Scoping study into climate change and climate variability

Peter Deuter
QLD Department of Primary Industries and Fisheries

Project Number: VG05051

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HAL

Know-how for Horticulture™

Final Report

HAL Project Number :- VG05051 (31/5/06)

Project Title :- Scoping Study - Climate Change and Climate Variability - Risks and Opportunities for Horticulture

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Media Summary

Key components of the project

The **terms of Reference** for this Scoping Study are as follows :-

1. Climate Change

- Document historical changes in the Australian climate to date.
- Present climate change scenarios for a number of important horticultural regions in Australia, for time periods up to 2030, based on best available science.
- Determine and document how these projected changes in climate could affect horticultural industries in future decades.
- Document potential adaptation mechanisms, that horticultural industries and growers might use to cope with these potential changes.
- Document the key research challenges for the next five years, that must be addressed to equip the horticulture demand chain to adapt to a changing climate.

2. Climate Variability

- Consult widely with climate scientists on tools that the vegetable (and the wider horticultural industry) might be able to use to its advantage in better managing climate variability.
- Scan the literature on tools which the vegetable (and the wider horticultural industry) could use to its advantage in better managing climate variability.
- Assess these tools for their ability to deliver information to growers and the horticultural industry to be able to better manage climate variability.
- Identify the shortcomings of these tools (for their application in horticulture), and in so doing determine potential modifications for them to be more useful in horticulture.
- Identify the types of tools that might be more useful in horticulture in better managing climate variability.

This scoping study includes a list of management tools currently available to agriculture for managing climate change and climate variability, on which horticultural industries might capitalise.

Industry significance of the project

Australia has one of the most variable climates in the world, with large extremes of rainfall and temperature. Climate change as a consequence of global warming will add to the difficulties which horticultural industries have in coping with an already variable climate. Australian's agricultural (including horticultural) industries, businesses and communities have historically been subject to greatly fluctuating incomes due to seasonal climate variation. They incur significant costs associated with drought, frosts, heat waves, storms and floods.

Horticultural industries are already dealing with increased threats from imported products; the need to become even more efficient; and changing social, economic and institutional pressures. Industry and individual growers will need to develop adaptive strategies to manage adverse environmental conditions, in addition to developing and implementing improved production/management practices to increase efficiency and productivity and meet supply chain needs.

Key outcomes

Climate Change.
Australian annual mean **temperatures have increased by 0.82^{o}C since 1910**, with rapid increases since 1950 (Smith, 2004). Night-time temperatures have increased faster (0.11^{o}C/decade) than daytime temperatures (0.06^{o}C/decade), together with increasing frequency of hot days (35^{o}C or more) of 0.08 days per year and a decreasing trend in cold nights (5^{o}C or less) of 0.16 nights per year.

A mean **warming of 0.4 to 2.0^{o}C** is anticipated over most of Australia **by the year 2030** (relative to 1990), and 1 to 6^{o}C by 2070 (CSIRO, 2001). Mean temperature change is likely to be greatest inland and least on the coast. Most warming is expected to occur in spring and summer, and least in winter.

Most of the anticipated climate changes point towards the need for a very high standard of crop management in order to respond to the challenges that expected changes pose. Industry and farm managers will need to **distinguish between 'old climate expectations' and 'new climate realities**' in determining and implementing new adaptation strategies or options.

For horticultural industries to successfully adapt to increasing temperatures and changing rainfall patterns, there will be a need to develop both pre-emptive and reactive adaptation strategies or options.

Climate Variability.
Currently the limitation on the use of tools (climate applications for managing climate variability) in horticultural industries, is the lack of climate science understanding that addresses the lead-time and season requirements of the horticultural industry.

The combination of long season (3 months) and short lead-time (zero), which are appropriate for other agricultural industries, is a significant constraint to the use of forecasting tools in horticulture, where a much shorter season length (several weeks to one month) and a much longer lead-time (3 to 4 months), would be much more useful. Given a sound forecast system that meets the requirements of the industry the appropriate tools can be produced.

There are no forecast systems based on the SOI and SST's which have been extensively tested for longer lead-times and shorter seasons. It is expected, although this has not been extensively tested, that other forecast systems would be needed to be able to provide this requirement for horticulture for rainfall forecasts.

A lead-time of up to 4 months would be very useful for many horticultural industries. The usefulness of the 3 month season forecasts embodied in most current forecast systems is significantly reduced by the need for most horticultural industries to have a season forecast of one month or less.

There are numerous web sites that provide information that can be useful to producers, industries, consultants and advisors in making more informed decisions. These information sources aim to provide a better understanding of climate variability, and how this variability affects specific industries. None of these are specific to Australian horticultural industries.

Conclusions and recommendations for practical application to industry.

There appear to be many potentially significant impacts of climate change on horticultural industries, some of which may be positive, some negative. ***It will be essential to reducing the impact of climate change, that a clearer understanding of what these impacts are, and that management strategies be identified and implemented to either offset the negative impacts, or to take advantage of positive responses***.

- For horticultural industries to successfully adapt to increasing temperatures and subsequent climate changes, there will be a need to develop both pre-emptive and reactive adaptation strategies or options. Horticultural industries are already dealing with increased threats from imported products, the need to become even more efficient, and changing social, economic and institutional pressures. Industry will need to develop these adaptive strategies to manage adverse environmental conditions in addition to developing and implementing improved production practices to increase efficiency and productivity.

- Temperature is the main factor determining location and timing of horticultural production in Australia. Increased temperatures may require changes in cultivars, timing of planting and harvesting. Increasing temperatures may also result in some current production areas becoming marginal, especially in the early and/or late periods of the production season.

- Some regions which are currently marginal for production, may offer some production advantages.

Recommendations for future R&D

Key challenges for horticulture :-

1. **Assess the Impact of Climate Change** – this might include :-

   - Identifying current "at risk" production sites (regions) and/or industries.
   - Documenting the effects of climate change for major overseas production regions, especially in those countries that are major competitors to Australian production; including identifying any additional export opportunities for Australian growers.
   - Determine climate change impacts on water reliability/availability.
   - Improving the reliability of climate change modelling outputs (scenarios).
   - Calculating expected shifts in crop maturity times for different regions.

2. **Understand How Crops Respond to Climate Change & Climate Variability** – including :-

   - Identifying those agronomic and physiological factors affecting crop performance.
   - Determining the sensitivities of these factors in a variable and changing climate.
   - Developing a better understanding, and ability to take advantage of, CO_2 fertilization and its effects on yield.

3. **Develop Climate Change Adaptation Strategies**, in response to 1. and 2. above – some examples might be :-

- ❖ Identifying management options – i.e. adaptation strategies.
- ❖ Identifying alternative districts that may be suitable for production.
- ❖ Monitoring climate changes in existing production areas.
- ❖ Reviewing irrigation research.
- ❖ Developing strategies to improve property management.

4. **Better Understand Climate Variability**

- ❖ Developing a better understanding of current climate variability and how it might be managed more effectively.
- ❖ Assessing the requirements of horticultural industries for seasonal temperature (and rainfall) forecasting information.
- ❖ Developing a better understanding of the lead-time and season requirements of horticultural industries, including the climate science understanding that would be embodied in a forecasting tool.

Tools used in managing climate variability, have in the main been designed and constructed for a specific purpose and for a specific agricultural or pastoral industry. None of these tools have been designed specifically with any horticultural industry or application in mind. Currently the limitation of these tools in their application to horticultural production is the lack of climate science that addresses the lead-time and season requirements of horticultural industries. Given a sound forecast system that meets the requirements of the industry, the appropriate tools can be produced.

A lead-time of up to 4 months would be very useful for many horticultural industries. The usefulness of the 3 month season forecasts which is embodied in most current forecast systems, is significantly reduced by the need for most horticultural industries to have a season forecast of one month or less.

There are numerous web sites that provide information that can be useful to producers, industries, consultants and advisors in making more informed decisions. These information sources aim to provide a better understanding of climate variability, and how this variability affects specific industries. None of these are specific to Australian horticultural industries.

The steps in addressing climate change in horticulture in Australia should commence with identifying those industries and/or specific locations which are most at risk from climate change, followed by the development of adaptation strategies for those industries and regions at risk. At the same time, climate variability (particularly temperature) will continue to challenge managers of horticultural supply and demand chains (production and marketing). Forecasting tools need to be developed, with the requirements of horticultural industries and managers specifically in mind.

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Technical Summary

Nature of the problem

Australia has one of the most variable climates in the world, with large extremes of rainfall and temperature. Climate change as a consequence of global warming will add to the difficulties which horticultural industries have in coping with an already variable climate. Australian's agricultural (including horticultural) industries, businesses and communities have historically been subject to greatly fluctuating incomes due to seasonal climate variation. They incur significant costs associated with drought, frosts, heat waves, storms and floods.
Horticultural industries are already dealing with increased threats from imported products; the need to become even more efficient; and changing social, economic and institutional pressures. Industry and individual growers will need to develop adaptive strategies to manage adverse environmental conditions, in addition to developing and implementing improved production practices to increase efficiency and productivity.

The Australian horticultural industry will be affected by climate change through :-

- Changes in frost frequency
- Damage from extreme events
- Increased, or changing pest and disease incidence
- Changes in time to harvest
- Changes in the suitability of cultivars
- Downgrading product quality
- Pollination difficulties for some crops
- Increased risk of spread and proliferation of soil borne diseases
- Increased irrigation demand
- Increased atmospheric CO_2 concentrations will benefit productivity of most horticultural crops, although the extent of this benefit is unknown.

Tools used in managing climate variability, have in the main been designed and constructed for a specific purpose and for a specific agricultural or pastoral industry. None of these tools have been designed specifically with any horticultural industry or application in mind.
Currently the limitation on the use of tools (climate applications for managing climate variability) in horticultural industries, is the lack of climate science understanding that addresses the lead-time and season requirements of the horticultural industry.

The combination of long season (3 months) and short lead-time (zero), which are appropriate for other agricultural industries, is a significant constraint to the use of forecasting tools in horticulture, where a much shorter season length (several weeks to one month) and a much longer lead-time (3 to 4 months), would be much more useful. Given a sound forecast system that meets the requirements of the industry the appropriate tools can be produced.

There are no forecast systems based on the SOI and SST's which have been extensively tested for longer lead-times and shorter seasons. It is expected, although this has not been extensively tested, that other forecast systems would be needed to be able to provide this requirement for horticulture for rainfall forecasts.

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Brief description of the science undertaken

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- Document the key research challenges for the next five years, that must be addressed to equip the horticulture demand chain to adapt to a changing climate.

2. Climate Variability

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- Identify the types of tools that might be more useful in horticulture in better managing climate variability.

This scoping study includes a list of management tools currently available to agriculture for managing climate change and climate variability, on which horticultural industries might capitalise.
The role of software tools is to embody the science, rather than to drive it. Currently the limitation on the use of these tools in their application to horticultural production is the lack of climate science understanding that addresses the lead-time and season requirements of the industry. Given a sound forecast system that meets the requirements of the industry, the appropriate tools can be produced.

Major research findings and industry outcomes

Climate Change
Australian annual mean **temperatures have increased by 0.82^{o}C since 1910**, with rapid increases since 1950 (Smith, 2004). Night-time temperatures have increased faster (0.11^{o}C/decade) than daytime temperatures (0.06^{o}C/decade), together with increasing frequency of hot days (35^{o}C or more) of 0.08 days per year and a decreasing trend in cold nights (5^{o}C or less) of 0.16 nights per year.

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Recommendations to industry, research peers and HAL

There appear to be many potentially significant impacts of climate change on horticultural industries, some of which may be positive, some negative. ***It will be essential to reducing the impact of climate change, that a clearer understanding of what these impacts are, and that management strategies be identified and implemented to either offset the negative impacts, or to take advantage of positive responses***.
Climate change as a consequence of global warming, will add to the difficulties which horticulture industries already have in coping with a very variable climate.

- In order for horticultural industries to successfully adapt to increasing temperatures and subsequent climate changes, there will be a need to develop both pre-emptive and reactive adaptation strategies or options. Horticultural industries are already dealing with increased threats from imported products, the need to become even more efficient and changing social, economic and institutional pressures. Industry will need to develop these adaptive strategies to manage adverse environmental conditions in addition to developing and implementing improved production practices to increase efficiency and productivity.

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- Some regions which are currently marginal for production, may offer some production advantages.

The following are some **R&D challenges for horticulture** to consider (short to medium term) :-

1. **Assess the Impact of Climate Change** – by :-

   - ❖ Identifying current "at risk" Australian production sites (regions) and/or industries.
   - ❖ Documenting climate change impacts on overseas competitors; and identifying any additional export opportunities for Australian producers.
   - ❖ Calculating expected shifts in crop maturity times for different regions.
   - ❖ Determine climate change impacts on water reliability/availability.
   - ❖ Improving the reliability of climate change modelling outputs.

2. **Understand How Crops Respond to Climate Change & Climate Variability** – by :-

   - ❖ Identifying those agronomic and physiological factors affecting crop performance.
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3. **Develop Climate Change Adaptation Strategies**, in response to 1. and 2. above – by :-

   - ❖ Identifying management options – i.e. adaptation strategies.
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   - ❖ Monitoring climate changes in existing production areas.

- ❖ Reviewing irrigation research.
- ❖ Developing strategies to improve property (enterprise) management.

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There are many tools for managing climate variability designed for a number of agricultural industries. No tools have been specifically designed for horticulture in Australia. The majority of these tools are associated with rainfall variability and very few provide information on how to manage variability in temperature. Temperature is the major factor in determining where horticulture crops can be grown successfully, and then how well these crops perform under varying seasonal conditions.

The requirements of horticultural industries for **seasonal temperature (and rainfall) forecasting information**, needs to be assessed.

e.g. Lettuce – in the Australian environment, temperature varies considerably from season to season in most districts, and cultivar selection and planting times cannot always be satisfactorily matched with the temperature conditions that significantly influence quality during the head filling stage, which is up to 3 months after transplanting, depending on season and location. To be able to make much better decisions on cultivar selection, planting dates and marketing plans, growers need information on the temperature regime for the growing period up to harvest (a forecast with 3-4 months lead-time). This is due to the need for growers to plan production and order lettuce seedlings well in advance of planting. This information is currently not available.

Contribution to new technology and any future work suggested.

There appear to be many potentially significant impacts of climate change on horticultural industries, some of which may be positive, some negative. ***It will be essential to reducing the impact of climate change, that a clearer understanding of what these impacts are, and that management strategies be identified and implemented to either offset the negative impacts, or to take advantage of positive responses***.

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The steps in addressing climate change in horticulture in Australia should commence with identifying those industries and/or specific locations which are most at risk from climate change, followed by the development of adaptation strategies for those industries and regions at risk. At the same time, climate variability (particularly temperature) will continue to challenge managers of horticultural supply and demand chains (production and marketing). Forecasting tools need to be developed, with the requirements of horticultural industries and managers specifically in mind.

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