2.5 percent to cover the expected declines in profits. However, if there were a 90 free allocation of permits, there would be a substantial change in the required productivity growth rates. Annual productivity increases would range from 0.33 percent to 0.83 percent. In previous years, the agricultural industry has been able to achieve productivity growth rates of 2 percent per annum. If we assumed that this productivity rate were to continue into the future, much of the costs associated with an ETS and the corresponding profit declines would be addressed through this continual increase in productivity. It would however, not be sufficient if the enterprise were at no cropping or 20 percent cropping, under no free allocation of emission permits with an emission price of $60.

Table 9: Annual productivity gains required to recover operating profit following the inclusion of direct and indirect costs of an ETS at the steady state scenario

Emission Price	'Free' allocation of emission permits	No cropping	20% cropping	40% cropping
$20	0%	Productivity =1.3%	Productivity=1.2%	Productivity=0.87%
	90%	Productivity=0.65%	Productivity=0.7%	Productivity=0.33%
$40	0%	Productivity=1.97%	Productivity=1.83%	Productivity=1.35%
	90%	Productivity=0.76%	Productivity=0.78%	Productivity=0.39%
$60	0%	Productivity=2.5%	Productivity=2.34%	Productivity=1.83%
	90%	Productivity=0.83%	Productivity=0.83%	Productivity=0.47%

(Please also refer to table 5)

b) Climate change impacts:

Table 10 below again illustrates the annual productivity gains that would be required to ensure that the percentage changes in operating profits outlined in Table 6 are recovered per annum. The difference between tables 9 and 10 is that the productivity figures considered below addresses not only the impact of an ETS but also the impacts of climatic changes. Hence, if the enterprise remained at no cropping, with no free allocation of permits and an emission price of $60, productivity would have to increase by 3.28 percent per annum to cover the expected 91 percent decline in profits. When climatic changes are accounted for, productivity increases are significantly greater than if there were no consideration for climatic changes. In table 10, for the same example of an emission price at $60, no free allocation of permits and at no cropping, productivity gains need to be nearly one percent greater when considering climatic impacts. Assuming that the agricultural industry maintains productivity growth rates of 2 percent per annum as stated above, if the emission price is $40 or greater and there is no free allocation of permits, the enterprise would be unable to cover the expected declines to profits. If, however, the ETS cost effect were smaller relative to farm productivity gains the farm enterprise would still be viable.

Table 10: Annual productivity gains required to recover operating profit following the inclusion of direct and indirect costs of an ETS combined with climatic impacts

Emission Price	'Free' allocation of emission permits	No cropping	20% cropping	40% cropping
$20	0%	Productivity =1.8%	Productivity=1.5%	Productivity=0.74%
	90%	Productivity=0.95%	Productivity=0.8%	Productivity=0.1%
$40	0%	Productivity=2.5%	Productivity=2.2%	Productivity=1.35%
	90%	Productivity=1.08%	Productivity=0.9%	Productivity=0.19%
$60	0%	Productivity=3.28%	Productivity=2.83%	Productivity=1.9%
	90%	Productivity=1.16%	Productivity=0.99%	Productivity=0.24%

(Please also refer to table 6)

Tables 9 and 10 demonstrate and highlight vividly how critical the rates of farm productivity growth are going to be to enable an enterprise to absorb the impact of ETS policies. Without productivity increases of 2 percent or above, the farm business will be unable to compensate for the expected profit declines per annum. Thus productivity needs to increase by 2 percent per annum to cover the emission costs and another 1 percent per annum to cover the cost price squeeze.

One of the important lessons from the introduction of an ETS is that farmers are likely to have to change the size of their operations to reduce average costs per unit of output, in order to offset the increase in their costs of production that arises from an ETS. Farmers across Australia in all industries have continually increased the size of their operation in the past - in the future this requirement may be even greater.

Conclusion

This report has assessed and illustrated the impacts a carbon tax and climatic changes have on an enterprise's farm budget. The purpose of this study was to increase the understanding of how a mixed farming enterprise might reduce and/or offset its emissions in response to an ETS, how farm profits may be adversely affected in these circumstances, and the impacts of climatic changes. Twelve scenarios were presented as a means of illustrating how an ETS and climatic changes would translate through a farming enterprise and the impact it would have on operating profits. Within the scenarios, changes occurred to emission prices, the nature of the farming enterprise and the degree in which free allocation of emission permits were obtained.

The key findings of the report are outlined below.

1) If the agricultural sector were to be included in an ETS irrespective of climatic impacts, in this case farm, reductions in profit below the status quo would be expected even when adjustments are made to the farm plan as a result of the added carbon cost. This is especially apparent if the agricultural industry is not given EITE status and therefore does not obtain 90 percent free allocation of permits. At an emission price of $20 per tonne, with no free allocation of emission permits, the case study farm suffers a decline in operating profit from the status quo situation of ($55,700). This is a significant decline which would necessitate greater adjustments than countenanced in this initial case study.

2) When fewer free emission permits are allocated, it becomes more likely that a substantial change in the enterprise mix will occur. The report showed trends that the introduction of 40 percent cropping had a more significant impact on the profit of the business than introducing 20 percent cropping. These trends were clear at the steady state but were more dominant when climatic changes were included in the analysis. At the status quo and the introduction of 20 percent cropping, the improvements to profit were insignificant. However, if 40 percent cropping is introduced at the status quo with an emission price of $60, profit improves by 22 percent, equating to a $40,542 increase in the profit of the business. When consideration of climatic impacts is included in the analysis, 40 percent cropping added significant changes to an profit. At the status quo with climatic impacts, introducing 40 percent cropping at a carbon emission price of $60, profit improved by $56,019, which represented an increase of 45 percent. This example illustrates the extent of the stress the farm enterprise is placed under when the

implications of an ETS and climatic changes are combined. Hence significant changes in the composition of the enterprise mix would need to occur to ensure that the farming system maintains at least existing profitability.

3) A 90 percent free allocation of emission permits helps to cushion an enterprise from the impacts of an ETS. At the status quo, with a 90 percent free allocation of permits, fewer incentives are created for changing the farm's enterprise mix. It is again the introduction of 40 percent cropping that alters the profit profile significantly more than 20 percent. Hence, regardless of whether the industry is granted a free allocation of emission permits, a change to the enterprise mix to include 40 percent cropping significantly reduces their emission obligations. This is particularly the case when climatic impacts are included.

4) Most importantly, the report illustrated how crucial farm productivity growth is for the future viability of the farm enterprise. Under the status quo scenario with no cropping and no free allocation of permits, productivity growth would need to grow between 1.3 to 2.5 percent annually to compensate for the expected percentage declines in profits. However, if there were a 90 free allocation of emission permits, then significantly lower productivity growth would be required, namely a range from 0.33 to 0.83 percent per annum. Given previous productivity growth of 2 percent per annum, much of the cost associated with an ETS would be addressed through the continual increases in productivity. However, with an emission price of $60, under no cropping or 20 percent cropping, with no free allocation of permits, productivity growth rates would not cover the associated carbon costs. When climatic impacts are considered, significantly higher productivity growths are required. In the case of a no free allocation of emission permits productivity rates would need reach up to 3.2 percent per annum to cover the expected percentage changes to profits. However, as stated earlier, the introduction of 40 percent to the enterprise mix would significantly decrease the required rates of productivity growth. Through 40 percent cropping, productivity growth rates required would be within the industry's previous 2 percent per annum improvements. Accordingly, the enterprise would be able to recover the percentage changes to profits. Without productivity increases of 2 percent or above annually, the enterprise will be unable to compensate for the expected profit declines as a consequence of emission costs.

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