Understanding and managing the impacts of climate on the

Australian Vegetable Industry

Changes, threats and opportunities and what you can do

www.vegetableclimate.com

Contents

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Cover photo: Measuring greenhouse gas emissions in the field, Camden NSW.

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Introduction

The Australian vegetable industry has recognised that issues around climate variability and climate change may affect growers and the broader industry. A review was commissioned by HAL in 2013 to provide a comprehensive assessment of these threats and opportunities, and develop a plan for the future.

The Australian vegetable industry is in a very strong position to deal effectively with climate change. The industry has excellent climate change credentials, is a low emitter of greenhouse gases, and has one of the lowest carbon and water footprints of any food producer. Vegetable growers also have greater capacity to adapt to change than most other rural industries.

The threats, however, are serious and the industry should not be complacent.

The viability of vegetable production can be affected either by the physical impacts of a changing climate, or by government policies aimed at addressing climate issues.

There will also be opportunities and help is available to take advantage of these. The review has focussed on identifying actions growers and the industry can take in the short and longer term to safeguard the Australian vegetable industry against climate-related threats.

Strategies identified as having the highest benefits are:

- Strategies to grow crops in a more variable climate including: varieties, irrigation practices, shading and protected cropping, postharvest cooling practices.
- Reducing electricity usage for cool rooms and pumps.
- Support the development of more accurate long-range (3-month) weather forecasts for vegetable growing regions.
- Access available funding to help with energy efficiencies and reducing emissions.
- Understand the likely regional changes in climate and develop strategies to manage the risk.
- Use tools to help manage climate impacts.
- Take advantage of the industry's excellent climate credentials in promotion and marketing.
- Develop an effective industry research plan.

The project team has produced detailed summaries and analyses of likely regional impacts on the production of major vegetable crops, impacts of government policy, strategies for dealing with change and opportunities for funding to support these measures. There is also a research investment plan to help inform the future direction of investment in climate change by the vegetable industry.

The project website is the place to go for all the project outputs, climate change resource material and current information on climate variability and the Australian vegetable industry.

Some of the highlights from the project are featured in this brochure. Full details and much more are available on the website www.vegetableclimate.com.

The Vegetable Climate website

The Vegetable Climate website is the place to go for information on climate and vegetables in Australia. You will find a wealth of useful information under the following headings:

Climate variability: Current assessment; Predicted changes; Regional predictions.

Government Impacts: Policy and regulations; Carbon Farming Initiative; Government support and funding.

Vegetable Industry Impacts: Climate credentials; Crop impacts; Profitability; Research and reports.

Strategies: Energy efficiency; Adaptation; Mitigation; Tools.

The site has current news, new reports and other new material relevant to the Australian vegetable industry. You can find the site at **www.vegetableclimate.com** or follow the link from the AusVeg website **www.ausveg.com.au**

What will happen to the climate in our vegetable growing regions?

While there is debate in the rural community about the cause(s) of our changing climate, there is no disputing that changes have already occurred.

Since 1960 the mean temperature in Australia has increased by about 0.7°C. Some areas have already experienced a warming of 1.5 to 2°C. On average the strongest warming has occurred in spring (about 0.9°C) and the weakest in summer (about 0.4°C).

The intensity and frequency of extreme weather events such as floods, cyclones, droughts and heatwaves will increase, and recent extreme events have already been linked to climate change.

The wine industry is already on the lookout for cooler climates. *Treasury Wine Estates*, the world's second-largest listed wine company, is seeking out vineyards in cooler regions in preference to ones in warmer areas as climate change starts to shift growing seasons.

"As the world heats, Tasmania's very well positioned because of the cooler climate. We've got out of places like the Hunter; in the longer term I think it will be hot and dry and expensive." (Treasury Wine Estates CEO David Dearie, SMH April 12, 2013).

Expected impacts on temperature

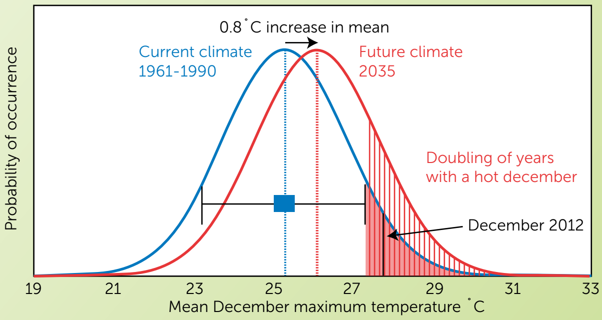
Changes in climate observed over the last 50 years will continue. For Australia, our best estimates are that by 2035, the temperature is projected to warm by about 1°C over Australia. Inland areas are likely to experience stronger warming of up to 1.8°C.

Southern winter production areas such as Werribee, Cranbourne and East Gippsland will benefit from higher average winter temperatures (0.5–1.2°C). These areas are used for summer production of leafy vegetables and will also experience higher average summer maximum temperatures

Case Study: Manjimup, WA

What do these predicted changes in temperature and variability mean for vegetable growers? To give an idea of what is predicted to occur, consider this case study of Manjimup, WA which experienced a 1:10 year heatwave in December 2012.

The average monthly temperature for December in Manjimup is 25.3°C and predicted to rise by 0.8°C to 26.1°C by 2035. This would mean that the number of hot Decembers (28°C average) will double from 1:10 to 1:5. In the figure below, the increased risk of a hot December is shown by the red shaded area.

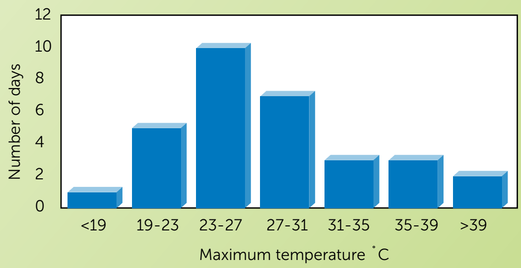


Source: The angry summer

Manjimup actually got a 1:10 hot December in 2012, and the average maximum temperature for the month was 27.8°C. But what did this mean?

The following figure shows the actual daily maximum temperatures experienced in December 2012.

While an average temperature of 27.8°C for December 2012 is only 2.5°C above the present average, and doesn't sound that bad, this included 5 days above 35°C and 2 days above 39°C.

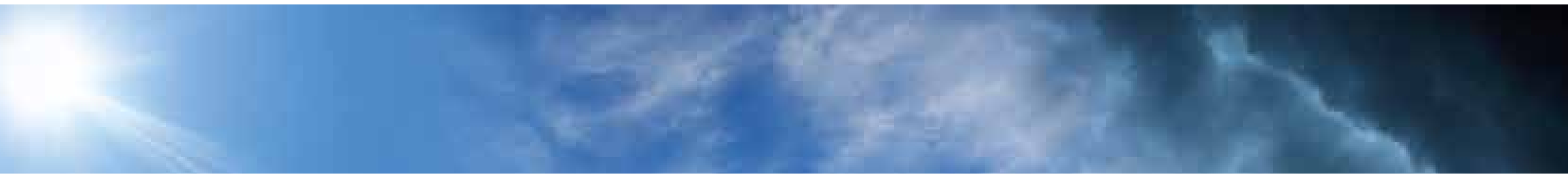


What did this mean for the crops growing at the time?

The crops grown in Manjimup over December are: lettuce, baby leaf crops (spinach, lettuce, rocket and others), brassicas and potatoes. Temperature requirements of these crops are shown in the table below. In all cases, temperatures in the 35+°C range are disastrous for cool season vegetables and will result in crop failures.

In our study, similar scenarios are predicted to increase in Gatton, Hay, Werribee and Murray Bridge. The only region studied that was likely to escape major temperature spikes was Devonport.

Crop	Growth and production			
	Min	Lower opt.	Upper opt.	Upper max
Babyleaf chard	5	15	18	24
Babyleaf rocket	5	16	24	32
Babyleaf spinach	5	15	18	30
Broccoli	4	15	18	30–32
Cabbage	7	15	18	24
Cauliflower	0	15	18	32
Lettuce – Cos	7	12	21	24
Lettuce – fancy and babyleaf	7	12	21	24
Lettuce – Iceberg	7	12	21	24



(0.6–1.3°C), making them more marginal. The northern cool season production areas such as Stanthorpe and the Atherton Tableland will become more marginal for cool season crops.

Central and northern regions used for winter and transition-period production of cool season crops will become more marginal at the boundaries of the seasons (early and late). Examples of these areas are the Lockyer Valley in spring/autumn for leafy vegetables and brassicas, central highlands and mid western areas of NSW.

Warm season crops in summer production areas will be less affected. There will be some effects on crops such as tomatoes and capsicums where pollination is adversely affected by average temperatures above 27°C, and there will be a marginal reduction in the length of production seasons.

The seasonality of frosts has already changed over the last 20 years, and analyses have revealed that in eastern Australia the frost window is both starting earlier (on average up to 10 days earlier by 2010) and ending later (up to 46 days later by 2010).

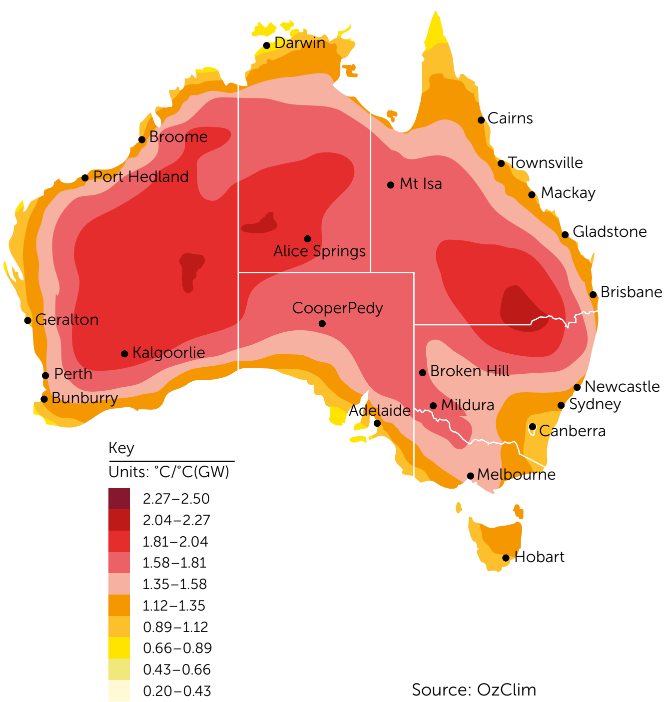
This means frost will be MORE likely to occur in the future.

Some examples of expected regional changes in temperature are shown below.

Expected regional changes in monthly average temperature by 2035

Region	Change in av. max (°C)	Change in av. min (°C)	Risk of 3–5 days > 40°C		Seasons of greatest temperature variability
			2012	2035	
Gatton (Qld)	+0.7– 1.4	+0.8–1.2	1:33	1:10	Spring and summer maximums; winter minimums.
Hay (NSW)	+0.7–1.4	+0.6–1.2	1:5	1:2	Spring, summer and autumn maximums.
Werribee (Vic)	+0.6–1.3	+0.5–1.0	1:5	1:2	Spring and summer maximums; minimums all year round.
Manjimup (WA)	+0.6–1.0	+0.5–0.9	1:5	1:3	Spring and summer maximums.
Murray Bridge (SA)	+0.6–1.1	+0.5–0.9	0	1:5	Summer maximums; summer, autumn and winter minimums.
Devonport (Tas)	+0.2–1.0	+0.2–0.8	0	0	Minimum temperatures in summer and autumn.

Predicted average monthly maximum temperature changes per °C of average warming for February[1]



Source: OzClim

1 http://www.csiro.au/ozclim

Expected impacts on rainfall and water

Rainfall patterns will become more variable but total rainfall amounts are not expected to change significantly, with exceptions such as south-western WA where rainfall will decline.

Rainfall is projected to decrease across Australia by 2–5% on average by 2035 (compared to 1990). The rainfall in far northern Australia is not expected to change. The rainfall in south-western Australia is projected to decline by 5–9% by 2035 adding to a 15% decline since 1988.

Crop water use is not predicted to change significantly and it is likely that the largest impact on crop water use will be the availability of water for irrigation.

Regional variability and longer-term climate predictions

Changes in temperature will not be uniform. Some areas will heat up more than average and others less than average. This map of Australia shows the expected changes in monthly maximum temperatures for February for every 1°C rise in average temperature. A value greater than 1 means the area will heat up more rapidly than the average and a value less than 1 means the area will heat up slower than the average. In the longer term (2070), Melbourne's climate is predicted to become like West Wyalong and Gawler; Sydney like Brisbane; Dubbo like Charleville; Brisbane like Ayr and Cairns like Weipa.

What are the major threats and opportunities for the vegetable industry?

Climate threats and opportunities

Short-term: (1–5 years) effects are increased weather variability and frequency of extreme weather events in our vegetable growing areas. This is already occurring.

Longer-term: (20 years) effects are increases in average temperature from 1–1.8°C, increased variability and a higher risk of frost damage.

Extreme events: If your cropping system already struggles with weather extremes, which historically may only have occurred 1 or 2 years in 10, these events will become the average by 2035.

Pests and diseases: There may also be new challenges arising from a sustained increase in winter minimums. For example, pest and diseases that were previously unable to overwinter may now become problematic more often and earlier in the season.

Government policy threats and opportunities

The impacts of climate change government policy for the vegetable industry are:

1. The **immediate** impacts of government climate change policies on input costs for growers and processors; and
2. The **medium-term** (5 years) opportunities for vegetable growers to participate in the Carbon Farming Initiative and generate revenue from carbon storage and emission reduction activities.

The **immediate** impacts arise from the introduction of a carbon price under the Federal Government's Clean Energy Act (2011). While vegetable growers have no liabilities under the carbon price nor do they have to report emissions, some up- and down-stream sectors of the vegetable industry may have liabilities.

The main impact of the carbon price will be on the cost of electricity and after 2014, transport.

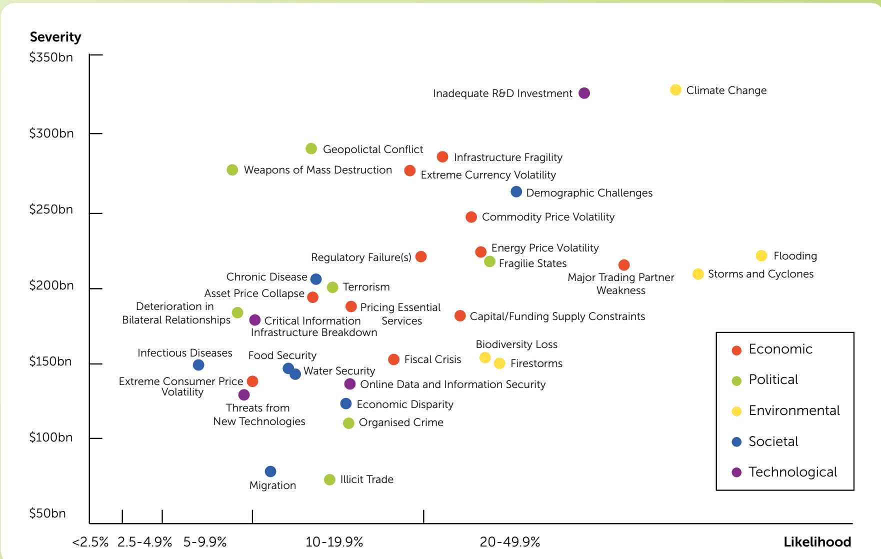
In the **medium term** there are limited opportunities for the vegetable industry to participate in the Carbon Farming Initiative and generate revenue from carbon storage and emission reduction activities. For this to occur new approved methodologies are required.

Risk associated with climate

KPMG conducts a survey of Australian business, government and academic leaders each year and asks about the likelihood and impact to the Australian economy of 34 key risk areas across the categories of economic, political, environmental, societal and technological.[2]

In 2012, climate change topped both the severity and likelihood rankings. The linkages to storms and cyclones, firestorms, flooding, biodiversity loss, food and water security, infectious diseases and infrastructure fragility were also highlighted.

The Australian risk landscape (KPMG)



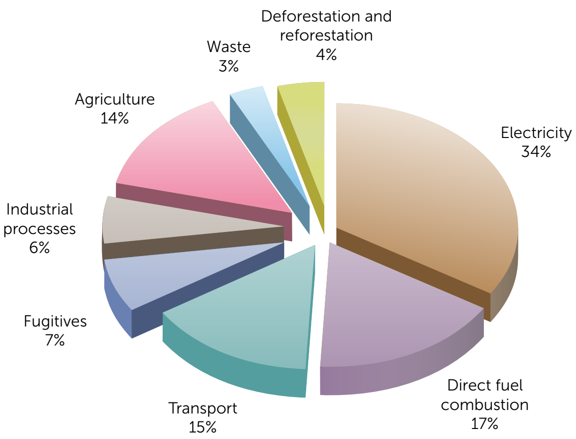
2 KPMG (2012). *Australia Report 2012 – Risks and Opportunities. Australia*, Report prepared by ADC in collaboration with KPMG.

Climate change credentials of the Australian vegetable industry: How are we doing?

The main greenhouse gases are carbon dioxide (CO_2), nitrous oxide and methane. Global atmospheric CO_2 levels have risen since pre-industrial times from 280 parts per million (ppm) to a current (2013) level of 396ppm. Nitrous oxide and methane levels have also risen during this time and together account for most of our current national emission of about 546 Mt CO_2-e per year (2012).

Agriculture accounts for about 14% of Australia's emissions. Horticulture accounts for about 1% of agriculture emissions (about 0.7 Mt CO_2-e per year) and vegetables about one-third of horticulture emissions.

National greenhouse gas emissions 2011



Source: National Greenhouse Gas Inventory.

Vegetable industry emissions

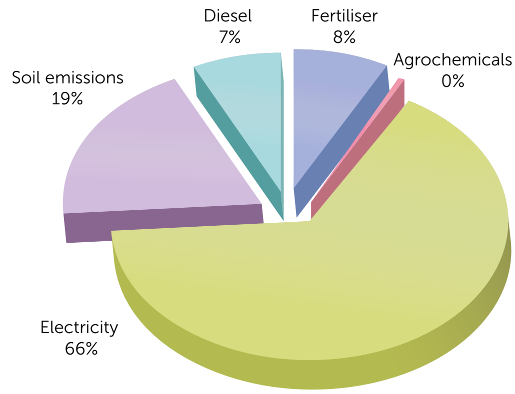
The horticulture and vegetable sectors have a very low rate of greenhouse gas emissions per $ of value produced. The vegetable sector produces 85t CO^2-e for every $1M in revenue generated and the horticulture industry generally produces 83t CO^2-e for every $1M in revenue generated (at the farm gate). The total emissions for horticulture are only 1% of agriculture or 0.12% of the national total. Vegetables are even less, at 0.05% of total emissions.

These figures are low relative to other rural industries. E.g. beef cattle emits 6,686 t CO^2-e for every $1M in revenue and sheep 3,513. The big polluters such as power generation and aluminium emit 9,945 and 7,357t CO^2-e for every $1M in revenue, respectively.

The vegetable industry is characterised by a high level of inputs and this results in a high average greenhouse gas intensity of 9.2t CO^2-e per hectare per year.

Vegetable farms are substantial users of electricity for pumping and cooling, and this accounts for 66% of the carbon footprint of the Australian vegetable industry. The remaining emissions are mainly from nitrous oxide emitted from soils, and due to the high usage of nitrogenous fertiliser.

Distribution of greenhouse emissions for the Australian vegetable industry[3]

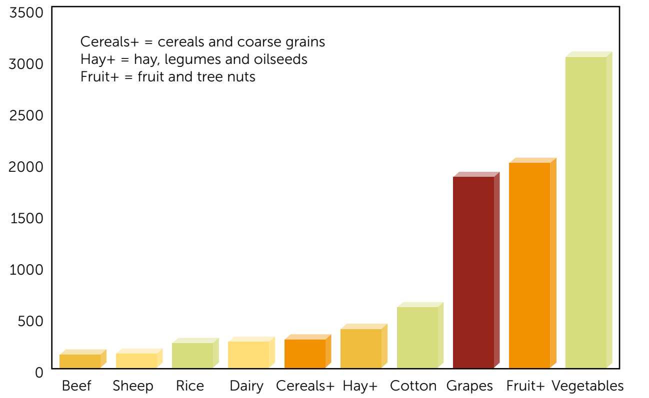


3 Rab M A, Fisher P D, et al. (2008). *Vegetable Industry Carbon Footprint Scoping Study – Discussion Papers & Workshop*. Preliminary Estimation of the Carbon Footprint of the Australian Vegetable Industry.

Water

The Australian vegetable industry is also a very efficient user of irrigation water, both in terms of productivity and financial returns per mega litre (ML) of water used. The figure below shows $ return per ML water used and vegetables are better than any other rural industry in terms of financial returns on water.

Revenue ($/ML) from land use and volume of water, Murrumbidgee-Murray-Goulburn regions 2000/1[4]



4 Hickey, Hoogers, Singh, Christen, Henderson, Ashcroft, Top, O'Donnell, Sylvia & Hoffmann (2006) *Maximising returns from water in the Australian vegetable industry: National report.* AusVeg

Consumers are becoming more aware of the carbon and water footprints of the food they eat, and while this is not currently influencing the buying decision of consumers, it may in the future.

Vegetables have a very low carbon (and water) footprint compared to most other food items and this is likely to be a significant marketing advantage for the industry into the future.

What should I be doing?

The most promising immediate actions that Australian vegetable growers can take to minimise impacts of increased climate variability, and prepare for the future are:

Improve electricity use efficiency

Electricity for running pumps and cool rooms is a major cost for the Australian vegetable industry. Savings in both cost and emissions can be achieved now through improving the efficiency in the way energy is used by vegetable farms. There are three ways in which this can be achieved:

1. **Electricity for irrigation.** Improvements in energy productivity or reductions in energy usage in relation to irrigation can be achieved in three ways:
    - Better irrigation management in the field.
    - Improved irrigation system design and maintenance.
    - Improved pump efficiency.

The most promising and immediate one of these is improving the efficiency of irrigation management to maximise productivity and safeguard against limited water availability in drought.

2. **Electricity for cooling.** Options exist here in:
    - Refrigerants and refrigeration plant, and impact of refrigerant leakage if priced as a greenhouse gas.
    - Cool room design.
    - Revised produce cooling protocols to meet specifications for adequate shelf life and quality rather than aiming to maximise shelf life.
3. **On-farm power generation technologies** and related options:
    - Solar (hot water and PV), wind (small and larger scale).
    - Gas-fuelled fuel cells.
    - Gas-fuelled electrical generators.
    - Biogas production.
    - Woody biomass-fired electricity generation.

Adaptations

There are adaptations to climate change and increased variability that can be used right now. These are explained in detail on the Vegetable Climate website:

- Breeding or selecting varieties that will grow in the changed climate.
- Adapting planting times or production slots in regions.
- Protected cropping including shade.
- Use of irrigation to manage frost and high temperature spikes.
- Manage irrigation for increased water-use efficiency and profitability when water is scarce.
- More efficient postharvest cooling and temperature management.

Reducing on-farm emissions (mitigation)

The main emissions from vegetable farms apart from electricity are nitrous oxide emissions from soils. These can be reduced through better management of nitrogen, or through the use of nitrification inhibitors. Carbon can be stored in soils as biochar.

Funding

There is funding available to assist with implementing energy efficiencies and preparing to take advantage of the CFI. These are presented on the website **www.vegetableclimate.com**.

For the longer term

In the longer term key areas of focus for increasing our capacity for a viable vegetable industry include:

- Improved medium-range weather forecasting (3 months).
- Better forecasting of extreme events.
- Understanding pest and disease interactions in a changing climate.
- Varieties that can produce good quality and high yields in a more variable climate.
- Better region-specific information on how crops will perform in our vegetable growing areas.
- Innovative energy-efficient protected cropping for vegetables.
- Improved on-farm power generation and more efficient cooling.

www.vegetableclimate.com