Chapter 8 Energy & greenhouse gas management

Objectives

- **to identify and reduce energy inputs wherever feasible in the production system**
- **to ensure sources of greenhouse gases are identified and emissions are reduced wherever feasible**

Although energy from sunlight is essential for plant growth, the energy balance of agricultural systems depends on additional energy, from non-renewable sources, to power machinery. Sustainable practices can improve the balance of energy and contribute to efficient energy use.

Most of our energy (including more than 90% of our electricity) comes from fossil fuels such as oil, coal and gas. Burning of fossil fuels releases carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (NH_4) into the atmosphere. This has resulted in the greenhouse effect known as 'global warming'.

All the major greenhouse gases have natural sources, but human activity increases the amount released. It is now generally agreed that this pollution has added to the natural greenhouse effect and will cause the temperature of the earth's surface to rise. Because some of the greenhouse gases last for a long time in the atmosphere, it is important that any action to reduce emissions of greenhouse gases is taken as early as possible.

Greenhouse gases of greatest concern in agriculture are methane and nitrous oxide. Methane arises from livestock, mainly through digestion (enteric fermentation). Nitrous oxide is released from soils through application, oxidation and natural transport of fertilisers and soil disturbance. Carbon dioxide emissions are released from transport and energy sources. Chlorofluorocarbons or CFCs (used for refrigeration and aerosol propellants) were also significant greenhouse gases but are now generally prohibited from use.

Further references and resources can be located at the end of this chapter.

An important issue is the high global warming potential of methane and nitrous oxide, expressed as 'carbon dioxide equivalents' or CO_2-e. The $CO_2$2-e of CH_4 is 21 while the CO_2-e of N_2O is 310. This means that methane has a global warming effect that is 21 times greater than carbon dioxide while that of nitrous oxide is 310 times greater! The implication is that we should be especially careful to avoid methane and, particularly, nitrous oxide emissions.

The Australian agricultural industry as a whole accounts for 16-18% of greenhouse emissions. Although horticulture accounts for only 1% of Australia's total greenhouse gas emissions (not including fossil fuel use), it tends to have greater emissions intensity per hectare of land than other agricultural production enterprises.

Sources of greenhouse gases in horticulture include: fuel and electricity use (70%), especially for irrigation, nitrogen fertilisers and animal manures (20%), and waste and refrigerant loss to the atmosphere (10%). Methane may be produced from composting processes and stagnant pools of contaminated water, it appears not to be a major concern.

Australia's mechanism to reduce emissions, the carbon price, came into effect in July 2012. While agricultural industries are not directly involved in the carbon price mechanism, the carbon price will impact on the cost of key agricultural inputs. These price increases have been and will continue to be most significant for energy (i.e. electricity and fuel) and energy-intensive inputs such as fertiliser and chemicals.

Note: As at 11 February 2014 the carbon price mechanism was still in place, but legislation to repeal the carbon price was also being considered. Regardless, some mechanism for reducing Australia's emissions will be in place in order to meet the bipartisan agreed emissions target of 5% from 2000 levels by 2020 and 60% by 2050. Consequently, practices to reduce energy use will continue to be important. See http://www.climatechange.gov.au/reducing-carbon/reducing-australias-emissions for more up to date information.

Improvements in the efficiency of energy use, more effective fertiliser management and minimizing soil disturbance are key actions for the industry to reduce greenhouse gas emissions and in reducing the operating costs of horticulture operations.

Further references and resources can be located at the end of this chapter.

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Risk assessment

LOW RISK – You probably don't have a significant problem in this area. You may like to read the Suggested Practices to check your understanding of the issue.

HIGH RISK – You need to take some action. Read the Suggested Practices for that chapter.

Further references and resources can be located at the end of this chapter.

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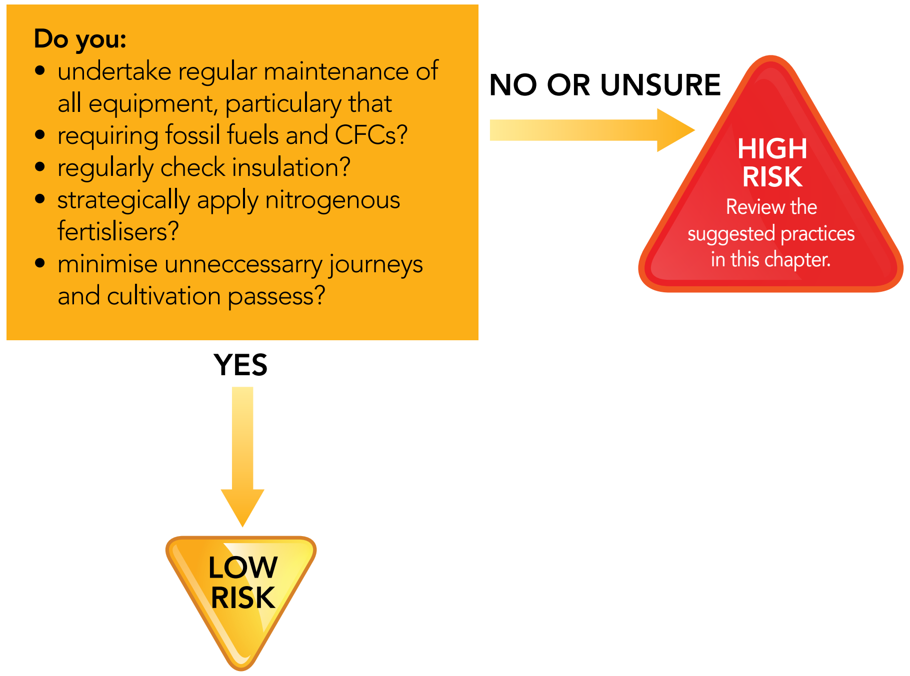
GREENHOUSE GASES



Review checklist

To go straight to the worksheet for this chapter click here.

Relevant legislation and regulation

Legal requirements are subject to change. Regularly check with Federal, State and Local authorities for updated requirements. See here for links.

Suggested practices

By understanding your emissions profile, you can identify opportunities for reducing energy use and emissions.

In assessing the total energy used in agricultural production 'from field to fork', synthetic fertiliser and pesticide manufacture are important indirect energy inputs, while irrigation, cultivation, harvesting and transport are major direct energy inputs. By managing the amount of fertiliser and pesticide applied as well as the more tangible direct agricultural activities, greenhouse gas emissions can be reduced.

A carbon footprint is a measure of the greenhouse gas emissions produced by a particular product or activity. Carbon footprinting is a method of carbon accounting.

The carbon footprint of a horticulture enterprise would account for all on-farm emissions of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and hydroflourocarbon, ie. all emissions occurring within the farm boundary from activities such as energy and fertiliser use.

Further references and resources can be located at the end of this chapter.

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There are currently several examples of carbon footprinting tools available for use within horticulture industry, including:

- Vegie carbon tool http://vegiecarbontool.com.au/
- Cool farms tool http://www.coolfarmtool.org/CoolFarmTool
- Nursery industry carbon calculator http://www.ngia.com.au/Category?Action=View&Category_id=466
- Nursery industry renewable energy calculator www.energycalc.ngi.org.au
- FarmGAS calculator (includes ability to select horticulture crops within the model, but was not specifically developed for horticulture) http://calculator.farminstitute.org.au/login
- Hort Carbon Info http://www.horticulture.com.au/areas_of_Investment/Environment/Climate/climate_tools.asp
- Orchard carbon tool http://www.orchardcarbontool.com.au/login.php?from=calculator

The primary reason for measuring carbon footprints is to report or account for the level of greenhouse gas emissions to a third party. At present (March 2014) there is no requirement for horticultural growers to undertake carbon accounting on their farms or to comply with carbon labeling requirements. However, consumer preferences and government policy may create the need for carbon accounting and reporting by growers in the future.

As an alternative to undertaking a full carbon footprint, consider an energy audit. Energy companies can give expert advice on how to save electricity and most can conduct an energy audit to identify areas for improvement.

Management actions in the horticulture industry to reduce greenhouse gas emissions include improving the efficiency of energy use and more effective fertiliser management.

Improve energy efficient to reduce carbon dioxide emissions

The most effective way of reducing carbon dioxide emissions is to use energy more efficiently and to exploit non-fossil fuels as alternative sources of energy.

Irrigation

Investigate options for replacing existing pumps or motors with more energy efficient models. Optimise the irrigation system to improve water use efficiency and use less energy.

Pumping water for irrigation is one of the main ways energy is used in horticultural production. Growers can use less energy and save costs by carefully choosing the type of irrigation equipment they use. Keeping irrigation equipment in good condition can also save energy. Irrigation pump engines should be serviced and well tuned. Make sure motors, switches and control panels are clean. Check connections to make sure they are tight, and lubricate moving parts. Variable speed electric motors are generally more efficient than fuel-driven pumps. Pumps will wear more quickly if water contains a lot of dirt or organic matter, leading to leaks and reduced energy efficiency. Regularly check and maintain inlet sieves.

The amount of energy used by your irrigation system depends on:

- System flow rate (larger-diameter pipes reduce flow rate losses due to friction, thus reducing pumping costs);
- Operating pressure (aim for low pressure systems, the less friction in the system the less pressure you need to start with);
- Hours of operation (utilise as much off peak power as possible – in many cases off peak power is cheaper because it is generated whether it is used or not [e.g. coal and wind generation]); and
- The combined efficiency of all the components.

Further references and resources can be located at the end of this chapter.

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Consider energy efficiency when new equipment is purchased.

Choose pumps that match the pressure flow you need. Pumps need to be used in their best operating range for best efficiency. Pumps should run at or above 65% efficiency. Some agricultural companies may be able to test your pump for efficiency. Pumps wear out over time – they may still pump water, but it is costing significantly more because of impeller wear. This test can help you know if a pumping plant is wasting energy.

Vehicles and equipment

Maintain and service vehicles and equipment regularly to ensure efficient operation. Well-maintained equipment operates better and costs less to run. This is good both for your business and the environment. Maintain engines by following the manufacturers' recommendations. A reduction of 5-15% in fuel consumption can be obtained by servicing air cleaners and fuel injectors regularly.

It is a good idea to have a regular maintenance program for all the equipment, machinery and vehicles used on your farm. Maintenance intervals will vary to suit levels and conditions of use for each vehicle and piece of equipment.

Choose tractors and machinery that are suitable for the tasks they will be performing. Use the lowest-powered tractor capable of doing the required job or adjust machinery (i.e. increase the width of implements) to match the tractor power.

Minimise unnecessary journeys and cultivation passes. Install a GPS on tractors to prevent overlap or missed coverage.

Install or turn on the power-save function on office equipment such as computers and photocopiers. Turn them off when you finish work.

Fuel

Try to save fuel. Every litre of petrol or diesel saved lowers greenhouse emissions and reduces production costs. Keep track of fuel use and set targets for saving fuel. Another good idea is to switch from diesel/petrol to LPG or compressed natural gas in cars, trucks and motorbikes. This can cut greenhouse gas emissions by 10 to 15%. Use a percentage of biofuels, which come from renewable sources.

Economise on fuel by precise control of the correct temperature regimes, using thermal screens and correct maintenance and insulation of boilers and burners.

Use electric fork lifts instead of internal combustion engine forklifts.

Lighting

By using energy-efficient lighting you can save money and help the environment at the same time. Compact fluorescent lighting is far more energy efficient that incandescent bulbs for use in greenhouses and work areas. For example, energy efficient compact fluorescent bulbs have about one-quarter lower wattage and about eight times the life of standard incandescent bulbs. This saves energy and lowers maintenance costs. Replacing mercury vapour yard lights with energy-efficient, high-pressure sodium lights can sometimes greatly cut electricity usage and costs.

Place movement sensors and timers on lighting systems so they are only on when required.

Coolrooms

Coolrooms should be properly designed and built to make sure that energy is not wasted. This includes fitting the right temperature control devices and keeping them properly calibrated. Incorrect calibration by only 1°C can greatly increase running costs and may affect the quality of stored produce.

Further references and resources can be located at the end of this chapter.

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Reduce loss of heating/cooling through effective insulation and preventing unintentional ventilation. Heated glasshouses, mushroom houses and polythene-covered structures are major users of energy. Don't overlook the huge thermal losses that occur through an uninsulated floor. A little more spent at the outset is quickly recovered. Polystyrene is the floor insulant of choice.

Once coolrooms have been built they need to be maintained and serviced. Regularly check things such as door seals, hinges and catches. This will minimise leaking of warm air into the coolrooms. The building should be checked for damage to insulation panels, roof and walls. If possible, build coolrooms with a shade roof covering or within a shed to reduce thermal loads. Windbreaks also reduce airflow onto the exterior surfaces and associated heat transfer.

Always try to remove field heat from produce (pre-cool) before storing it in the coolroom as this can greatly reduce the amount of energy used. You should also minimise the time coolroom doors are open. Don't open doors often or hold them open for a long time. If doors need to be kept open during some daily operations, use plastic door strips, automatic coolroom doors or rapid-rise curtains. These devices can help to keep warm air out of the coolroom. When forklifts are in coolrooms for extended periods, consider using electric forklifts (as opposed to gas) for heat and OH&S gains. Gas forklifts can also release gases that affect produce quality (maturity and taste).

Renewable resources

The efficient use of renewable energy resources such as hydro-electricity, solar or wind power should be targeted since the use of non-renewable sources, such as fossil fuel, is not sustainable in the long term. Switch to more environmentally friendly renewable energy sources, or what is known as 'green power', where this option is available. This electricity may cost a little more than conventional power from coal-fired power stations. However, costs can be maintained to the same total cost by improving energy-use efficiency. Reverse auctions and collective bargaining may help businesses achieve better deal from electricity suppliers. See www.greenpower.gov.au for more information.

Minimise use of fossil fuel for power generation, for example:

- Optimise field operations, including transportation from field to packhouse, carefully select equipment; and
- Ensure proper and timely maintenance of equipment.

Minimise the input of synthetic fertilisers and consider alternative organic and renewable fertiliser technologies taking into account crop needs, fertiliser cost and comparative costs (including fuel use) of delivery and spreading.

Review practicality of best current waste re-use, recycling and disposal technologies available.

Some growers and processors have large amounts of organic waste (or by-product), such as cores, skins, peels, outer leaves, tops, seeds, stems, shells, husks and other plant parts, and are looking at ways that the waste can be composted to produce methane that can be used as a fuel.

Other sources of carbon dioxide

Large amounts of fossil fuel are needed to manufacture nitrogen fertilisers. Only use fertilisers at the rates suitable for the cropping situation. Ensure fertiliser spreaders are properly maintained and use suitable settings for different types of fertiliser.

Carbon dioxide is also created from the breakdown of liming materials in the soil.

Using less packaging, or packaging made from recycled/ recyclable materials.

Further references and resources can be located at the end of this chapter.

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Source products from companies making an effort to cut their emissions and lower the impact of the carbon price on their products.

Consider ways to minimise the time produce stays on farm post-harvest, in order to minimise the refrigeration requirements. Investigate options to reduce on-farm processing.

Nitrous oxide

Nitrous oxide from agriculture is released from nitrogen compounds in manures, fertilisers, crops, soils and watercourses. It is likely to be produced in oxygen-free conditions. The most effective way to reduce the release of this gas is to use nitrogen fertilisers and manures efficiently so that crop requirement is met while losses of nitrogen are minimised.

Maintaining good soil structure (see Topic 1c – Soil structure) will help to keep the soil well aerated and reduce the potential for an oxygen free environment.

Chloroflurocarbons (CFCs)

Apart from their effect as greenhouse gases, CFCs also damage the ozone layer. CFCs were used in refrigeration equipment but are now generally prohibited. If your equipment uses CFCs, it is important to keep refrigeration equipment properly maintained to minimise the risks of leaks of refrigerant. Whenever such equipment is serviced, make sure that no refrigerant is lost. Do not allow unused equipment to deteriorate on site. Specialist contractors can safely remove refrigerant so that it can be recycled or destroyed. CFC's have not been used in refrigeration equipment since 1995.

Offset opportunities – Carbon Farming Initiative

The rural sector is a major source of emissions, but also has a potential opportunity to play a role in Australia's mitigation (emissions reduction) effort.

However, uncertainties about the domestic emissions reduction market, the level of demand for credits, and realistic abatement and sequestration potentials make it difficult to estimate the actual economic potential for horticulture at this time. There may be opportunities for horticulture to access financial incentives for reduction of emissions or the increase of carbon sinks on farm (known as carbon farming) in the future. However, all of the available information suggests that the income potential for horticultural producers will be limited or at the very least lower than other agricultural industries.

Current on-farm offset opportunities in horticulture relate to the creation of carbon sinks (also known as carbon sequestration) by:

- Better soil management e.g. controlled traffic technologies;
- Increasing soil carbon;
- Growing native vegetation; and
- Incorporating biochar and organic matter into soil.

The most promising emissions reduction option seems to be mitigation of nitrous oxide emissions from improved fertiliser management. However, other opportunities could include reforestation, revegetation and carbon soil sequestration. Environmental plantings could be used as windbreaks or visual screens and thereby provide additional benefits to the farm.

For up to date information on the domestic policy situation visit the Clean Energy Regulator website www.cleanenergyregulator.gov.au. Specific information on the existing Carbon Farming Initiative (CFI) can be found at http://www.cleanenergyregulator.gov.au/Carbon-Farming-Initiative/Pages/default.aspx.

Further references and resources can be located at the end of this chapter.

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8 Energy & greenhouse gas management

Current on-farm offset opportunities relate to the creation of carbon sinks (also known as carbon sequestration) by:

- Better soil management e.g. controlled traffic technologies;
- Increasing soil carbon;
- Growing native vegetation; and
- Incorporating biochar and organic matter into soil.

Biochar

Considerable uncertainty still surrounds the use of biochar in farming systems given the range of production processes, the types of biochar, and the variety of soil types in horticulture. There is also uncertainty surrounding its value within a domestic carbon market as well. Work is being done to address these uncertainties and quantify the benefits.

For use of biochar see Topic 1c - Soil structure.

For more information on biochar see HAL/NSW DPI publication on biochar in horticulture (2012) http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/447857/DPI-BioChar-in-Horticulture.

Monitoring and recording

Energy usage can be monitored by checking electricity and fuel bills. Energy efficiency over time can be assessed against production yields or throughput.

Remember the strong relationship between energy saved and your chequebook! Other records that can be useful include:

- Coolroom and machinery maintenance records;
- Thermometer or temperature monitoring device calibration records;
- Irrigation records;
- Fertiliser records detailing use of nitrogenous fertilisers; and
- Internal energy audits.

References and further resources

For access to relevant references and further resources click here.

Further references and resources can be located at the end of this chapter.

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Energy and greenhouse gas management - references and further resources

(web links accurate as at 11 February 2014)

Note: A number of Horticulture Australia Limited (HAL)-funded project final reports have been identified as references within this document. This is by no means representative of all the research & development (R&D) or final reports available in this area. For full list of HAL final reports visit the HAL website www.horticulture.com.au. Alternatively, contact HAL or your peak industry body for more information on research & development outcomes specific to your industry.

AS/NZS (1998) AS/NZS ISO 14040:1998 (ISO 14041:1997) Environmental Management: Life cycle assessment – Principles and Framework. Homebush, Standards Australia and Standards New Zealand. www.standards.org.au

Australian Government Department of the Environment – Atmosphere page http://www.environment.gov.au/node/22791

Australian Government Department of the Environment – Carbon Farming Initiative http://www.cleanenergyregulator.gov.au/Carbon-Farming-Initiative/Pages/default.aspx

Climate Change Research Strategy for Primary Industries (CCRSPI) www.ccrspi.org.au

Climate Council - The Climate Council is an independent non-profit organisation funded by donations by the public that provides expert advice to the Australian public on climate change. http://www.climatecouncil.org.au

Carbon footprinting tools (developed for or relevant to horticulture):

- Vegie carbon tool http://vegiecarbontool.com.au/
- Cool farms tool http://www.coolfarmtool.org/CoolFarmTool
- Nursery industry carbon calculator http://www.ngia.com.au/Category?Action=View&Category_id=466
- Nursery industry renewable energy calculator www.energycalc.ngi.org.au
- FarmGAS calculator (includes ability to select horticulture crops within the model, but was not specifically developed for horticulture) http://calculator.farminstitute.org.au/login
- Hort Carbon Info [link not currently available]
- Orchard carbon tool [link not currently available]

Climate Kelpie – round up of climate tools for Australian farmers http://www.climatekelpie.com.au

Climate Institute http://www.climateinstitute.org.au

Cox, J; Downie, A; Jenkins, A; Hickey, M; Lines-Kelly, R; McClintock, A; Powell, J; Singh, BP; Van Zwieten, L. (2012) Biochar in horticulture: Prospects for the use of biochar in Australian horticulture (HAL Project Reference AH11006), Horticulture Australia Ltd, Sydney, NSW. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/447857/DPI-BioChar-in-Horticulture.pdf

CSIRO (2011) Climate Change: Science and Solutions for Australia, CSIRO http://www.csiro.au/Outcomes/Climate/Climate-Change-Book.aspx

EcoBiz program, includes sections on energy efficiency, waste and water use efficiency http://www.cciqecobiz.com.au

Foran, B. (1998) Looking for opportunity and avoiding obvious potholes: Some future influences on agriculture to 2050, CSIRO. http://www.regional.org.au/au/asa/1998/plenary/environmental/foran.htm#TopOfPage or www.cse.csiro.au/publications/1998/lookingforops-98-13.pdf

Garnaut, R. (2011) Update Paper 4: Transforming rural land use. http://www.garnautreview.org.au/update-2011/update-papers.html

Grace, P. (2007) Soil Carbon – Carbon study shifts focus to nitrogen. GRDC. http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-70-September-October-2007/Soil-Carbon-Carbon-study-shifts-focus-to-nitrogen

GreenPower – Accredited Renewable Energy www.greenpower.gov.au

Intergovermental Panel on Climate Change http://www.ipcc.ch/

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Energy & greenhouse gas management - references & further resources

HAL (2011) Climate Change: Managing Variability and Carbon, Horticulture Australia Ltd, Sydney, NSW. Project final report published by Horticulture Australia Ltd, Sydney, NSW. www.horticulture.com.au. Or directly via http://ausveg.businesscatalyst.com/rnd/fact%20sheets/Climate%20Change%20and%20Managing%20Carbon.pdf

HAL – Horticulture climate change investment page http://www.horticulture.com.au/areas_of_Investment/Environment/Climate/climate_tools.asp

Horticulture Industry Network - Cooling Down About Electricity Costs - Apple & Pear http://www.hin.com.au/resources/cooling-down-about-electricity-costs

Klein, C; Novoa, R; Ogle, S; Smith, K; Rochette, P; Wirth, T; McConkey, B; Mosier, A; Rypdal, K; Walsh, M; and Williams, S. (2006) Chapter 11: Chapter 11: N2O Emissions from Managed Soils, and CO2 Emissions from Lime and Urea Application, IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf

O'Connell D, Braid A, Raison J, Hatfield Dodds S, Wiedmann T, Cowie A, Littleboy L, Clark M (2013) Navigating sustainability: measurement, evaluation and action. CSIRO, Australia. http://www.csiro.au/Organisation-Structure/Flagships/Energy-Flagship/Measuring-sustainability.aspx

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Putland, D. (2012) The impacts of the carbon price on Australia Horticulture (Final Report for HAL Project Reference AH11019), Horticulture Australia Ltd, Sydney, NSW. www.horticulture.com.au

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