Chapter 2

The impacts of climate change for the Australian agricultural sector

Introduction

2.1 The committee received many submissions and substantial evidence on the implications of climate change for the Australian agricultural sector. The potential impacts of climate change are diverse. Some impacts are direct, such as climatic changes to agricultural land, and others are indirect, such as the implications of government policy related to climate change.

2.2 This chapter begins with an overview of the Australian agricultural sector. The chapter then provides a brief discussion on the limitations of predicting the impacts of climate change. The chapter then discusses the implications for the Australian agricultural sector of specific climatic impacts of climate change. The discussion then moves to some of the broader implications of climate change, such as the impact on rural communities, the impact on biodiversity and how consumer expectations in relation to climate change issues will impact on the agricultural sector.

2.3 The opportunities and challenges that climate change impacts have on current and future farm enterprises are discussed in detail in Chapter 3 of the report. The committee received a substantial number of submissions and evidence outlining the impacts of an emissions trading scheme on the Australian agricultural and forestry sector. The committee considers these issues in detail in Chapter 4 of the report.

The Australian agricultural sector

Composition of the sector

2.4 The National Farmers' Federation (NFF) provided the following summary of the Australian agricultural sector's contribution to the Australian economy:

> The agricultural sector, at farm-gate, contributes approximately 3% of Australia's total Gross Domestic Product (GDP). However, when factoring in the value-adding activities that occur to farm outputs post farm-gate, and the value of all the economic activities supporting farm production in the farm-input sector, agriculture has averaged a contribution of 12.1% of GDP (approximately $103 billion in 2004-05 dollar terms) in the six years ending 2003-04. Australian agricultural exports are valued at approximately $30 billion annually, accounting for around one fifth of Australian merchandise exports.
>
> In addition, there are currently 308,000 people directly employed in Australian agriculture. However, the complete agricultural supply chain,

> including affiliated industries, provides over 1.6 million jobs to the Australian economy (1-in-6 of all jobs).[1]

2.5 The Australian Bureau of Statistics summarised the main industries comprising the agricultural sector for the period 2006-07 as follows:

> … the number of agricultural businesses at 30 June 2007 had fallen by 3% to 150,403 [since 1 July 2006].
>
> The beef cattle farming industry was the largest, with around 30% of all agricultural businesses. The mixed farming sector (grain-sheep/beef cattle) was the next largest with around 9%, followed by sheep farming with 8%.[2]

2.6 In terms of the gross dollar value, the NFF's website states that the top three agricultural commodities produced nationally are: cattle and calves; milk; and wheat.[3]

Vulnerability of the Australian agricultural sector to climate change

2.7 A number of submissions highlighted the vulnerability of the Australian agricultural sector to climate change. For example, Mr Ian Bowie's submission cited work by the Australian Bureau of Agricultural and Resource Economics which indicated that while agricultural production would decline globally, some of Australia's major competitors may not be as challenged by this as Australia.[4] Similarly, the submission of Meat and Livestock Australia highlighted the vulnerability of the Australian agricultural sector to climate change:

> Projections indicate that relative to other developed countries, Australia is exceptionally sensitive to climate change and agriculture is one of the most vulnerable sectors due to the impacts on productivity of changes in water availability, water quality, temperature, and pests and diseases.[5]

2.8 The committee also notes the assessment of the Garnaut Climate Change Review of the vulnerability of various subsectors of the agricultural sector to climate change, particularly the irrigated sheep, dairy and cattle industries with a very high vulnerability to climate change.[6]

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1 *Submission 24*, p. 3 (references not included).

2 Australian Bureau of Statistics, *Agricultural Commodities, Australia 2006-07*, May 2008, p. 4.

3 National Farmers' Federation (NFF) website, *Farm Facts*, http://www.nff.org.au/farm-facts.html, accessed 21 October 2008.

4 *Submission 2*, p. 2, citing Australian Bureau of Agricultural and Resource Economics, *Australian Commodities*, Vol. 14, No. 4, December quarter 2007, pp 657-676.

5 Meat and Livestock Australia, *Submission 36*, p. 2 (references not included).

6 Professor Ross Garnaut, *Garnaut Climate Change Review: Final Report*, 30 September 2008, p. 535. In this assessment 'vulnerability' is a measure of exposure, sensitivity and adaptive capacity of an industry.

The limitations of predicting the impacts of climate change

2.9 The committee's Interim Report summarises regional climate change projections from *Climate Change in Australia*, a joint project of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM).[7] The committee noted in its Interim Report that there is some uncertainty in making climate projections, and that there is ongoing work to produce long-term climate projections on a global and national scale. The committee also noted the need for further work to be done to downscale climate change projections to a local level to be of greater use to farmers in decision-making.[8]

2.10 The CSIRO made the following qualification in its submission about how this uncertainty in projections impacts on the reliability of predicting the impacts of climate change:

> While there are some general principles about how impacts of climate change will vary geographically, regional indications of climate change impacts are highly uncertain … regional climate change projections are currently more useful for describing the wide range of uncertainty and for probabilistic risk assessment than serving as reliable predictors for planning and decision making.
>
> The comments [in the CSIRO's submission] should therefore be used as an indication of the likely range of impacts for which primary industries will have to prepare, and NOT as a reliable predictions of exactly where specific impacts will occur.[9]

2.11 In its Interim Report the committee acknowledged the frustration that this type of uncertainty can cause for those in the agricultural sector.[10] However, with these limitations of current climate projections in mind, the committee is of the view that the information available on future climate is sufficient, in any case, to provide the foundation for discussion about the potential implications of climate change on the Australian agricultural sector.

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7 Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM): *Climate Change in Australia – Technical Report 2007* (*Climate Change in Australia)*.

8 See Senate Rural and Regional Affairs and Transport Committee, *Climate change and the Australian agricultural sector: Interim report* (Interim Report), September 2008, Chapter 2, and specifically pp 5-6, on the issue of the uncertainty of climate change predictions and pp 10-11 on the need for downscaling of climate projections.

9 *Submission 32*, pp 6-7, emphasis in original.

10 Interim Report, p. 13.

Climatic impacts of climate change

2.12 The CSIRO's submission provided an extensive description of the likely range of impacts of climate change, by region and by agricultural industry.[11] The Queensland Government and the Victorian Department of Primary Industries also provided the committee with detailed information on the impacts of climate change on the specific agricultural industries in those states.[12] Industry organisations also made submissions to the committee setting out the potential impacts of climate change on their specific industry.[13]

2.13 This section of the report discusses some of the common biophysical impacts that were raised in submissions and evidence:

- competition for water resources and reduced water availability;
- increases in temperature;
- increasing frequency of extreme climatic events;
- elevated levels of carbon dioxide in the atmosphere; and
- pest and disease distribution and pathogenicity, and weed distribution and management.

2.14 Although issues are discussed individually, it is important to recognise that there is extensive interplay between impacts.

Water resources

2.15 One of the well-recognised implications of climate change on the agricultural industry, particularly in southern Australia, is reduced water availability in a hotter, drier climate.[14] This was highlighted in the Intergovernmental Panel on Climate Change Fourth Assessment Report:

> As a result of reduced precipitation and increased evaporation, water security problems are projected to intensify by 2030 in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions...[15]

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11 *Submission 32*, pp 7-11.

12 Victorian Department of Primary Industries, *Submission 27*, p. 5; Queensland Government, *Submission* 30, pp 8-12.

13 See for example: Apple and Pear Australia Limited (APAL), *Submission 23*, pp 3-6; Growcom, *Submission 31*, pp 9-10.

14 See for example: NFF, *Submission 24*, p. 4; Agricultural Alliance on Climate Change, *Submission 37*, p. 8.

15 Hennessy, K., B. Fitzharris, B.C. Bates, N. Harvey, S.M. Howden, L. Hughes, J. Salinger and R. Warrick, 2007: *Australia and New Zealand. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, p. 509.

2.16 As the CSIRO noted in its submission, there are multiple factors which interact to threaten water resources: significant development of surface and groundwater resources; declining rainfall in recent decades; and projected reductions in future rainfall and runoff.[16]

2.17 The New South Wales Irrigators' Council submission clearly sets out the implication of reduced water availability - competition for water resources amongst all users:

> We have recognised that there are multiple users of water – human needs, stock needs, the environment and irrigated agriculture.
>
> We have recognised that those users must share the available water resources – and that some needs are more critical than others.
>
> We have recognised that water must be distributed based on sustainable yields over the longer term.[17]

Implications of reduced water availability

2.18 Reduced water availability affects all areas of the agricultural sector, and many submissions emphasised this point. The NSW Irrigators' Council noted:

> Irrigation sits at the very forefront of climate change policy. The availability and reliability of water is clearly at the heart of irrigation. It is also at the heart of climate change.[18]

2.19 The Western Australian Department of Water highlighted the importance of reliable on-farm water supplies in the dryland agricultural areas of Western Australia:

> … seasonal fluctuations in rainfall necessitate the design of reliable on-farm water supplies so that farming enterprises can continue to function in years with low rainfall. When failure occurs, carting water generates high costs to the farmer in terms of both dollars and time.[19]

2.20 Apple and Pear Australia Limited (APAL) outlined the value of water for its industry:

> In a hotter, potentially drier climate, evaporation and transpiration will be increased leading to increased demands for irrigation and increased water use per hectare. Water has become a valuable resource and is often not available when required. This increased requirement for water, if water is expensive or not available, would lead to reduced orchard viability.[20]

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16 *Submission 32*, p. 11. See also: Victorian Department of Primary Industries, *Submission 27*, p. 7.

17 *Submission 18*, p. 3. See also: Gwydir Valley Irrigators Association, *Submission 14*, p. 3.

18 *Submission 18*, p. 2.

19 *Submission 26*, p. 2.

20 *Submission 23*, p. 4.

2.21 The CSIRO in its coverage of the impacts of climate change on the Australian agriculture sector, highlighted a number of industries as vulnerable to reduced rainfall and water availability. For the sugarcane industry the projected change in the amount, frequency and intensity of future rainfall will be '[p]robably the greatest impact (and adaptation challenge)':

> In many regions the amount of effective rainfall available to the crop will be reduced, whilst water demand is likely to increase due to greater rates of evapotranspiration linked to atmospheric warming.[21]

2.22 In relation to viticulture, the CSIRO said the 'water demand of winegrape vines will increase in a warmer climate while rainfall and, more importantly, runoff to water storages is projected to decrease'.[22] The CSIRO also highlighted the vulnerability of cropping in current 'dry margins', but did note that there may be an expansion into areas that are currently too wet for regular cropping.[23] The CSIRO also indicated that the irrigated dairy industry would be impacted by reduced water availability and concluded that there should be an assessment of the vulnerability of irrigated dairy to reduced water supply.[24]

The relationship between rainfall and run-off

2.23 The committee's Interim Report highlighted the disparity in rainfall projections by different climate models and the difficulty this creates in making definitive statements about changes in precipitation.[25] Dr Mark Howden of the CSIRO noted that for southern Australia there is 'a fair bit of congruence in terms of predictions of lower rainfall', however there still remains uncertainty as to whether there will be a large or small amount of reduction.[26]

2.24 In addition to the uncertainty of predicting changes in rainfall is the further complexity in determining how reduced rainfall will impact on run-off. eWater Cooperative Research Centre (eWater CRC) explained the nature of the relationship in its submission:

> A decrease in catchment precipitation of 10% may lead to a decrease in catchment runoff in the order of 20% to 30%, due to complicated non-linear relationships between the factors.[27]

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21 *Submission 32*, p. 13.

22 *Submission 32*, p. 14.

23 *Submission 32*, p. 8.

24 *Submission 32*, pp 8, 9, 10, and 24.

25 Interim Report, p. 8.

26 *Committee Hansard*, 30 June 2008, p. 15.

27 *Submission 8*, p. 4.

2.25 Dr Michael Coughlan of the Bureau of Meteorology explained to the committee the difficulties in accurately measuring reductions in run-off:

> …measuring rainfall is a lot simpler than measuring run-off. In measuring rainfall we put a bucket out there and measure how much rain falls into it. What happens to the rain after it falls is a pretty complex process. You cannot – or it is difficult – to measure it directly, except what then ultimately ends up in the rivers. So that generally has to be done through some modelling process and if that modelling process is 'uncertain'…often what we ultimately observe will differ from what we actually model. Getting the modelling right is a difficult process. It often depends very much on the particular catchment for which you are doing your modelling. So what you might observe as effective run-off in, say, Western Australia might differ quite markedly from, say, in south-eastern Australia.[28]

2.26 Professor Michael Young of the Wentworth Group of Concerned Scientists, acknowledged that there was much more 'sophisticated' science behind such predictions, but provided the committee with a 'rule of thumb' estimation for reduction of run-off resulting from a reduction in rainfall:

> The reality is…that for every one per cent reduction in mean rainfall, inflows into dams dropped by about three per cent. As you get to really dry steps, it becomes more like four per cent and even five per cent. That really matters and it happens because you have to wet a landscape before you get run-off.[29]

2.27 The evidence of a representative of the Murray-Darling Basin Commission, in describing the impact of successive dry seasons on run-off in the Murray-Darling Basin, provided a prime example of the phenomena described by Professor Young:

> What we have at the moment with the current situation is the 10 lowest rainfall years on record, and so average inflows into the Murray system have dropped dramatically. The year 2006-07 was the driest on record. But perhaps more importantly there has never been a period of regularly dry seasons one after the other…
>
> The pattern we have been seeing is that rainfall has been reduced during the autumn. The effect of this is that the catchments do not wet up in the same way as they did previously and so there is a much greater decline in run-off than in rainfall.[30]

2.28 The committee also questioned representatives of the Murray-Darling Basin Commission on how reduced inflows into the Murray-Darling Basin would impact on the water available for irrigation and the environment:

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28 *Committee Hansard*, 30 June 2008, p. 23.

29 *Committee Hansard*, 1 July 2008, p. 40.

30 Mr Jason Alexandra, Director, Water Policy Coordination, Murray-Darling Basin Commission, *Committee Hansard*, 30 June 2008, p. 67.

> There was work done by the Victorian Department of Sustainability and Environment as part of the northern region water strategy…that looks at the reduction of inflows under a range of scenarios and then how that would play out in terms of reductions to irrigation and to environmental flows…For example, for the Murray, under the medium impact of climate change scenario, they have modelled a 25 per cent reduction in inflows, a six per cent reduction to irrigation and a 33 per cent reduction to the environment. So that is assuming that, if you like, the rules are not changed and you will get that disproportionate impact for the environmental water.[31]

2.29 The representative for the Murray-Darling Basin Commission agreed that such a disproportionate impact would not be sustainable.[32]

Sustainable Water Policies

2.30 The Gwydir Valley Irrigators Association stated in its submission that one of the challenges of government is to decide how to share what may be decreased, or increased, levels of water availability.[33]

2.31 The committee received submissions giving examples of water policies which enabled sustainable water distribution to agriculture. The Western Australian Department of Water noted that 'a well planned, well organised and integrated' approach to water supply development was required in the dryland areas of the agricultural regions of Western Australia:

> The Rural Water Plan was developed as a strategic tool to encourage rural farming communities to be involved in water supply projects; accept an element of responsibility; take ownership of local water supply assets; and engage in an ongoing planning and improvement process. By employing an integrated planning approach, it is possible to develop reliable on-farm water supplies that meet all domestic, crop spraying and livestock needs in most agricultural areas. An ad hoc approach to water supply development can result in inadequate or ineffective supplies that fail during extended dry periods which are predicted to be the norm in the future.[34]

2.32 Both the NSW Irrigators' Council and the Gwydir Valley Irrigators Association made submissions to the effect that the current water sharing plans in NSW are robust enough to deal with climate variability and climate change. In its submission the NSW Irrigators' Council described how, in NSW, Water Sharing Plans (WSPs) have been documented and agreed which recognise the multiple demands on water resources:

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31 Mr Jason Alexandra, *Committee Hansard*, 30 June 2008, p. 70.

32 Mr Jason Alexandra, *Committee Hansard*, 30 June 2008, p. 70.

33 *Submission 14*, p. 2.

34 *Submission 26*, p. 2.

> An Available Water Determination (AWD) pursuant to the WSP is made on a regular basis stating the total amount of water that can be used in a delineated time period by all users. In the event that climate variability or change result in less water being available, the AWD method set out in the WSP will distribute that water which is available in a pre-determined method.[35]

2.33 However, the Murray-Darling Basin Commission noted in their evidence that current systems for water distribution only cover part of the extraction cycle:

> What we are really seeing is – under scarcity of water – that there is increasing demand. There are a whole lot of ways of accessing that available water resource, and the systems we have for allocating water have only developed to deal with part of the extraction cycle.[36]

Higher temperatures

2.34 Higher temperatures are projected to have significant impacts on the Australian agriculture sector. Dr Mark Howden of the CSIRO noted in his evidence to the committee that there is a 'strong degree of congruence in the forecasts about increases in temperature' and these can be slated back to regional implications.[37]

2.35 The CSIRO's submission stated that there is an increased likelihood that heat stress on livestock and crops is likely to occur in certain areas of Australia, for example the 'Mediterranean' south-west of Western Australia, the south-east of South Australia, and the south-west of Victoria; and the 'subtropical moist' areas of the south-east coast.[38] The Queensland Government also stated in its submission that heat stress would constrain beef production and that heat shock will decrease the dough making qualities of grain.[39]

2.36 The CSIRO noted the intensive livestock industry in south-west Tasmania may benefit from 'warming and drying' and there may be reduced energy demands for heating production sheds.[40]

2.37 Growcom provided the committee with details of a grower workshop on horticulture and climate change it hosted in January 2008. Participants at the workshop indicated that increased temperatures were an important issue for consideration in the horticultural industry:

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35 NSW Irrigators' Council, *Submission 18*, p. 3.

36 Mr Jason Alexandra, *Committee Hansard*, 30 June 2008, p. 70.

37 *Committee Hansard*, 30 June 2008, p. 15. See also: Interim Report, p. 7; Agricultural Alliance on Climate Change, *Submission 37*, p. 7.

38 *Submission 32*, p. 8.

39 *Submission 30*, pp 1 and 9.

40 *Submission 32*, p. 7.

> increased temperature is likely to present a more critical issue than reduced rainfall due to the sensitivity of crops to temperature change and the intensive / irrigated nature of horticulture production.[41]

2.38 APAL outlined in its submission that increasing temperatures will be an important factor for the pome fruit industry:

> The most obvious impact for pome fruit such as apples and pears will be the expected continued rise in temperatures and hence a reduction in chilling hours.
>
> …Another impact of warming, particularly rising minimum temperatures, is expected to be a decreased incidence of frost. As apples require frost-free conditions once the buds begin to open there may be some benefits in this. However, the situation is likely to be more complex. For example, if rising minimums are accompanied by greater variability there may be an increased risk of unexpected frost at critical times.[42]

2.39 Evidence to the committee also demonstrated the important interplay between higher temperatures and reduced water availability:

> …just a one per cent increase in average temperature is deemed to have a significant impact, because it means that the longer, warmer period of active plant growth – those forested catchments – will use more water and, therefore, less will go as run-off.[43]

2.40 Increasing temperatures are also expected to have impacts on pest and disease distributions across Australia, and this is discussed below in the section 'Pests, disease and weeds'.

Extreme climatic events

2.41 The committee's Interim Report briefly discussed *Climate Change in Australia's* projections in relation to extreme climatic events such as droughts, bushfires and storms. *Climate Change in Australia* projected that there would be:

- increases in agricultural droughts (periods of extremely low soil moisture);
- a substantial increase in fire weather risk in south-eastern Australia; and
- the potential for significant increases in inundations from storm surges, resulting in flooding and erosion, due to higher mean sea level and more intense weather systems.[44]

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41 Growcom, *Submission 31*, attachment: Growcom, *Growcom horticulture and climate change workshop report*, 25 January 2008, p. 4.

42 *Submission 23*, p. 3.

43 Mr Jason Alexandra, *Committee Hansard*, 30 June 2008, p. 78.

44 *Climate Change in Australia Summary Brochure – Observed changes and projections*, pp 11-12. See also: Interim Report, p. 9.

2.42 The Intergovernmental Panel on Climate Change also highlighted the effect of drought and fire on agricultural and forestry production in Australia:

> By 2030, production from agriculture and forestry is projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire.[45]

2.43 The committee received some submissions and evidence on the impact that these extreme climatic events would have on the Australian agricultural sector. The Victorian Department of Primary Industries stated in its submission that these increases in extreme climatic events were a greater threat to agriculture and forestry than anticipated changes in temperature:

> Increased climate variability, which implies an increased frequency and intensity of extreme climatic events, is likely to pose a greater threat to many agriculture and forestry businesses than anticipated changes in average temperatures. This is due to its combination of greater unpredictability coupled with increased intensity of natural disasters e.g. fire, flood, drought and disease. An important issue for farmers is their capacity to recover from extreme climate-related events such as droughts, floods and fires.[46]

2.44 Similarly, the BoM stated that the impact of climate change on agriculture will result in the interaction of climate variability and long-term trends, leading in particular to more frequent extreme events:

> Such outcomes might be characterised by events such as the recent droughts, which have seen record high temperatures compounding the rainfall deficiencies.
>
> This interaction means that climate change is likely to occur as a series of shocks during which systems experience new combinations of stressors.[47]

2.45 The evidence to the committee on the impacts of drought demonstrated that the impacts went beyond reduced precipitation and water availability. Ms Nicolette Boele of the Agricultural Alliance on Climate Change (AACC) described the ongoing pressure of droughts as a 'cancer', which will only be exacerbated by climate change.[48] The Queensland Government's submission noted that more frequent and severe drought events would mean that the state's stock route network, which is used for moving stock and short term drought relief, would become increasingly important to the pastoral industry.[49] The CSIRO also noted that the cost of horticultural crops tend

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45 IPCC, 2007: *Climate Change 2007: Synthesis Report. Contributions of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, p. 50.

46 *Submission 27*, p. 12 (references not included). See also: Growcom, *Submission 31*, p. 7.

47 *Submission 7*, p. 4.

48 *Committee Hansard*, 1 July 2008, p. 22.

49 *Submission 30*, p. 9.

to rise during droughts, and that this would be expected to occur more often if there was an increased frequency of droughts.[50]

2.46 A number of submissions highlighted the potential risks faced by the forestry industry from a projected increase in frequency and severity of bushfires.[51]

Rising carbon dioxide (CO_2) levels

2.47 Another of the biophysical changes that may have an effect on agricultural production is the increasing concentration of carbon dioxide in the atmosphere. As the eWater CRC explained in its submission:

> The effect of rising atmospheric CO_2 concentrations on vegetation growth in agricultural zones, generally, is to increase vegetation productivity for a given amount of available water (i.e. precipitation). This 'CO_2-fertilisation' effect will go some way to counteracting decreases in productivity if precipitation decreases over time.[52]

2.48 The eWater CRC submission goes on to state that there is some evidence already that there have been increases in vegetation cover over the past 2-3 decades, even in places where precipitation has declined. However, the eWater CRC cautions:

> There are no simple, generic rules about how vegetation will change. There is some evidence indicating that enhanced CO_2 concentration will increase the productivity of long-lived, deep-rooted species (e.g., perennial vegetation) more than short-lived species (e.g., annual grasses and crops).[53]

2.49 According to the eWater CRC, the implications of this are that tree-based cropping systems may become relatively more productive than those systems are currently.[54] On this point, the CSIRO note that grazing in some regions of Australia may be impacted by rising carbon dioxide levels favouring trees over pasture production, and that pasture quality may decline.[55]

2.50 The Queensland Government submission also noted that a rise in carbon dioxide concentration in the atmosphere may increase pasture growth, particularly in water-limited environments. However, the Queensland Government referred to studies

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50 *Submission 32*, p. 15.

51 See for example: National Association of Forestry Industries, *Submission 6*, p. 2; Victorian Department of Primary Industries, *Submission 27*, p. 5; and CSIRO, *Submission 32*, p. 15.

52 *Submission 8*, p. 4. See also: CSIRO, *Submission 32*, p. 9, in relation to impacts of grazing in the subtropical sub-humid areas of Australia where the impacts of reduced rainfall and increasing incidence of drought on savannas may be offset by increased CO_2 levels and prolonged growing season from warming.

53 *Submission 8*, p. 5.

54 *Submission 8*, p. 5.

55 *Submission 32*, pp 9-10, in relation to grazing in the subtropical sub-humid, tropical warm-season moist, and tropical warm-season wet areas of Australia.

which indicated that this increase in plant productivity may be offset by a 10% reduction in rainfall:

> A rise in CO_2 concentration is likely to increase pasture growth, particularly in the water-limited environments in Australia and specifically Queensland. However, if rainfall is reduced by 10%, this CO_2 benefit is likely to be offset. A 20% reduction in rainfall is likely to reduce pasture productivity by an average of 15% and live weight gain in cattle by 12%, substantially increasing variability in stocking rates and reducing farm income.[56]

2.51 The Queensland Government submission also outlined the impact of increased levels of carbon dioxide in the atmosphere on the nitrogen content of plants:

> Elevated concentrations of CO_2 significantly decrease leaf nitrogen content and increase non-structural carbohydrate, but cause little changes in digestibility. In farming systems with high nitrogen forage (e.g., temperate pastures), these effects are likely to increase energy availability, nitrogen processing in the rumen and productivity. In contrast, where nitrogen is deficient (e.g., Queensland's extensive rangelands), higher temperatures are likely to exacerbate existing problems by decreasing non-structural carbohydrate concentrations and digestibility, particularly in tropical C4 grasses.[57]

2.52 eWater CRC also noted that with increasing levels of carbon dioxide, and the possibility of increased productivity to some types of vegetation, woody weed control may become increasingly important.[58] The CRC for National Plant Biosecurity stated that elevated carbon dioxide levels in the atmosphere may also affect plant pest pathogens.[59] The issue of weed management and pests is discussed further in the section 'Pests, disease and weeds'.

Pests, disease and weeds

2.53 A number of submissions highlighted the impact changing climate could have on the distribution and pathogenicity of pests and diseases, and weed distribution and management. These impacts are generally secondary impacts, resulting from changes in temperature, rainfall or atmospheric carbon levels.[60]

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56 *Submission 30*, p. 9 (references not included). See also: Victorian Department of Primary Industries, *Submission 27*, p. 7.

57 *Submission 30*, p. 9 (references not included).

58 *Submission 8*, p. 5.

59 *Submission 16*, p. 2.

60 See for example Council of Australasian Weed Societies Inc, *Submission 5*; Cooperative Research Centre for National Plant Biosecurity (CRC for National Plant Biosecurity), *Submission 16*; CRC for Australian Weed Management, *Submission 19*; Queensland Government, *Submission 30*, pp 6-7.

Distribution and pathogenicity of pests and diseases

2.54 The CRC for National Plant Biosecurity stated in its submission that changes are already occurring in the distribution of pests and pathogens:

> A poleward shift in the geographical range of some pests and pathogens has been observed during the last century … Rising temperatures associated with climate change are predicted to be associated with the future poleward movement of other Emergency Plant Pests (EPPs) …[61]

2.55 The CRC for National Plant Biosecurity used the example of citrus canker to demonstrate how these changes could impact the Australian agricultural sector:

> A recent modelling analysis indicated that if citrus canker had become established in Queensland, the geographical range of the pathogen, *Xanthomonas axonopodis* pv.*citri*, was predicted to extend further south to major Australian citrus growing regions with a 1-5ºC temperature increase …[62]

2.56 APAL indicated that increased pesticide applications, one of the potential flow on effects of changed plant pest distributions, could impact on the export market for orchard fruits:

> Warmer conditions will have significant effects on the orchard ecosystem including many orchard pests and potentially their predators. There will be movement of warm climate pests, notably fruit flies, from warmer production areas to areas that are currently free of these pests. This would necessitate additional pesticide applications targeting this pest and potentially affects market access for fruit to export countries such as Japan.
>
> For other pests such as codling moth and light brown apple moth, it is anticipated there would be an increase in the number of breeding cycles per year … As the number of insects in an orchard increases with each breeding cycle an extra cycle will lead to a substantial increase in insect pressure. This has a compounding effect in that the extra cycle also leads to an increase in the number of insects that over winter and hence to an increase in the number of insects present in the first breeding cycle in the following spring. As many of the chemicals used to control these pests are banned in export countries, as are the presence of live insects in consignments, this would have a negative impact on the export of fruit out of Australia.[63]

2.57 APAL also stated that warmer weather would also increase the incidence of plant diseases:

> …plant diseases grow, multiply and infect at faster rates in warmer weather. Hence with global warming there would be an increase in the incidence, severity and spread of orchard diseases that will need to be

61 *Submission 16*, p. 1 (references not included).

62 *Submission 16*, pp 1-2 (references not included).

63 *Submission 23*, p. 6.

> controlled. This would have a very negative impact on the growing organic industry, which lacks good disease control chemicals. In addition, as for insecticides, many of the chemicals used to control these diseases are banned in export countries, as are the presence of the diseases in consignments.[64]

2.58 The Queensland Government, while highlighting the many ways climate change could impact on the distribution of pests, also noted that there may be some benefits of climate change in terms of controlling some pests:

> Climate change will reduce the impacts and/or range of some pest species and there is likely to be increased opportunities to better manage some species due to less favourable climatic conditions (e.g. reduced rainfall, drought).[65]

2.59 While predictions can be made about the changing distribution of plant pests, the CRC for National Plant Biosecurity expressed the concern that other impacts of plant pests required further investigation:

> While future spatial distribution can be predicted under climate change scenarios using models and examining historical trends, there appears to be limited knowledge of how climate change will impact on the biology of the EPPs (e.g. pathogenicity) and how the interaction with their host responds to potentially many climatic factors. Major climate change factors identified that affect plant pest infestation and diseases include increased atmospheric CO_2, frost, heavy and unseasonal rains, increased humidity, drought, cyclones and hurricanes, and warmer temperatures.[66]

2.60 Of particular concern is the impact of increased levels of carbon dioxide in the atmosphere which, according to the CRC for National Plant Biosecurity, may modify pathogen aggressiveness and/or host susceptibility and affect the initial establishment of the pathogen.[67]

2.61 The Queensland Government submission also addressed the impact of climate change on the distribution and pathogenicity of animal diseases:

> The world is facing an unprecedented impact from emerging and re-emerging animal diseases that have a major impact on production and trade (e.g. nipah virus, foot and mouth disease, tuberculosis). Climate change can affect many processes that influence animal diseases including the pathogen or parasite, the host, the vector and the behaviour of the disease (epidemiology). Warmer temperatures and more extreme rainfall events will produce conditions that are more favourable to many livestock

64 *Submission 23*, p. 6. See also: Growcom, *Submission 31*, p. 9.

65 *Submission 30*, p. 6.

66 *Submission 16*, p. 2.

67 *Submission 16*, p. 2.

> diseases. Insect vectors of disease such as mosquitoes and midges are likely to expand their range increasing the risk of disease spread to new areas.[68]

Weed distribution and management

2.62 The committee received a limited number of submissions that highlighted the importance of weed distribution and management as one the impacts arising from climate change.

2.63 In its submission, the CRC for Australian Weed Management summarised the potential that climate change presented for weed invasion:

> Overall, climatic changes place existing vegetation, whether native, pasture or crops, under stress. This creates spaces for new species to move into, and species with efficient dispersal mechanisms, whether by bird, wind, water or by human activities, are the best equipped to take advantage of the spaces created. Invasive plants generally have excellent seed transport mechanisms, often by human activity or by birds, and are likely to spread rapidly into new areas, quickly exploiting changing climatic conditions that favour their establishment. Climate change can therefore be expected to favour invasive plants over established vegetation including crops, especially if accompanied by an increase in extreme conditions such as droughts alternating with very wet years.[69]

2.64 The CRC for Australian Weed Management outlined in its submission how specific changes in climate may impact weed distribution, for example: as a result of higher temperatures all invasive plants can be expected to shift southward in range, with tropical and subtropical species moving south, and temperate species being displaced southward; many weeds have a carbon metabolism which will benefit greatly from increased atmospheric carbon dioxide; reduced rainfall may limit or reduce the distribution of weeks in some localities. However, the CRC for Australian Weed Management stated that there was a 'real need for an independent scientific review of currently-available modelling tools used to predict how plants, in particular current and potential weedy species, will respond to changing climate scenarios'.[70]

2.65 In evidence to the committee, Associate Professor Christopher Preston of the CRC for Australian Weed Management stated that, in his opinion, the biggest issue for weed distribution in the context of climate change is the reduced availability of water:

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68 *Submission 30*, p. 7.

69 *Submission 19*, p. 1. See also: the Department of Agriculture, Fisheries and Forestry and Department of Climate Change, *Submission 34*, p. 3.

70 *Submission 19*, pp 1-2. See also: eWater CRC, *Submission 8*, p. 5, on the impacts of elevated atmospheric carbon dioxide levels and the potential implications for woody weed management; CSIRO, *Submission 32*, p. 9, which states that pest and disease impacts on the horticultural industry in temperate cool-season wet regions may be reduced with lower rainfall projected.

> One of the issues that arise is the inability to have good pasture coverage because of lower rainfall patterns at various times, and that allows weed invasion into pastures. The second one that is quite important in the grains industry has been the change in rainfall pattern from one almost entirely dominated by winter rainfall to having increasing amounts of summer rainfall. Farmers are needing to spend more time, effort and money controlling summer weeds because they need that moisture to grow a crop. Severe weather conditions can also be a major issue because they create gaps in the environment for weeds to invade.[71]

2.66 Associate Professor Preston also identified the abandoning of farms, arising from reduced water availability, as another potential means of weed invasion:

> The majority of farmers in Australia have most of their equity in land and their land is only as valuable as the water that they can get. So with declining water resources, whether that is declining irrigation or declining rainfall, there is the chance that for many of these farmers their land will become less and less valuable. That makes it more and more difficult for them to move out of the industry or move into different industries and it creates the issue where, instead of changing industries, the land is just abandoned and allowed to go to waste. Again, that is an opportunity for weed invasion.[72]

2.67 The CRC for Australian Weed Management also indicated that there is a need to modify existing weed risk assessment systems to take into account possible 'sleeper' weeds that may be favoured by a changing climate.[73]

2.68 In evidence to the committee, Associate Professor Preston raised a further issue in relation to weed management, specifically the introduction of species for biofuel production:

> The Australian environment is littered with examples of industries which seemed like a good idea at the time but which, for one reason or another, never really made it. In many of those situations we have plant species that have become weeds and animal species that have become feral. Rubber vine is probably a good example of this; olives are another example that I am very familiar with, coming from South Australia – these sorts of boom and bust industries. I think we need to be very careful about how we go forward with the biofuels sector. Many of the species that have been touted as prominent biofuels species, like jatropha, are well known worldwide for

71 *Committee Hansard*, 30 June 2008, pp 93-94.

72 *Committee Hansard*, 30 June 2008, p. 94.

73 *Submission 19*, p. 1. See also: Associate Professor Preston, *Committee Hansard*, 30 June 2008, p. 93; and Queensland Government, *Submission 30*, p. 6. Weed risk assessment systems are used by the Australian Quarantine and Inspection Service and others for border protection but also widely used by states and regions for post-border weed prioritisation.

> being weedy, and if the industries do not take off we could well be left with a legacy of weeds on our hands.[74]

2.69 The committee followed up the issue of the management of new species with Mr Kevin Goss of the Future Farm Industries CRC:

> We have a weeds protocol that the [Future Farm Industries] CRC has adopted and that we implement. The weeds protocol has being worked out in a joint project with the CRC for Australian Weed Management … We apply that to all that we do. That, importantly, is not simply about bringing plants into the country, which is a matter for Biosecurity Australia and [the Australian Quarantine and Inspection Service]; that protocol extends to how we manage the sites internally and to our ongoing observation of those sites and dealing with any issues that arise.[75]

2.70 The committee also received a submission from the Council of Australasian Weed Societies Inc which stated that 'weeds are widely recognised as one of Australia's most pressing natural resource management issues' and that farmers have recently ranked weeds as their greatest national resource management issue. The Council of Australian Weed Societies submission also noted the social costs that weed management impose on farmers:

> These include health risks through toxins in livestock products and allergenic pollens, loss of access and amenity in national parks and waterways, and increased fire risks in peri-urban areas from dense thickets of invasive grasses and shrubs. The major social impact of weeds is the time-demanding nature of weed control – a loss of productive and recreational time borne by many Australians.[76]

Non-climatic impacts of climate change

2.71 The range of impacts of climate change on the Australian agricultural sector is not limited to climatic impacts. The next section of the report discusses the potential flow-on effects from climate change on three areas to demonstrate the breadth of climate change implications on the Australian agricultural sector, specifically:

- rural communities;
- biodiversity in the Australian landscape; and
- consumer expectations.

Rural communities

2.72 The impacts of climate change on the Australian agricultural sector will have immediate consequences for rural communities. The Agricultural Alliance on Climate

74 *Committee Hansard*, 30 June 2008, p. 94.

75 *Committee Hansard*, 30 June 2008, p. 90.

76 *Submission 5*, p. 1.

Change (AACC) painted a bleak picture in its submission of the impact of climate change on rural communities, particularly where farmers are struggling to adapt to changing their farming practices to new climatic conditions:

> …as is happening still in some areas of Australia gripped in drought, some farming families and communities will experience financial hardship and chronic social pressures, especially mental health issues.
>
> The recently established NSW Rural Mental Health Network identified climatic change impacts, such as drought, as a key external driver of mental health problems in rural Australia…the NSW Farmers' Association highlighted that deaths from suicide of male farmers and farm workers are now double that of any other group in the male population.[77]

2.73 The AACC submission went on:

> If adapting to climate change proves too difficult in some areas, populations will decline and the abandonment of rural towns and farming areas could follow, with the consequent loss of local history, culture and dire natural resource implications. The advent of weeds, pests, disease and erosion could be considerable resulting from the exodus from certain rural and remote areas.[78]

2.74 The Australian Landcare Council submitted that the social impacts of climate change for these communities is largely being ignored:

> Should climatic variability increase significantly, the social impacts may be considerable, especially among rural communities, although it should be said that not all social impacts will be negative. Studies by rural social scientists of this topic should be encouraged and supported.[79]

2.75 The committee's inquiries on this issue found that there is little evidence of work being done on the impacts of climate change on rural communities. Mr Andrew Dolling of the Victorian Department of Primary Industries indicated to the committee that the department is 'cognisant' of the social impacts of climate change:

> …we do take into consideration the social impacts of the various climate change and policy scenarios. We do have an area which is specifically undertaking social research related to a number of challenges that farming communities face, of which climate change is one. There are, of course, others.[80]

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77 Agricultural Alliance on Climate Change, *Submission 37*, p. 10.

78 Agricultural Alliance on Climate Change, *Submission 37*, p. 10.

79 *Submission 13*, p. 5.

80 *Committee Hansard*, 1 July 2008, p. 70.

2.76 Ms Boele of the AACC informed the committee that the AACC has not done much work investigating the flow-on effects of climate change on rural communities, however, the AACC is 'very committed' to better understanding those impacts.[81]

Biodiversity in the Australian landscape

2.77 The submission from Hawkesbury Harvest explained the important role that the agricultural sector has in maintaining biodiversity in the Australian landscape:

> Agriculture has an important role in providing for biodiversity at a landscape scale. Agricultural landscapes are where soils are produced, nutrients recycled, water infiltrates through crops/grasslands. These landscapes are also useful for maintaining remnant vegetation that can act as fauna links through vegetative corridors and buffer the edge of urban development from natural areas.[82]

2.78 Representatives of the forestry industry also gave evidence to the committee about the important role that sector plays in maintaining biodiversity.[83]

2.79 Given the important role that agriculture has in this area, the committee was interested to hear about the impacts that climate change would have on biodiversity. The committee was told by a number of organisations how they assessed the biodiversity impacts of climate change and adaptative options.

2.80 In evidence to the committee Dr Mark Howden of the CSIRO noted that 'one of the three delivery themes that the Climate Adaptation Flagship focuses on is biodiversity and ecosystem services'. Further, Dr Howden stated that 'clearly' this issue is in the CSIRO's sights in its work on investigating adaptation by the agriculture sector.[84]

2.81 Mr Goss of the Future Farm Industries CRC also gave evidence about how that organisation's research aims to look at the impacts of biodiversity:

> …we are selecting among native plants for potential productive plants on farms. Some of these are known but some are very new. We have people who have been out plant collecting and looking afresh at a whole suite of Australian native plants and then putting them through an assessment. We have got this down to, let's say, tens of plants that we think are worth a

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81 *Committee Hansard*, 1 July 2008, p. 22.

82 *Submission 12*, attachment: Ian Knowd, David Mason, Andrew Docking, *Urban agriculture: The new frontier*, Changing City Structures, 2006, p. 23-12 (references not included).

83 Mr Allan Hansard, Chief Executive Officer, National Association of Forest Industries, *Committee Hansard*, 30 June 2008, p. 101.

84 *Committee Hansard*, 30 June 2008, p. 3; See also: Dr Michael Robinson, Executive Director of Land & Water Australia, and Chair of the Joint Strategy Team for the National Climate Change Research Strategy for Primary Industries (CCRSPI), *Committee Hansard*, 30 June 2008, p. 64. The National Climate Change Research Strategy for Primary Industries is discussed in detail in Chapter 5.

> closer look, and some of them are planted out already. Some are leguminous; some are not. They are all perennial and they are selected because they are very well adapted to what we see as the climate they are going to face in the future. You could conclude that that is a good thing from a biodiversity viewpoint, but—and I think this is behind your question—our job is not to assume that. Our job is, when it is in these potential productive systems, to actually observe that and then build some capacity to predict what the biodiversity benefits might be.[85]

2.82 The Sydney Centre for International Law outlined international obligations that the Australian Government has under the *Convention on Biological Diversity* (1992), as implemented in the *Environment Protection and Biodiversity Protection Act* 1999 (Cth). The Sydney Centre for International Law noted that such obligations may, in some cases, require Australia to abandon farming in areas where serious harm to biodiversity results:

> In such cases, it may be appropriate to return some areas currently used for pasture to protected areas such as national parks. There may be economic opportunities arising from increased tourism in new national park areas. Of course it should be noted that protected areas themselves will be subject to climate change pressures which will require responses.[86]

2.83 The committee heard evidence from Dr Christine Jones giving a very positive example of how changes to farm management practices were improving the biodiversity of some agricultural lands.

> Birds have also started to come back onto their farms. People have got thousands of little grass-feeding birds like cisticolas – which, honestly, I had never heard of – on their farms. Apparently they were very common at one time. And now that we are providing this habitat, little ground-foraging native animals like bettongs, which are like little rat kangaroos and live in grasslands, are coming back onto farms that at one time were sprayed from one end to the other and had no ground cover. So we are getting this whole biodiversity thing.[87]

Consumer expectations

2.84 The committee also received evidence on how climate change would impact on consumer expectations. For example, the Food Industry Council of Tasmania (FICT) highlighted the impact that climate change would have on the agricultural sector from a marketing perspective because consumers are becoming more discerning in their purchasing habits:

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85 *Committee Hansard*, 30 June 2008, p. 89.

86 *Submission 39*, pp 4-5.

87 *Committee Hansard*, 30 June 2008, pp 53-54.

> Food miles and carbon footprinting are two areas of focus for FICT due to Tasmania's relatively high value of agricultural products and our distance from consumer markets…
>
> In some cases, these factors are already affecting Tasmanian food and beverage products' access to markets both nationally and internationally.[88]

2.85 The FICT also noted a growing international movement to introduce 'carbon' labels, showing greenhouse gas emissions created in the production, transportation and eventual disposal of all products. The FICT noted that these carbon labels would allow consumers to make choices about their consumption based on the carbon footprint of the product.[89]

2.86 Mr Charles McElhone of the National Farmers Federation provided to the committee an example of one study demonstrating how food miles may be misrepresentative of the real impact of food production on the environment:

> …there are some studies out of Lincoln University in New Zealand which demonstrate that food from production systems in New Zealand shipped to Europe has a lower carbon footprint than the same food produced in a UK heated greenhouse and delivered to those same consumers. So to just look at the transportation element within the carbon footprint is very misleading.[90]

2.87 Mr McElhone went on to state that food miles may in fact be an opportunity for Australian agriculture:

> We are saying that it is widely acknowledged that Australian agriculture production systems are low intensity in terms of their emissions per unit of production output and therefore there may be an opportunity from a global marketplace perspective if we get the science right in understanding the life cycle of agriculture emissions in our production systems more effectively.[91]

2.88 Dr Michael Robinson of Land & Water Australia indicated that food miles is definitely an area requiring further research:

> We have received a very clear, very strong message that we need to do full life cycle analysis on agricultural products so that we do not get inappropriate, I guess, or the wrong answers out, and so that we do not get perverse outcomes.[92]

2.89 Meat and Livestock Australia also highlighted the impacts of changing consumer demands in the light of climate change:

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88 *Submission 25*, p. 1.

89 *Submission 25*, p. 1.

90 *Committee Hansard*, 1 July 2008, p. 29.

91 *Committee Hansard*, 1 July 2008, pp 29-30.

92 *Committee Hansard*, 30 June 2008, p. 63.

> …The increased media focus on greenhouse implications of products, including food is creating an expectation of environmental 'ethics' that is subject to manipulation by advocates of particular views, e.g. the anti-meat lobby. A shift away from meat-based diets towards vegetable-based diets will have important ramifications for the economic viability of livestock producers and processing industries. It will also have impacts on landscape health if more fragile lands are cropped rather than grazed, especially under irrigation.[93]

93 *Submission 36*, p. 5.