Australian Government

National Land & Water Resources Audit

Signposts for Australian Agriculture

The Australian horticulture industry

www.nlwra.gov.au

Signposts for Australian Agriculture

The Australian horticulture industry

2008

HAL
Know-how for Horticulture™

RESEARCH WITHOUT BOUNDS
Kiri-ganai research

Published by:
National Land & Water Resources Audit

Level 1 The Phoenix
86 Northbourne Ave
Braddon ACT 2612

Telephone: 02 6263 6000
Facsimile: 02 6263 6099
Home page: http://www.nlwra.gov.au

Disclaimer

We invite all interested people, both within and outside the government, to make use of the Audit's reports, information, its Atlas and products. We encourage you to discuss the Audit's findings with the various partners and contributors who have prepared this information.

The Commonwealth accepts no responsibility for the accuracy or the completeness of any material contained in this report and recommends that users exercise their own skill and care with respect to its use.

Publication data: National Land & Water Resources Audit (2008). *Signposts for Australian Agriculture — The Australian Horticulture Industry*, NLWRA, Canberra.

ISBN:	978-0-642-37159-1
Product number:	PN21405 (Fact sheet: PN21920)
Acknowledgment:	With thanks to the significant input from a range of stakeholders, particularly Alison Turnbull and Andrew Collins of Horticulture Australia Ltd, and Karen Cody, Blair Wood and Claire Harris from the National Land & Water Resources Audit.
Authors:	Ken Moore (Boorara Management), Richard Price and Daniel Goode (Kiri-ganai Research), Mike Williams (Mike Williams & Assocs)
Editors:	Biotext Pty Ltd
Cover photos:	Australian Government Department of Agriculture, Fisheries and Forestry.

Printed with vegetable-based inks on stock that comprises 80% recycled fibre from postconsumer waste and 20% totally chlorine-free pulp, sourced from sustainable forests.

 This project was managed by Karen Cody, Social and Economic Information Coordinator, National Land & Water Resources Audit, under funding from the Department of Agriculture Fisheries and Forestry.

Foreword

Agriculture is under pressure to demonstrate its performance credentials — in particular, its environmental credentials — and to inform the community about its management practices. The agricultural sector recognises that failure to respond to this pressure may constrain future access to natural resources and markets and increase the risk of regulation of agricultural practices.

Since 1997, the National Land & Water Resources Audit has played an important role in the national coordination, collation and reporting of data and information. Under Signposts, government, industry and research bodies have collaborated in providing strategic direction and in exchanging data and information.

Signposts provides access to social, economic and environmental data specific to an industry and geographical area to inform policy development, strategic decision making and future research priorities. The Signposts reporting framework has been designed to align with other government reporting initiatives, including the evaluation framework for natural resource management programs such as Caring for our Country and Landcare.

The partnership built under Signposts needs to continue, to ensure an ongoing legacy of cross-agency collaboration in reporting.

Geoff Gorrie

Chair

The National Land & Water Resources Audit Advisory Council and Signposts Reference Group

Acronyms and abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
APAL	Apple & Pear Australia Ltd
CIE	Centre for International Economics
CO_2e	carbon dioxide equivalent
DAFF	Department of Agriculture, Fisheries and Forestry
EMS	environmental management systems
ESD	ecologically sustainable development
GHG	greenhouse gas
GL	gigalitre
GVP	gross value of production
ha	hectare
HAL	Horticulture Australia Limited
HAC	Horticulture Australia Council
HRDC	Horticultural Research and Development Corporation
IPP	Industry Partnership Program
ML	megalitre
NAD	Northern Agricultural District
NAP	National Action Plan for Salinity and Water Quality
NFF	National Farmers' Federation
NLWRA	National Land & Water Resources Audit (the Audit)
NRM	natural resource management
R&D	research and development

Contents

Tables

Figures

Summary

Signposts for Australian Agriculture (Signposts)

Industries are increasingly being required to account for their economic, social and environmental contribution.

Such accountability is driven by community expectations for socially and environmentally responsible business, market preferences for products and services produced in a sustainable and healthy way, and international and domestic regulations requiring compliance with social and environmental best practice.

Signposts is an initiative of the Australian Government that will allow industry and government to provide the information necessary to respond to the community and market expectations and demands that are arising in Australia and internationally. Signposts currently relies on the availability of data derived primarily from the National Land & Water Resources Audit and hence depends on the continuation of this program.

The Signposts framework has been designed to answer the question: 'How do Australian agricultural industries contribute to ecologically sustainable development (ESD)?'

Through this question, Signposts provides a platform for compiling data and communicating information that can be used to:

- build an industry's credentials in markets and the community for highly valued economic, environmental and social performance
- address community perceptions of the industry's management and activities
- identify priority issues and areas for planning and action.

This report is based on data that have been compiled through the Signposts horticulture industry profile.[1] In some cases, the Signposts data are supplemented from other government and industry sources, where this provides a more complete and up-to-date description of the report's topics. The availability and quality of data varies, and the ability to monitor trends on ecologically sustainable development objectives will depend on continuity and ongoing improvements in data collection and reporting for key indicators.

The report concerns the contribution of the horticulture industry to ecologically sustainable development, as reflected in the current Signposts framework. It has been prepared with the cooperation of Horticulture Australia Ltd (HAL) and relates to horticultural production to the farm gate.

Government and industry will find this report useful. From a public policy perspective, government is interested in and monitors the economic, social and environmental performance of the industry. The horticulture industry provides a valuable contribution to national and regional economies; to the nutrition and health of Australians; and the active participation of producers in natural resource management and environmental conservation.

The aims of this report are to reach some conclusions on how the industry is performing based on Signposts ecologically sustainable development indicators.

[1] See http://signposts4ag.com/signposts-horticulture

The Australian horticulture industry

The portfolio of HAL is extremely diverse, comprising fruit, vegetables, nuts, nursery products, extractive crops, cut flowers and turf. HAL's membership includes more than 30 specific industry bodies, covering edible and non-edible products.

Horticultural production is widely dispersed in all states and territories and across climatic zones from cool temperate to tropical. This report is about the farm sector, but output from growers is supplied through a packing, processing, distribution, wholesaling and retaining value chain that creates income for other industries, regional economies and the national economy.

Horticulture as a whole is Australia's third largest agricultural industry, with an estimated gross value of production (GVP) of $7.1 billion in 2006–07 (Figure i).

Economic contribution

Signposts measures the economic contribution of the horticulture industry in terms of its:

- productive capacity
- ability to increase exports to ensure industry growth
- net worth (ie total value of assets minus the value of liabilities) to undertake future investment
- productivity, which must increase to maintain future profitability in the face of declining terms of trade.

Capsicums, Adelaide (photo by Land & Water Australia 2006)

Table i Gross value ($million) of selected horticultural crops by state and territory, year ending 30 June 2007

	Apples	Other fruit and nuts	Potatoes	Tomatoes	Other vegetables	Total	% of total
Queensland	32.8	832.6	53.0	179.5	759.1	1857.0	34.1
Victoria	243.2	465.2	90.2	74.7	457.4	1330.7	24.4
New South Wales	68.7	423.6	50.3	15.4	246.0	804.0	14.8
South Australia	64.7	264.2	190.3	9.8	196.1	725.1	13.3
Western Australia	31.3	139.3	43.6	11.2	228.8	454.2	8.3
Tasmania	34.3	20.1	86.2	3.1	93.1	236.8	4.3
ACT/NT	0.0	32.1	0.0	0.1	9.2	41.4	0.8
Australia	**475.0**	**2177.1**	**513.7**	**293.8**	**1989.7**	**5449.3**	**100.0**

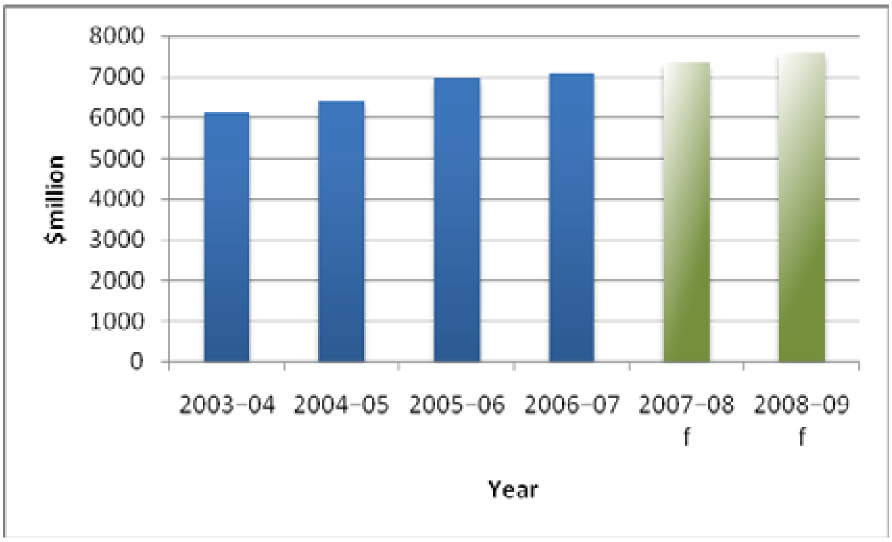
ACT = Australian Capital Territory; NT = Northern Territory
Source: ABS (2008)

Gross value of horticulture production

The horticulture industry's GVP increased by an average of 5% per year from 2003–04 to 2006–07 (Figure i). The two largest product sectors of horticulture, fruit and vegetables, have generally achieved increasing GVPs since 1999–2000. The fruit GVP increased every year, apart from 2003–04, which followed a severe drought. The vegetable GVP has been more variable and vulnerable to droughts. It has also experienced a significant market downturn for processing vegetables.

Since 2000–01, the main constraint on the industry's productive capacity has been climate variability, and the impact of two severe droughts in quick succession on production and farm profitability. Low water availability from natural rainfall and restricted irrigation water allocations have been the key production-limiting factors.

Figure i Gross value of production in horticulture, 2003–04 to 2008–09 (forecast)



f = columns are based on ABARE forecast data
Source: ABARE (2008)

Horticulture exports

Australian horticultural production is strongly directed to the domestic market, with only approximately 10% of output exported.

Australia's trade performance in horticultural products has been weak. For the two major horticulture sectors, Australia became a net importer of fruit in 2006–07 and has been a net importer of vegetables since 2002–03.

Australian exports account for only 0.1% of the world's traded fruit and vegetables. This occurs from a production base of approximately 1% of world production. For the other major agricultural industries, Australia's share of world trade greatly exceeds its production base expressed in world terms.

Net worth per farm

Indicators of net worth, such as the value of farm assets, business equity and rates of return on farm capital, for the vegetable sector show a relatively sound financial position for growers on average.

Total farm capital (average per farm) was $3.1 million in 2005–06, average farm equity was 72%, the average rate of return excluding capital appreciation was 3.2% and including capital appreciation (mainly land value) it was 9.2%. Apart from average farm equity, the vegetable industry outperformed wool, beef and other cropping farms in 2005–06 (ABARE 2007b).

Industry productivity

Future Focus, the industry's strategic planning initiative, identifies increasing productivity as the key strategy for countering the threat to profitability arising from increased import competition and rising import costs.

A discussion paper for *Future Focus* states that 'the fact that the fruit and vegetable industry has not grown to become highly export oriented like Australia's other agricultural industries, is evidence that it has not achieved the strong rates of productivity growth that have underpinned the export success of other Australian agricultural industries'(CIE 2007).

Industry productivity data is required to enable the *Future Focus* strategy to be addressed.

Environmental contribution

Horticultural crops are distributed widely throughout Australia, but are largely dependent on climatic conditions. Rainfall is the most significant climatic factor in Australian agriculture. Drought affects production and profitability.

Proactive management of environmental concerns

Nitrogen: this macronutrient is important for high yields. Individual farm soil testing ensures the effective, timely and environmentally sustainable application of nitrogen.

Phosphorous: Australia has generally low levels of soil phosphorous. Farmers manage this by testing the soil and applying fertilisers that match plant demand.

Salinity: irrigation-induced salinity is a more significant problem for the horticulture industry than dryland salinity. Best practice irrigation can prevent this natural resource management (NRM) problem.

Acidity: on-farm application of lime raises soil pH, improves yields and alleviates long-term soil degradation and loss of fertility.

The horticulture industry manages a complex set of natural resource management (NRM) and environmental issues, including soil fertility, irrigation-induced soil salinity, soil acidity, native vegetation conservation, weeds, greenhouse gas emissions, water use and water quality. Environmental stewardship is recognised as an industry priority and the industry has invested heavily in NRM programs.

Natural capacity to produce food

A range of resource management issues confront the horticultural industry's natural capacity to produce food.

Soil nitrogen and phosphorous

Nitrogen and phosphorous application is an ongoing soil fertility issue for horticulture. The nitrogen and phosphorous status of soils varies greatly between regions and requires different application rates in different areas.

Farmers are increasingly recognising that soil fertility and fertiliser applications need to be managed carefully to achieve production targets without causing environmental damage. HAL issued the *Guidelines for Environmental Assurance in Australian Horticulture* in 2006, which recommends best practice nutrient management and fertiliser application.

Soil salinity and acidity

Signposts addresses the issues of soil salinity and acidity. Dryland salinity is not a significant issue for the horticulture industry.

Irrigation-induced salinity resulting from both overirrigation and underirrigation is a significant issue for the horticulture industry. Improving water use efficiency is a key strategy to ameliorate this problem. Actions include modernising irrigation infrastructure, upgrading irrigation technology, improving scheduling and ensuring water reuse.

Data on estimated average nitrogen and phosphorous application to plants, and removal by plants shows excess application for most crops.

National Land and Water Resources Audit data for 2000 suggests that soil acidity is an issue in almost half of the horticulture production area. Soil acidity can be corrected by the application of lime in the form of agricultural lime or dolomite. This is a common practice amongst horticulturalists.

Water use and quality

Water is a key resource for the horticulture industry for permanent and annual plantings. Total water consumption for surveyed periods in 2000–01 and 2004–05 was around 1.1 million megalitres, representing approximately 6% of national water consumption.

The Horticulture Water Initiative was established by HAL as an industry-level water strategy in 2003. HAL has also invested in partnership projects with other national irrigation research and development funders to address key issues facing the industry.

The key water quality issue for horticulturalists is the prevention of fertiliser leakage to surface and ground water both on and off-farm.

Natural capacity to provide ecosystem services

The most compelling current issues in the minds of both consumers and the general community are the contribution of industries to the conservation of biodiversity and greenhouse gas emissions (or conversely greenhouse gas or carbon sequestration).

Almond trees in South Australia Riverland region (photo by Land & Water Australia 2006)

Biodiversity conservation relates to the capacity of land held by the industry to conserve native biodiversity.

Sources of greenhouse gases in horticulture include: nitrous oxide from soils, particularly fertilisers; nitrous oxide and methane emissions; field burning of agricultural residues; and carbon dioxide from the operation of fossil fuel machinery.

Emissions from these sources (apart from fossil fuel use) were estimated at 698 gigagrams (0.7 million tonnes) of CO_2e in 2005, which was approximately 0.8% of total agricultural emissions. Horticulture emissions doubled between 1990 and 2001, although the rate of increase from synthetic fertiliser application has declined since 2001.

Improvements in the efficiency of energy use and more effective fertiliser management are key actions for the industry to reduce greenhouse gas emissions. Some growers are members of the Greenhouse Challenge Plus, a partnership with the Australian Government to improve energy efficiency and reduce greenhouse gas emissions.

Social contribution

The horticulture industry contributes to Australia's social systems by changing the values of:

- its own human and social capital
- the human and social capital held by others.

Attributes of the human capital component that will be measured by Signposts include technical skills and the health, age and life stage of growers.

Fruit picker Ernie Bolat at the Veripodia orchards Ardmona, Victoria (photo by Arthur Mostead 2005)

Social capital is defined in terms of group relations, partnerships, norms and networks that facilitate the diffusion of knowledge and innovation, provide support during structural adjustment and promote cooperative behaviour.

The social contribution of the Australian horticulture industry also includes the benefits and costs extending beyond the industry itself — to the national community, regional communities and employees.

The contributions that the industry makes to social systems at the national scale include employment; the national culture and identity; and the nutritional contribution of fruit, vegetables and nuts that are consumed by all Australians. Nationally, the horticulture industry employed almost 70 000 people in 2001, which represented approximately 25% of all employment in agriculture.

Introduction

This Signposts report on the horticulture industry is one of six initial reports on the contribution of Australia's major agricultural industries to ecologically sustainable development.

The *Australian National Strategy for Ecologically Sustainable Development* (Council of Australian Governments 1992) defined ecologically sustainable development as:

> Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

In the Signposts framework, ecologically sustainable development is interpreted as an overall increase in the value of the nation's capital assets (which include produced capital, such as physical infrastructure, human capital, social capital and natural capital) that is available to increase the wellbeing of the Australian population. Similarly, at an industry level, ecologically sustainable development is interpreted as an increase in the value of an industry's capital that is available to produce income and environmental and social benefits for both the industry's stakeholders and the broader society.

Partnership with industry

This report relates to horticulture production to the farm gate and has been prepared in collaboration with Horticulture Australia Ltd (HAL). HAL is an industry-owned company that provides services to the Australian horticulture industry. These services cover national research, development and marketing. HAL invests almost $80 million annually in projects in partnership with the horticulture sector, which include a diversity of topics, such as market access, market research, export marketing, domestic marketing, supply chain management, quality assurance, food safety, skills development, industry communication, biotechnology, biosecurity, breeding, plant health, pesticide regulation, agronomy, crop regulation, physiology, irrigation and sustainable practices.

The Horticulture Australia Council (HAC) represents 19 peak industry bodies for the advancement and prosperity of Australian horticulture. It deals with whole-of-horticulture issues, develops policy and facilitates change through advocacy for the industry. HAC also seeks to develop and encourage the adoption of policies, procedures, standards and codes of practice that will achieve the advancement and prosperity of Australian horticulture. In addition, it assists and supports the production and dissemination of information about the industry.

The Signposts framework

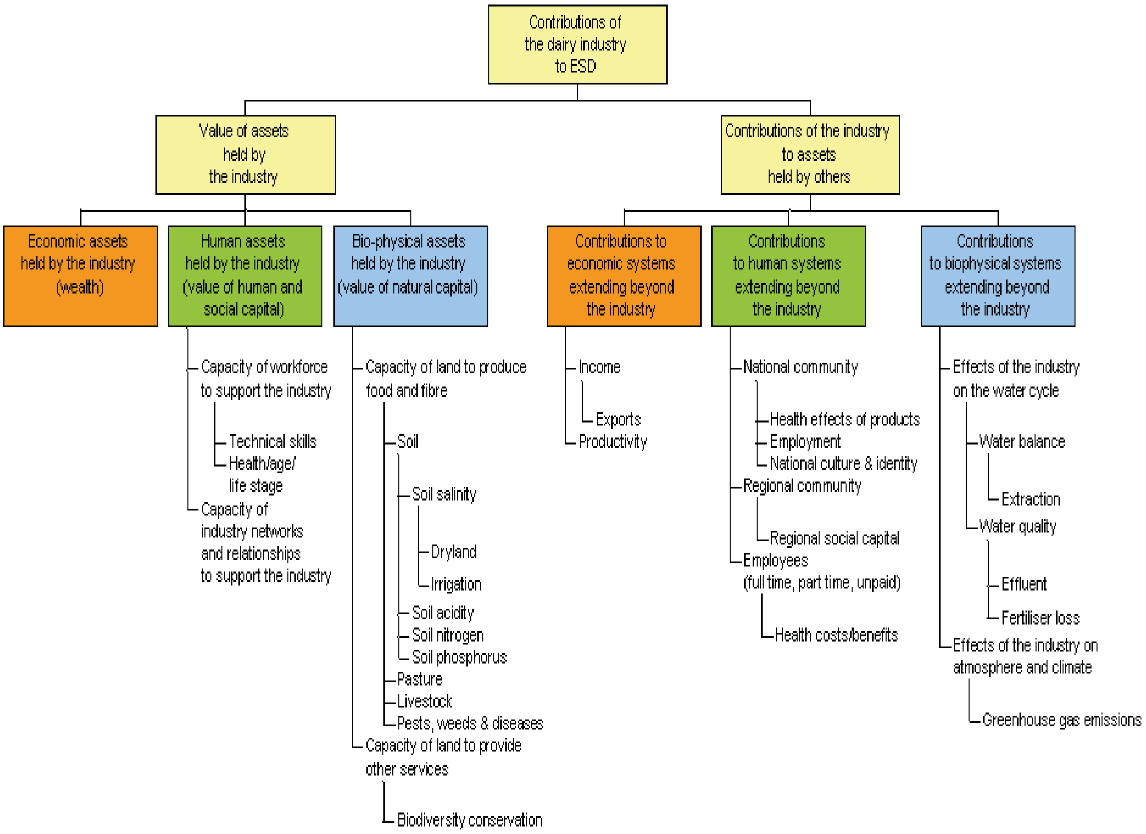
This report is based on data compiled through the Signposts horticulture industry profile, which is web-based. The report provides the best available data from Signposts where these are included in the framework. In some cases, Signpost data are supplemented from other government and industry sources where they provide a more complete and up-to-date description of the report's topics.

This report does not repeat the rich conceptual and definitional material of Signposts, and readers seeking this information can access the relevant Signposts' URL.[2] At this stage in the development of Signposts, many of the components and subcomponents have not been populated with the required data.

Data imperfections are a fact of life in most industry reporting, but Signposts provides a platform where information can be updated, refined and extended over time. The Signposts framework envisages that over time a complete dataset and means of analysis of the industry's contribution to ecologically sustainable development (as shown in Figure 1) can be established.

[2] See http://www.nlwra.gov.au/Natural_Resource_Topics/Signposts_for_Australian_Agriculture/index.aspx

Figure 1 Signposts for agriculture — horticulture industry profile



ESD = ecologically sustainable development
Source: http://signposts4ag.com/signposts-horticulture/full-component-tree

The contributions of the industry are set out in the component tree in Figure 1. Each component includes a statement of the desired outcome and measures (ie an indicator and a summary measure) to show progress towards the outcome. Where data are available, results are provided for the indicator and summary measure. The industry profile also describes industry and government responses, and the adoption of specific management practices.

Use of Signposts reports

The reporting needs of government and industry are, to the greatest extent possible, accommodated in the Signposts reports.

From a public policy perspective, government is interested in and monitors the economic, social and environmental performance of the industry. Similarly, the industry itself monitors these variables for a variety of purposes:

- advising government and making a contribution to public policy development
- providing information about the industry back to its stakeholders, to better inform decision making at the business level
- meeting reporting requirements arising from statutory obligations, the need to inform markets and consumers, and the need to inform financial markets, which supply funds to the industry for investment
- promoting the industry within the broader society.

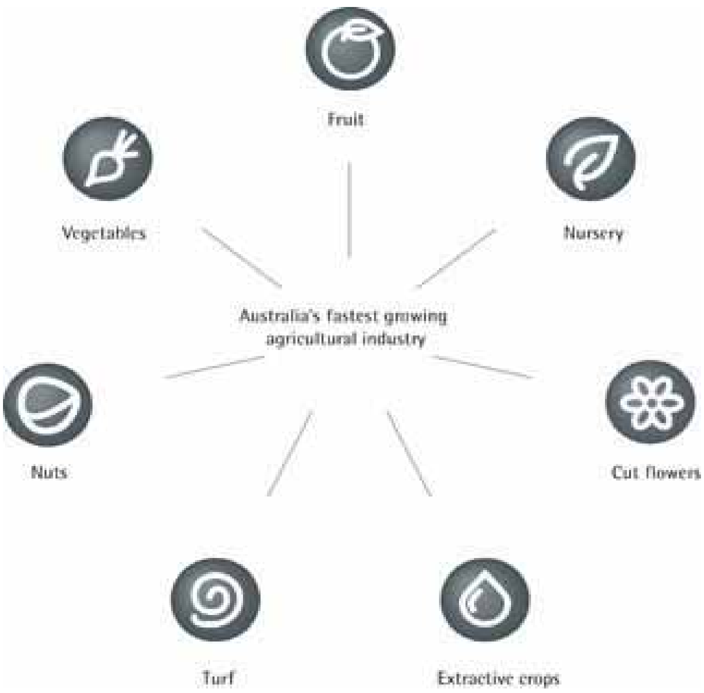
The economic contribution

Signposts examines the economic contribution of the Australian horticulture industry from four key perspectives:

- to national income through horticultural production, and supply to domestic and international markets
- to exports, as future growth in the industry's income will rely heavily on exports
- with the value of the industry's assets that currently yield income or have the potential to yield income in the future
- with the industry's total factor productivity, which indicates its actual performance and potential to contribute to growth in production, income and profits.

Horticultural production, as covered by the HAL portfolio, is extremely diverse, comprising fruit, vegetables, nuts, nursery products, extractive crops, cut flowers and turf. It does not include wine grape growing, which is considered to be part of the Australian wine industry, but fruit does include table grapes and dried grapes.

Figure 2 Australian horticulture industries within the HAL portfolio



Source: http://www.horticulture.com.au/industry/overview_horticulture1.asp

The output of horticultural farms includes both edible (fruit, vegetables and nuts) and non-edible products (cut flowers, nursery products and turf). In the edible sector, products are supplied to the fresh market as whole fruit and vegetables or packaged fresh cuts. Some of the processing and packaging for the fresh market takes place on-farm.

The edible sector also includes fruit, vegetables and nuts supplied as the raw material for the processing sector to produce juices, ingredients, packaged frozen fruit and vegetables, and canned fruit and vegetables. The non-edible sector includes cut flowers, plants for the nursery market and turf.

Output from the farm sector is supplied through a processing, distribution, wholesaling and retailing value chain that creates income for other industries. Horticultural production, like other agricultural industries, has led to the creation of an extensive service sector that provides transport, storage, selling, marketing, brokering, financial, information, research, consulting, education and training services.

The on-farm sector also contributes to the wider economy through the effects of incomes earned from horticultural farms that are spent in other sectors of the economy. This is a very important contribution to rural, regional and metropolitan communities that lie within horticultural areas, or are in close proximity to these areas.

Horticultural production is widely dispersed in all states and across climatic zones, from cool temperate to tropical. The major growing areas for edible horticulture include:

- the Goulburn Valley (Victoria)
- the Murrumbidgee Irrigation Area (New South Wales)
- the Sunraysia district (Victoria, New South Wales)
- the Riverland region (South Australia)
- northern Tasmania
- southwest Western Australia
- the coastal strip of northern New South Wales and Queensland.

Nursery and turf production generally occurs within or close to the capital cities or regional centres.

Banana, pineapple, mandarin, avocado, mango and fresh tomato production is concentrated in Queensland; stonefruit and oranges in New South Wales, Victoria and South Australia; processing potatoes in Tasmania; fresh pears, canning fruit and processing tomatoes in Victoria; and apples and fresh vegetables in all states and territories.

Australia has a sizeable tropical horticultural industry above the twenty-sixth parallel, which includes large irrigation schemes in the Ord Irrigation Area of Western Australia and the Burdekin Irrigation Area in Queensland. Bananas, mangoes, avocados, papaya, lychees, cucurbits (rockmelons, watermelons, pumpkins) together with tropical nursery plants and vegetables are important industries. There is also a growing ‘rare and exotic’ fruit industry that produces fruits such as rambutans, durians, tamarillos, carambolas, jackfruit and mangosteens.

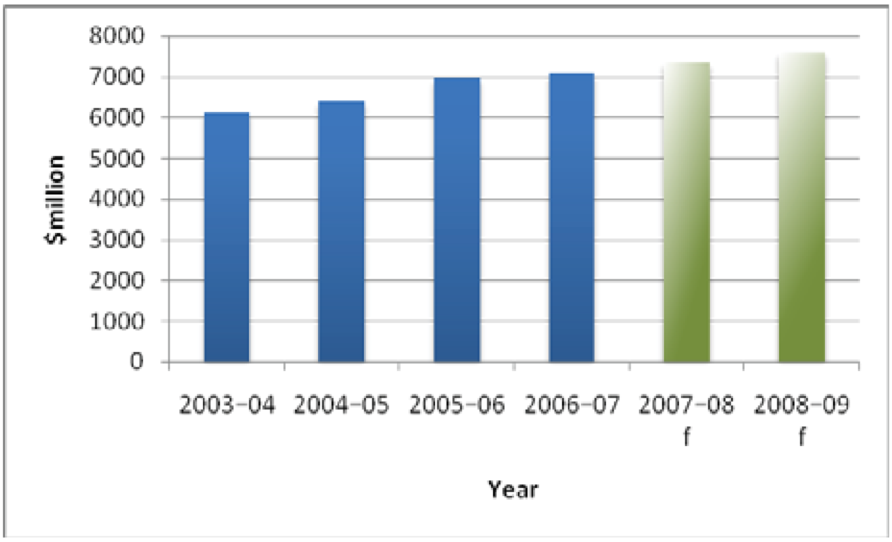
Gross value of horticulture production

At the national level, the desired outcome for an industry is that its net contribution to the economy is positive and increasing over time. In the absence of net value of production statistics,[3] the gross value of production (GVP) is an indicator of an industry’s income and productive capacity.

The GVP of the wider horticulture industry (edible and non-edible sectors) was estimated to be $7.1 billion in 2006–07 (ABARE 2008). This makes horticulture Australia’s third-largest agricultural industry behind grains and beef; although individually, fruit, vegetables and non-edible (nursery, cut flowers and turf) horticulture have GVPs below that of the dairy industry.

3 The net value of production of an agricultural industry is equal to aggregate farm business gross revenue generated from the production of agricultural goods, minus production costs.

Figure 3 Gross value of production in horticulture, 2003–04 to 2008–09 (forecast)

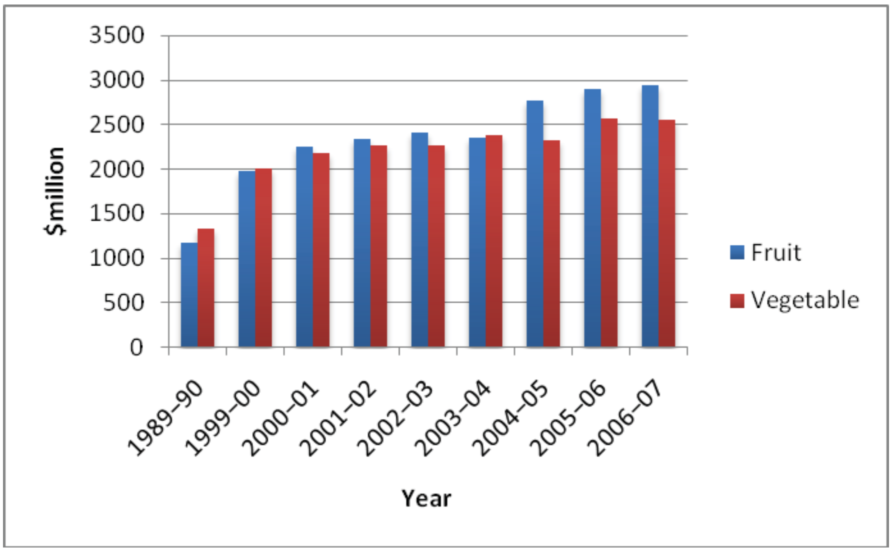


f = columns are based on ABARE forecast data
Source: ABARE (2008)

Initial findings of the industry's strategic planning initiative, *Future Focus,* indicate that 'if the industry is to maintain its place in the Australian economy, it needs to achieve industry growth of around 3 per cent a year, or 35 per cent growth over the next decade' (CIE 2007a).

The vegetable industry's vision expressed in its strategic plan, *Vegvision 2020*, is 'to double the 2006 value of fresh, processed and packaged vegetables in real terms by stimulating and meeting consumer preference for Australian products in domestic and global markets'.

Figure 4 Gross value of production in fruit and vegetable industries, 1989–90 to 2006–07



Source: ABARE (2007a)

In 2006–07, the GVP was $2.9 billion for fruit and $2.5 billion for vegetables. The GVP for fruit has increased each year since 1999–00, except for 2003–04. The GVP for vegetables has fluctuated with downturns in 2002–03, 2004–05 and 2006–07.

The GVP of non-edible horticulture was estimated at $1.6 billion in 2006 (CIE 2007b).

Table 1 shows the GVP of selected horticultural crops by state and territory. Queensland is the largest producer in value terms followed by Victoria, New South Wales, South Australia, Western Australia and Tasmania.

Table 1 Gross value ($million) of selected horticultural crops by state and territory, year ending 30 June

	Apples	Other fruit and nuts	Potatoes	Tomatoes	Other vegetables	Total	% of total
Queensland	32.8	832.6	53.0	179.5	759.1	1857.0	34.1
Victoria	243.2	465.2	90.2	74.7	457.4	1330.7	24.4
New South Wales	68.7	423.6	50.3	15.4	246.0	804.0	14.8
South Australia	64.7	264.2	190.3	9.8	196.1	725.1	13.3
Western Australia	31.3	139.3	43.6	11.2	228.8	454.2	8.3
Tasmania	34.3	20.1	86.2	3.1	93.1	236.8	4.3
ACT/NT	0.0	32.1	0.0	0.1	9.2	41.4	0.8
Australia	**475.0**	**2177.1**	**513.7**	**293.8**	**1989.7**	**5449.3**	**100.0**

ACT = Australian Capital Territory; NT = Northern Territory
Source: ABS (2008)

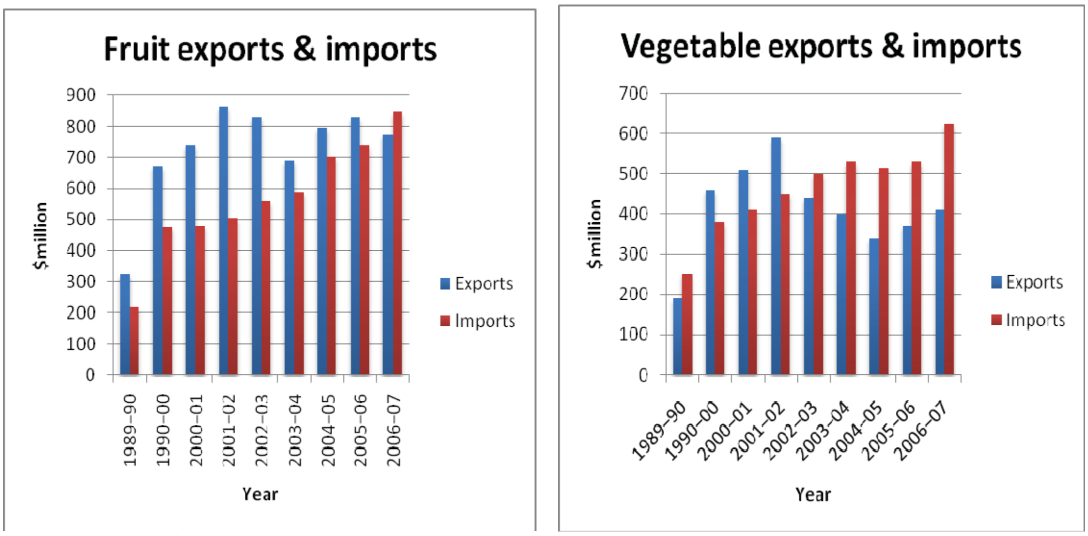
Horticulture exports

Initial findings of *Future Focus* indicate that 'unless the horticultural industry can develop and maintain strong export markets, its growth and prosperity are highly limited and subject to erosion by imports'. The findings suggest that a 10% increase in export demand might be worth more than double a 10% increase in domestic demand (CIE 2007a).

The Centre for International Economics paper notes that 'globally, growth in trade in horticulture is very strong and (apart from Australia) southern hemisphere countries have been able to capture this. Horticultural imports to Australia are growing'.

Australia's trade performance in horticultural products has been weak. For the two major horticulture sectors, Australia became a net importer of fruit in 2006–07 and has been a net importer of vegetables since 2002–03 (see Figure 5).

Figure 5 Balance of trade for fruit and vegetables, 1989–00 to 2006–07



Source: ABARE (2007a)

The main growth in imports has been in processed horticultural products and Table 2 shows a worsening trade balance over the period 2000–01 to 2004–05. Although the trade balance for fresh horticulture has remained positive over the period, it has significantly declined.

Table 2 Value ($m) of total horticultural exports and imports, 2000–01 to 2004–05

	2000–01	2001–02	2002–03	2003–04	2004–05
Fresh					
Exports	783	929	855	701	800
Imports	247	256	275	311	362
Trade balance	536	673	580	390	438
Processed					
Exports	514	569	467	434	387
Imports	674	732	803	806	864
Trade balance	–160	–163	–336	–372	–477

m = million
Source: ABS (2002–06)

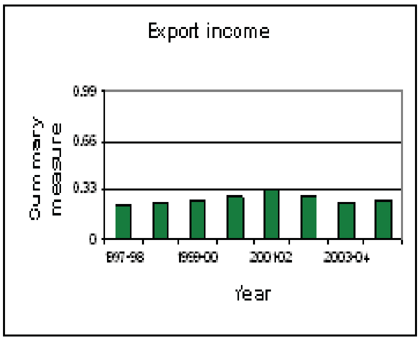
In 2005, HAL adopted an objective to increase Australia's horticultural exports by more than three times the 2002 level by 2010. Carlisle (2007) notes that the world market for fruit and vegetables is approximately A$680 billion. Australian exports account for only 0.1% of the world's traded fruit and vegetables. This is from a production base of around 1% of world production. For the other major agricultural industries, Australia's share of world trade exceeds its production base expressed in world terms.

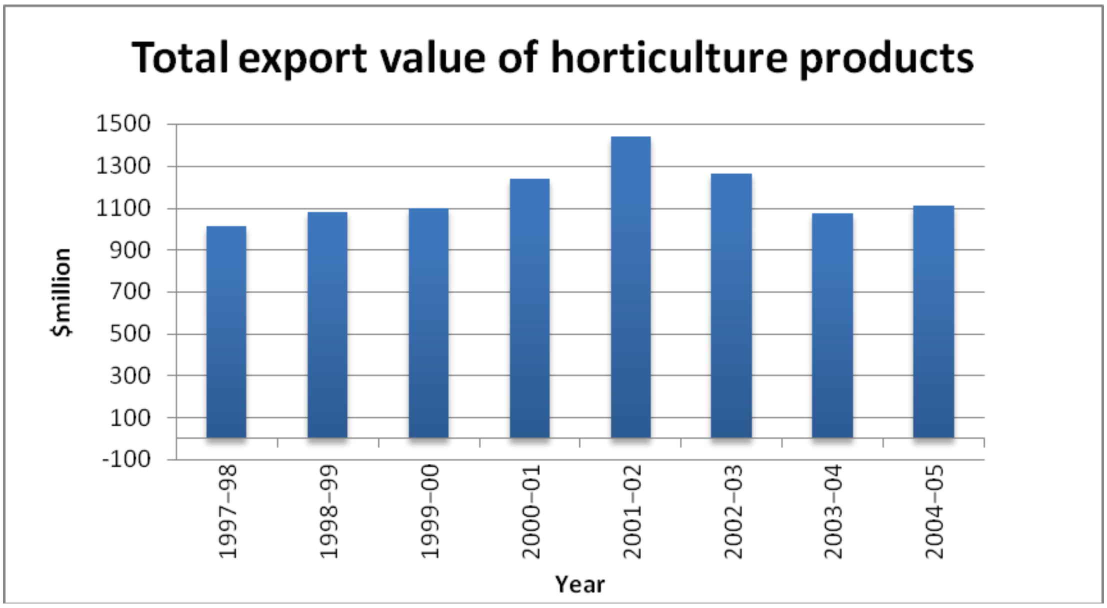
Following many years of growth, exports of fresh horticultural produce declined in 2002–03 and 2003–04, largely due to the impact of drought and difficult market conditions, but recovered to some extent in 2004–05. Exports of processed produce have been declining over a long period. This poor export performance may have been compounded by an appreciating Australian dollar and trade barriers against Australian produce.

Achievement of HAL's export objective will require a substantial change in the export performance of Australian horticulture. The Signposts summary measure is the value of horticultural exports as a proportion of the 2010 target, scaled from 0 to 1.0, with the latter representing the achievement of the target. The summary measure reached 0.33 in 2001–02, but has declined significantly since then (See Figure 6).

Although overall horticulture export performance is weak, there is considerable variation among products. Citrus, nuts and mushrooms have performed well. In addition, there is variation between states, territories and regions with some areas performing better than others, such as Western Australia with vegetable exports.

Figure 6 Signposts performance summary measure for horticulture exports





Sources: DAFF (2005), ABARE Australian Food Statistics (2005), Carlisle (2007)

With regard to non-edible horticulture, export opportunities are limited, but the balance of trade is not likely to be adversely affected because imports are highly restricted. Quarantine restrictions and the costs relating to transporting soil in and out of Australia limit both exports and imports to plants with washed roots. In these circumstances, trade is likely to be costly and conducted in small volumes.

Net worth per farm

The value of industry assets or wealth can be measured as net worth (the total value of the industry's assets minus the value of its liabilities). The desired economic position of an industry is that its net worth is positive and increasing over time. Rising net worth reflects increasing capacity of the industry to attract investment in the industry and generate future increases in income.

An Australian Bureau of Agriculture and Resource Economics (ABARE) study of the international competitiveness of the vegetable production sector for 2004–05 and an economic survey of vegetable growers for 2005–06 provides financial performance data relating to a horticulture industry.

Despite considerable variation in farm cash income and business profit in the two years surveyed, the underlying net worth position of the vegetable industry is relatively sound, particularly when compared to other wool, beef and cropping farms.

The main findings for the vegetable industry are:

- total farm capital (average per farm) was $2.5 million in 2004–05 and $3.1 million in 2006–07
- average equity ratio per surveyed farm was 87% in 2004–05, compared with 81% for wool, beef and cropping farms (Table 3)
- in 2005–06, the equity ratio for the vegetable farms surveyed was considerably lower at 72%, with farms in Victoria, Queensland and South Australia having ratios of 63%, 62% and 66%, respectively
- vegetable farms in Western Australia had a high equity ratio of 91% in 2006–07.

Table 3 Farm financial performance relating to net worth, average per farm 2004–05

	Total farm capital ($m)	Equity ratio (%)	Rate of return excluding capital appreciation (%)	Rate of return including capital appreciation (%)
Victoria	2.7	86	3.4	4.8
Northern Tasmania	2.1	83	2.9	5.8
Western Australia	3.1	88	3.5	5.3
Southeastern Queensland	2.5	91	2.0	5.0
All vegetable growers	2.5	87	3.1	5.1
Wool, beef, cropping lands	2.7	81	0.7	7.2

Source: ABARE (2006)

With regard to rates of return on farm capital in 2005–06 (Table 4):

- the average rate of return to capital (excluding capital appreciation) among vegetable growers was 3.2%, compared with 0.6% for broadacre farms
- the Northern Territory had the highest rate of return on capital, excluding capital appreciation, at around 7.5% per farm
- Tasmania had a negative rate of return of –1.7%, largely due to low prices and loss of contracts for processing vegetables
- capital appreciation, particularly rising land values near urban fringes, produced average rates of return for the surveyed farms of 9.2% (compared with 7.2% in 2004–05)
- growers in Western Australia had average rates of return including capital appreciation of 15% and those in the Northern Territory averaged almost 14%.

Table 4 Farm financial performance relating to net worth, average per farm 2005–06

	Total farm capital, 30 June ($m)	Equity ratio (%)	Rate of return excluding capital appreciation (%)	Rate of return including capital appreciation (%)
New South Wales	2.9	82	2.5	4.8
Victoria	3.5	63	5.0	8.3
Queensland	3.6	62	3.2	9.8
South Australia	2.1	66	4.2	6.7
Western Australia	3.6	91	4.6	15.0
Tasmania	2.5	84	–1.7	2.3
Northern Territory	1.6	82	7.5	13.9
Australia	**3.1**	**72**	**3.2**	**9.2**

Source: ABARE (2007b)

The rate of return to vegetable growers is clearly related to the size of enterprise, reflecting the economies of scale in production (Table 5).

Table 5 Rate of return on farm capital, excluding capital appreciation, for vegetable growers, 2005–06

	Rate of return, excluding capital appreciation (%)
<5 ha	0.8
5–20 ha	1.7
20–70 ha	2.2
>70 ha	4.7

Source: ABARE (2007b)

Industry productivity

Prices received for agricultural commodities have failed to keep pace with the prices paid for agricultural inputs over the past three decades. Increasing productivity has been necessary to offset declining terms of trade and to maintain the viability of agricultural industries.

Total factor productivity is a measure of on-farm productivity that compares output with the combined use of all resources. Total factor productivity is expressed as an index and is frequently used as an indicator of industry performance because it measures the effect on output of factors such as technological advances, improvements in management and exploitation of economies of scale.

Initial findings of *Future Focus* indicate that increases in farm productivity along with increases in export and domestic market demand are the key profitability drivers that could deliver improved economic performance for the edible horticulture sector. Increasing productivity is the key strategy to tackle the threat to profitability arising from increasing import competition and rising input costs.

The 2005–06 survey by ABARE of the vegetable production industry asked growers to indicate a range of management practices that would improve the productivity of their farm business. The most common responses were to introduce more productive or higher yielding vegetable varieties (59% of growers), and to introduce or expand mechanisation (54% of growers). Approximately 13% of growers believed that they were already as productive as possible.

Australian horticulture producers are considered to be quick adopters of technological and management improvements. There are many examples of horticulture businesses adopting world-class technology relating to crop production and management, improved irrigation and water use efficiency (eg use of recycled water sources, use of high yielding and disease resistant seedlings and root stock).

Although many horticulture enterprises are small in scale, there has been a move towards larger-scale production facilities with increasing degrees of mechanisation and controlled atmosphere production and storage. These developments are aimed at productivity improvements and cost savings.

A discussion paper for *Future Focus* states that 'the fact that the fruit and vegetable industry has not grown to become highly export oriented like Australia's other agricultural industries, is evidence that it has not achieved the strong rates of productivity growth that have underpinned the export success of other Australian agricultural industries' (CIE 2007a).

However, the paper notes that raising levels of productivity without also developing export markets will mainly be to the benefit of domestic consumers, and producers will find it hard to capture any gains. This creates a low incentive to invest in research and development, and new technology.

Case study Future Orchards 2012: the apple and pear industry responding to global changes

In 2005, Apple and Pear Australia Ltd (APAL) recognised that the industry was facing a period of unprecedented change. The domestic market had become linked with the global market, and subject to the pressures of globalisation where international competitiveness is the key factor in industry survival and future prosperity.

> Becoming fully world competitive and surviving in a market environment where all fruit can expect to achieve no more than world parity prices has become urgent. The pressing need is to prepare the apple and pear industry for the (near) future with a range of activities across several areas of the industry. (APAL 2005)

Apples and pears. Adelaide (photo by Land & Water Australia 2006)

In response, APAL entered a partnership with the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) under the Industry Partnership Program (IPP) to undertake research designed to assist the industry improve its long-term viability and sustainability in a globally competitive market environment.

The adoption of intensive orchards

One of the studies under the IPP found that most Australian growers had fallen behind world's best practice in orchard systems and that the viability of the industry would depend on an urgent and strategic response to accelerate the adoption of intensive orchards (Kiri-ganai Research 2005).

Australian apple orchards averaged about 640 trees per hectare (ha), but industry consultants recommended that to be internationally competitive, the planting density should 2500 or more trees per ha, grown according to the following principles:

- rootstocks and management practices that minimise the vertical tree height to 3–4 m in the district and soil type in which the orchard is grown
- nursery trees that are well feathered and capable of achieving sustainable cropping from year two
- central leader/vertical axis tree training in conjunction with a trellis (ie a tree support system)
- orchard management techniques that can reach production of 55 tonnes per ha by year five.

For pears, a planting density of 2000 or more trees per ha, along with similar management principles to high intensity apple orchards, was recommended by industry consultants.

APAL endorsed these recommendations and considered that: 'To compete globally, Australian orchards need to be able to produce high proportions of premium quality fruit at lower cost than today, be able to change varieties relatively quickly and reach commercial production levels early'.

To meet these requirements, APAL indicated that an intensive orchard system with trees grown on dwarfing rootstocks at a density of 2500 trees per ha for apples and 2000 trees per ha for pears should be considered the minimum benchmark for future international competitiveness.

Initial plantings of apple orchards with more than 3000 trees per hectare commenced in Europe more than 30 years ago. European apple orchards are said to consistently produce 45 tonne per ha by the third year from planting, with production levels of 65–80 tonne per ha being achieved on an ongoing basis.

Other countries have also moved to more intensive plantings and international comparisons showed that:

- Australian apple production averages approximately 20 tonnes per ha
- New Zealand produces 40–50 tonnes per ha
- Italy's average yield is approximately 55 tonnes per ha.

Similar intensive systems are available for pears that produce a commercial crop within three years instead of 10 years, and have full crops in five to six years instead of 15 years.

Following the completion of the research reports under the IPP, the Australian Government contributed $1 million for a national extension program to be run over two years. This program was to begin the process of transforming Australian pome fruit orchards to the recommended benchmarks for international competitiveness — Future Orchards 2012.

The characteristics of the response

Future Orchards 2012 began in 2006 under the management of APAL and an industry-wide steering committee. APAL engaged AgFirst, a New Zealand consultancy company, to run the project.

AgFirst had facilitated the pome fruit Focus Orchard Program in New Zealand and had conducted benchmarking and farm monitoring projects for the New Zealand pipfruit industry. Several of its consultants were specialists in modern apple production systems and had gained knowledge of intensive systems from leading apple and pear growing regions in the United States, Italy, France, Chile and Argentina.

Future Orchards 2012 aims to have apple and pear growers understanding intensive production systems within two years, to have all new plantings to be intensive within five years and to have an internationally competitive industry in Australia within 10 years. It seeks to increase Australia's average apple yield from the present 20 tonnes per ha to at least 45 tonnes per ha.

The main drivers of Future Orchards 2012 are to lower orchard production costs per kilogram of fruit, increase the percentage of premium fruit harvested and bring Australian orchardists up to international competitiveness in the domestic and export markets.

The key activities of Future Orchards 2012 are to monitor the performance of orchard demonstration blocks, collect data to compare the costs and returns of different tree planting densities and to make that information available to growers.

Growers and industry advisors are able to visit monitor blocks during scheduled orchard walks, which are conducted four times per year in different regions. The walks are designed to demonstrate the issues growers face and to discuss orchard performance.

Other features of Future Orchards 2012 are:

- seminars on a wide range of apple and pear production topics
- an overseas study tour in 2008
- an overseas exchange program for young growers
- presentations by invited national and international experts in various aspects of apple and pear production during the orchard walks.

The benefits and constraints of the response

By demonstrating real life management issues and providing data on orchard performance, Future Orchards 2012 supports growers in making the business decision to plant intensive systems if they can deliver commercial advantages to their business.

Perceived benefits

Although intensive systems have a variety of attributes, three key market drivers underpin the benefits of the adoption of these production systems.

Meeting consumer expectations: Domestic and international consumers are increasingly health conscious and demand consistent, high-quality fruit throughout the year. Growers who can meet this demand will have more choices of potential customers and the opportunity for the best market prices for a high proportion of their crop.

Intensive systems represent the best production technology to produce a more consistent fruit size and will increase the percentage of premium quality fruit that is harvested. This improves the prices received by growers because more goes to the premium fresh market and less to processing with lower prices.

Intensive orchards also offer the prospect of a faster response to changing consumer tastes by coming into production more quickly than conventional systems. Thus, growers who choose to plant newer varieties in intensive systems can respond more rapidly to changing consumer demand.

Increasing orchard productivity: In an increasingly competitive environment, innovations that can improve returns for growers from existing resources are critical. In many regions, water availability and rising costs are a major limitation on the capacity of growers to increase production. Growers who can increase production from the same amount of water will have a commercial advantage.

Intensive orchards offer the opportunity for increased production from a grower's existing land and water resources. This stems from growers starting to receive a return in year two after planting because the trees come into production more quickly and then produce higher yields (kg/ha) than traditional orchard systems.

Attracting labour and reducing costs: The supply and cost of labour is a major issue for growers. The lower tree height and increased yields of quality fruit in intensive orchards make harvesting more appealing to pickers and more efficient (kg/hour). Thus, farms that have intensive systems will be better placed in attracting labour in the increasingly competitive environment for fruit pickers.

There are also environmental benefits from intensive orchards. Chemical usage per tonne of fruit can be reduced by up to half. In addition, because the same amount of fruit can be grown on less area, water and fuel inputs will be lower.

Perceived constraints

In 2005, Kiri-ganai Research listed the impediments to the adoption of intensive orchard systems:

- There is a climate of uncertainty of future industry profitability, which creates lack of confidence to invest.
- Capital cost of investment is high, which increases the risk of negative returns and creates problems for many growers in raising sufficient capital.
- The economic case for intensive orchards in Australia has not been clearly demonstrated through professional and credible analysis.
- The industry structure, comprising many small and medium-size family orchards, creates difficulties in accessing capital to invest in intensive orchard systems.
- There is grower uncertainty and lack of confidence in managing intensive systems and in the results that can be achieved.
- The age structure of apple and pear growers (average age is over 60 years) deters investment from those growers who do not have a succession plan.
- There is uncertainty in the quality and availability of required nursery trees on appropriate dwarfing rootstock, with inadequate two-way flow of information on grower requirements and nursery supplies.
- The commercial extension capacity in Australia is underdeveloped and unable to fully provide professional and practical technical, economic and management advisory services required by growers.
- Strengthening of industry and government institutional support is required to motivate and support the industries in this major change program. Overseas experience shows financial incentives will be required to stimulate change, but these need to involve co-investment by the industry and government, be compatible with the Australian policy context and be non-distortionary in production and marketing terms.

Actual results

Grower feedback to APAL is that Future Orchards 2012 is the 'best project that has ever been run in the industry' (Alma Reynolds, Project Manager, personal communication, 2008). Although government funding of the program will conclude on 30 June 2008, the industry has agreed to continue funding it for a further two years. The industry believes that the provision of government funding provided the initial incentive and confidence to implement Future Orchards 2012 and will represent a significant return on that investment to make Australian orchards internationally competitive.

Monitor blocks

Establishment of the monitor blocks has allowed real-life demonstration of the benefits of intensive orchards and has addressed many of the constraints listed by Kiri-ganai Research in 2005. An evaluation of the results achieved during the period of government funding will be undertaken, but is not available for this report.

Ninety-seven monitor orchard blocks have been established for apple production comprising 36 in Victoria, 23 in New South Wales, 16 in South Australia, 11 in Tasmania, eight in Queensland and three in Western Australia. The blocks cover five varieties: rosy glow, Cripps pink, royal gala, gala and Fuji.

Planting densities of the monitor blocks range from 655 to 5000 trees per ha. The monitor block activity classifies planting densities as traditional if they are up to 1000 trees per ha, semi-intensive with between 1000 and 1500 trees per ha and intensive with more than 1500 trees per ha. However, 35% of the blocks are at or above the high density benchmark of 2500 trees per ha.

For pears, there are 12 monitor blocks with nine in Victoria, two in South Australia and one in Western Australia. Planting densities range from 269 to 2222 trees per ha, with 33% at or above the high density benchmark of 2000 trees per ha.

The Future Orchards 2012 website for members provides details of the monitor blocks and shows profit ($/ha) and gross yield (kg/ha). There is wide variation in the profit and yield results between monitor blocks, which is influenced by location, planting density, tree age and climatic or weather events, such as the impact of the 2006–07 drought on water availability. However, the results show yields and profit per ha generally increases as the planting density increases.

Orchard walks

The program has provided four orchard walks per year for growers and advisors. These have been well attended and have provided benefits for participants in seeing the blocks and receiving information from monitor-block growers. In addition, invited specialists have made presentations on aspects of orchard management and have been available to answer questions from growers. The monitor-block growers have also benefited from feedback from participants in the orchard walks.

An extensive library of literature has been developed from the facilitator notes of the orchard walks and presentations by specialists, which is provided on the Future Orchards 2012 website.[4]

Overseas exchange program

The overseas exchange initiative is directed at younger growers of up to 30 years of age and is a response to the age profile of growers (average age of 60 years). It is aimed at developing the orcharding, business and leadership skills of people who will be in the industry for many years in the future. To date, the program has arranged five placements for Australian growers to spend up to one month on an overseas orchard. The countries in which the placements have been made are Italy, France, the United States and New Zealand. Participants in these placements invariably return with a high level of motivation to introduce the best practices seen on orchards in other countries.

In addition, an overseas study tour will be held in 2008 to enable all interested growers to learn from overseas experience.

4 See http://www.apal.org.au/future-orchards.cfm

The environmental contribution

Signposts addresses the environmental contribution or impact of agricultural industries in terms of biophysical assets and systems. Biophysical assets are also referred to as natural assets. In agricultural terms, the natural assets of primary interest are the atmosphere, climate, land, water and plants. Obviously, these elements are highly interlinked and in combination determine the capacity of farms to produce food, ingredients for other products, fibre, fuel and ecosystem services such as biodiversity conservation and greenhouse gas sequestration.

The Signposts framework for horticulture maps out the environmental contribution of the industry in terms of the natural assets held and managed by the industry and its contribution to natural systems extending beyond the industry itself (particularly the water cycle and atmosphere).

Natural assets to produce food and other products

The components of the industry's natural assets relating to the production of food and other products comprise climate, soil and biota (total animal and plant life in an area):

- Climate — the industry is widely distributed throughout Australia with crops dependent on climatic conditions which extend from cool temperate to tropical. As with most of agriculture, rainfall is the most significant climatic factor in Australian horticulture as evidenced by the impact of drought on production and profitability.
- Soil — there are soil fertility issues (soil nitrogen and phosphorous) and soil degradation issues (dryland and irrigation induced salinity and soil acidity) of importance to the industry.
- Horticultural species — there is a range of plant genetic resources available to the industry.
- Pests, weeds and diseases — the presence of pests, weeds and diseases on land held by the industry may affect horticultural yields and quality, and their management and control adds to the cost of production.

Signposts addresses water issues in terms of the contributions to natural systems extending beyond the horticulture industry. The industry is highly dependent on irrigation and this report considers water in terms of the capacity of the horticulture industry to produce food, non-edible products and ecosystem services.

Natural assets to produce ecosystem services

There are many aspects to the capacity of an industry to provide ecosystem services. This is a developing area that requires further research and knowledge. In some cases, markets are starting to be developed, which over time may be attractive for horticulture growers.

The most compelling issues in the minds of both consumers and the general community at present are the contribution of the horticulture industry to the conservation of biodiversity and greenhouse gas emissions or, conversely, greenhouse gas sequestration.

Signposts notes that an increase in the capacity of the land to provide ecosystem services increases the value of the industry's natural capital and is, therefore, a positive contribution to ecologically sustainable development. The current horticulture industry profile reports on the provision of biodiversity conservation services.

The Signposts profile also addresses greenhouse gas emissions, but in the context of contributions to natural systems extending beyond the industry. This report addresses both horticulture greenhouse gas emissions and sequestration under the section on ecosystem services.

Natural assets to produce food

This section assesses soil and water assets under the Signposts framework.

Soil

The main soil aspects considered in the Signposts framework are fertility (nitrogen and phosphorous levels) and degradation (salinity and acidity). Soil fertility is the result of the combined effects of three major interacting components: the chemical, physical and biological characteristics of the soil. Australian soils are generally shallow and infertile in terms of chemical and biological components.

Horticulture producers, therefore, need to ameliorate their soils through application of fertiliser, particularly nitrogen and phosphorous. This practice is both an environmental and economic issue. Good management practice is required to minimise the environmental impacts of using fertiliser and to minimise cost pressures on farm budgets and profitability associated with rapidly rising fertiliser prices.

Soil nitrogen (Norton and Srivastava 2007a)

Nitrogen is an important macronutrient in soil and is essential to plant growth and high yield. It is present in soils, either as part of organic matter, which is unavailable for plant uptake, or in mineralised form (nitrate or ammonium ions), which is available to plants. In most soils, more than 95% of the nitrogen is present in organic form.

Soil nitrogen can be measured in terms of total nitrogen and 'available nitrogen'; the latter being the component of total soil nitrogen that can be absorbed by plants. There is little data on available soil nitrogen, and total soil nitrogen is used by Signposts as the indicator of the nitrogen 'health' of soil for horticulture. Generally, plant yield is positively correlated with total soil nitrogen.

Signposts uses the proportion of land with total soil nitrogen above 0.2% as a summary measure of the nitrogen status of soils for horticulture. This level is considered moderate to high in the National Land & Water Resources Audit (the Audit) (NLWRA 2001).

Horticultural production is predominantly carried out in high rainfall zones or under irrigation, which means that plant growth potential is high due to good moisture availability. Under such conditions, soil nitrogen levels need to be high enough for profitable production or conversely to not be a production limiting factor.

Table 6 shows the proportion of land with total nitrogen greater than 0.2% for National Action Plan for Salinity and Water Quality (NAP) regions. The Signposts summary measure ranges from 0 to 0.9 for the respective regions:

- at the high end, the Midlands region of Tasmania had 90% of its horticultural land categorised as greater than 0.2% of total soil nitrogen
- between 50% and 75% of horticulture land was in this category in the Glenelg-Hopkins-Corangamite region of Victoria, the Macquarie-Castlereagh region of New South Wales and the South Coast and South West regions of Western Australia
- the lowest values occurred in all northern Australian regions, some regions of Western Australia, the Namoi-Gwydir region of New South Wales and the Lower Murray region of Victoria.

Table 6 Area of horticulture farming land with total soil nitrogen greater than 0.2% by National Action Plan for Salinity and Water Quality (NAP) region

NAP region	Total area of horticulture land (ha)	Area of horticulture land with total N > 0.2% (ha)	Proportion of horticulture land with total N > 0.2%
Avoca-Loddon-Campaspe	5 600	2 400	0.45
Avon	500	0	0.00
Border Rivers	5 000	200	0.04
Burdekin-Fitzroy	5 000	200	0.04
Condamine-Balonne-Maranoa	1200	400	0.33
Darwin-Katherine	600	0	0.00
Glenelg-Hopkins-Corangamite	3 400	2 300	0.68
Goulburn-Broken	12 000	500	0.04
Lachlan-Murrumbidgee	19 200	5 100	0.27
Lockyer-Burnett-Mary	25 800	9 600	0.37
Lower Murray	29 900	600	0.02
Macquarie-Castlereagh	2 400	1 600	0.67
Midlands	6 000	5 400	0.90
Mt Lofty-Kangaroo Island-Northern Agricultural District	7 200	2 000	0.28
Mt Lofty-Kangaroo Island-Northern Agricultural District-Lower Murray	1 700	400	0.24
Murray	3 700	100	0.03
Namoi-Gwydir	500	0	0.00
Northern Agricultural Region	700	0	0.00
Ord	1 500	0	0.00
South Coast	800	400	0.50
South East	2 600	900	0.35
South West	6 100	4 500	0.74
All NAP regions	**141 400**	**36 600**	**0.26**

N = nitrogen
Source: Norton and Srivastava (2007a)

The application of nitrogen fertiliser is an accepted management practice in horticulture to maximise growth rates and yields. Table 7 shows the total annual consumption and average application rate of nitrogen fertilisers in horticulture in 1996.

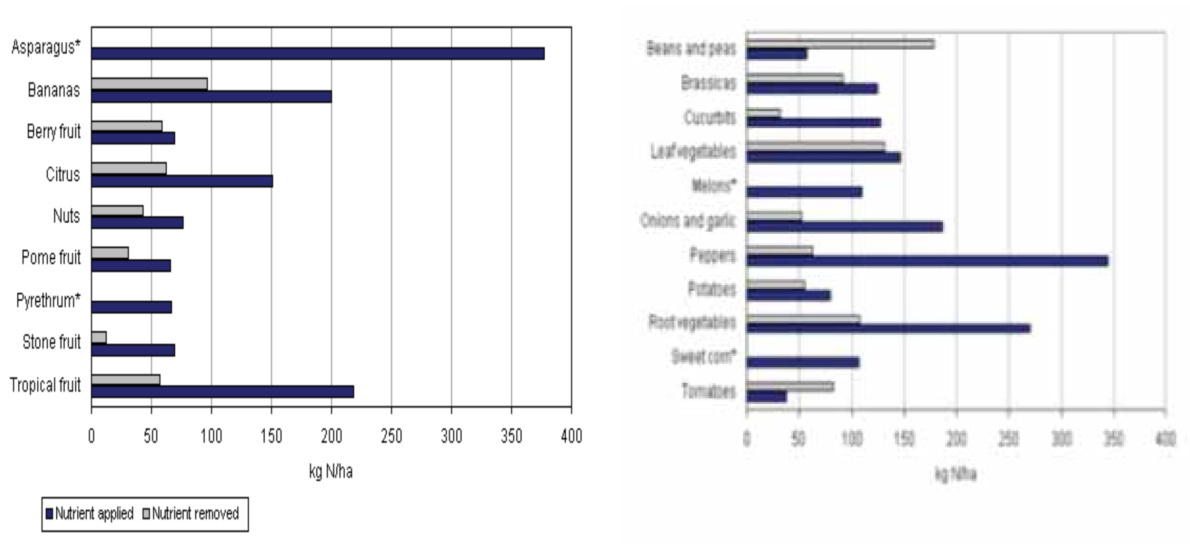
Table 7 Total amount of nitrogen fertiliser applied and average application rate in horticulture growing in 1996

	Area ('000 ha)	Total nitrogen fertiliser consumption ('000 tonnes)	Average application rate (kg/ha)
NSW and Qld	164	33.5	204
Tas	25	1.7	68
Vic and SA	158	24.0	152
WA	24	4.8	200
Total	**369**	**64.0**	**173**

Source: McArthur Agribusiness and Sinclair Knight Merz (2001)

Figure 7 shows the nitrogen application and removal for annual and perennial horticultural crops. For most crops, fertiliser application exceeds nitrogen removal. Comparatively little nitrogen is applied to peas and beans due to self-supply by the plant through fixation of atmospheric nitrogen in symbiosis with *Rhizobium* bacteria.

Figure 7 Estimated average nitrogen application (kg N/ha) to and removal by annual and perennial crops in the Australian horticulture industry



* No nutrient removal data available
Source: McArthur Agribusiness and Sinclair Knight Merz (2001)

Farmers are increasingly recognising that soil fertility and fertiliser applications need to be carefully managed to achieve production targets without causing environmental damage. Mineral nitrogen fertiliser is easily leached from the soil profile or dissolved in runoff water if not used by plants soon after application.

This may contribute to off-site degradation of ground and surface waters or increase soil acidity. In addition, ammonium or urea fertilisers easily volatilise in dry, alkaline or sandy soils, while nitrate fertilisers undergo denitrification in waterlogged soil. This may lead to reduced nutrient availability to plants and increased greenhouse gas emissions in the form of nitrous oxide.

Appropriate management practices to minimise environmental risk include avoiding overfertilisation, choosing the fertiliser appropriate to the conditions and applying the nitrogen levels required at the right time to meet crop demands. HAL issued *Guidelines for Environmental Assurance in Australian Horticulture* (Lovell 2006) that recommend:

- nitrogen fertilisation in conjunction with soil and plant tissue nutrient testing
- nutrient budgeting
- accurate record-keeping for fertiliser applications
- splitting nitrogen applications to better match availability and plant need
- calibration of fertiliser-spreading equipment
- optimisation of fertiliser placement.

Soil phosphorous (Norton and Srivastava 2007b)

Like soil nitrogen, phosphorous is also a macronutrient critically important to crop yield. Phosphorous can be added to the soil through the application of phosphate fertiliser to maintain the productive capacity of the soil. However, only a small proportion of total phosphorous is accessible to plants (1–4%) and its availability is highly dependent on soil pH.

The bulk of soil phosphorous exists in three general groups of compounds: organic phosphorous, calcium-bound inorganic phosphorous, and iron or aluminium-bound inorganic phosphorous. Most of the compounds in these groups have very low solubility and are not readily available for plant uptake.

Phosphorous is usually plant-available in soil as inorganic phosphate ions (HPO42– and H2PO42–) and sometimes as soluble organic phosphorous. The HPO42 anion dominates in strongly acidic soils, while the H2PO42 anion dominates in alkaline soils. Both anions are important in near-neutral soils.

Signposts uses the level of phosphorous in the topsoil as an indicator of the available phosphorous and the proportion of land with total soil phosphorous above 0.02% as the summary measure of the phosphorous 'health' of horticulture farming soils. The Audit defines 0.02% as a medium to high level of total soil phosphorous (NLWRA 2001).

Table 8 shows the area and proportion of total horticulture farming land with total soil phosphorous greater than 0.02% for NAP regions. The results vary considerably among regions with low values in Western Australia and South Australia, and high values in northern New South Wales and Queensland.

Table 8 Area of horticulture farming land with total soil phosphorous greater than 0.02% by National Action Plan for Salinity and Water Quality (NAP) region

NAP region	Total area of horticulture land (ha)	Area of horticulture land with total P > 0.02% (ha)	Proportion of horticulture land with total P > 0.02%
Avoca-Loddon-Campaspe	5 600	3 900	0.70
Avon	500	0	0.00
Border Rivers	5 000	5 000	1.00
Burdekin-Fitzroy	5 000	4 300	0.86
Condamine-Balonne-Maranoa	1 200	1 200	1.00
Darwin-Katherine	600	500	0.83
Glenelg-Hopkins-Corangamite	3 400	2 700	0.79
Goulburn-Broken	12 000	10 500	0.88
Lachlan-Murrumbidgee	19 200	12 300	0.64
Lockyer-Burnett-Mary	25 800	22 200	0.86
Lower Murray	29 900	11 600	0.39
Macquarie-Castlereagh	2 400	1 700	0.71
Midlands	6 000	4 500	0.75
Mt Lofty-Kangaroo Island-Northern Agricultural District	7 200	3 100	0.43
Mt Lofty-Kangaroo Island-Northern Agricultural District-Lower Murray	1 700	300	0.18
Murray	3 700	1 400	0.38
Namoi-Gwydir	500	500	1.00
Northern Agricultural Region	700	100	0.14
Ord	1 500	0	0.00
South Coast	800	300	0.38
South East	2 600	500	0.19
South West	6 100	200	0.03
All NAP regions	**141 400**	**86 800**	**0.61**

P = phosphorus
Source: Norton and Srivastava (2007b)

Table 9 shows the total annual consumption and average application rate of phosphorus fertilisers in the horticulture industry in 1996.

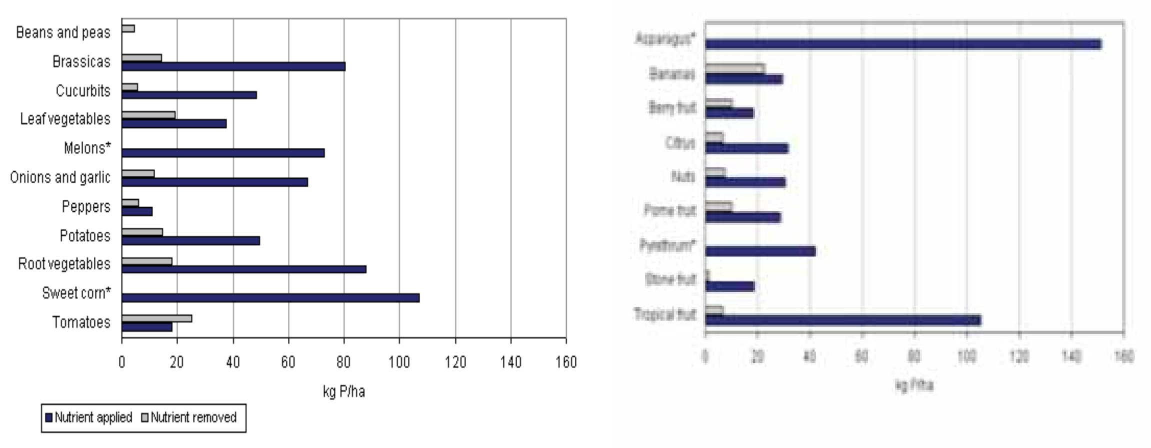
Table 9 Total annual amount of phosphorous applied in horticulture and average application rate in 1996

State	Area ('000 ha)	Total phosphorus fertiliser consumption ('000 tonnes)	Average application rate (kg/ha)
New South Wales and Queensland	164	9.9	60.4
Tasmania	25	3.7	148.0
Victoria and South Australia	158	22.6	143.0
Western Australia	24	0.7	29.2
Total	**369**	**36.9**	**100.0**

Source: McArthur Agribusiness and Sinclair Knight Merz (2001)

Figure 8 shows the estimated average amount of phosphorus applied to, and removed by, annual and perennial horticultural crops. The figures illustrate that the amount of phosphorus added to the soil per year mostly exceeded the amount removed by the crop.

Figure 8 Estimated average phosphorus application (kg P/ha) to, and removal by, annual and perennial horticultural crops



* No nutrient removal data available
Source: McArthur Agribusiness and Sinclair Knight Merz (2001)

Phosphorus is bound to clay and organic matter particles in the soil and does not easily leach, but builds up over time under conditions of overfertilisation. Erosion of fertilised topsoil by wind and water may result in phosphorus entering water bodies, lowering water quality and increasing the risk of algal blooms.

To reduce the risk of overfertilisation, the *Guidelines for Environmental Assurance in Australian Horticulture* (Lovell 2006) recommend that soil phosphorus levels and the nutrient requirements of the crop be measured, and to use fertilisation only in combination with other management practices as outlined above for nitrogen application.

In addition, the choice of phosphorus fertilisers with low levels of heavy metal contaminants (eg cadmium, lead or mercury) is encouraged to avoid their accumulation in the soil.

Dryland salinity (Whitworth et al 2007a)

Salts are distributed widely across Australian landscapes. However, dryland salinity becomes a problem when soils and vegetation are degraded by the discharge of saline groundwater. This occurs when the watertable reaches within two metres of the ground surface.

Australia's natural salinity has been exacerbated by clearing large areas and replacing the native vegetation with shallow rooting crops, which do not use as much water. This has meant that water from rainfall has entered the watertable causing it to rise and mobilise salt, which then rises to the land surface. Once watertables are near the surface, salt stored in the soil or groundwater may be concentrated through transpiration by plants and evaporation. If this occurs in the root zone it can affect plant production.

Dryland salinity is not a significant issue for the horticulture industry as measured by the Signposts salinity risk indicator (ie the area identified as 'high salinity risk or hazard'). These areas were determined for the year 2000 using assessments of groundwater levels and trends, groundwater salinity and salinity outbreaks. Where data were not available, the key drivers of salinity, such as geological features, land use and climate, were used to determine high-risk or hazard areas (NLWRA 2001).

Irrigation-induced salinity is a more significant issue for the horticulture industry. It can result from both overirrigation and underirrigation. In the case of overirrigation, water percolates beyond the root zone into the watertable. It may also be caused by leakage from earthen distribution channels and water drainage systems.

Norton (2007c) refers to research that shows that there have been substantial rises of watertables under most irrigation areas in Australia. Where groundwatertables have reached one to three metres below the surface, there is a high risk of salinisation of the root zone and detrimental effects on plant production.

In the case of underirrigation, salts accumulate in the upper soil layers over time because insufficient water is applied to leach them below the root zone. This effect is considered to be of less importance than salinity due to overirrigation, but is flagged as a potential problem following an extended drought period and restricted water allocations.

Signposts has adopted an indicator based on an assessment of risk, rather than an actual measurement of soil salinity. From this, Signposts has derived a summary measure for dryland salinity, which is the proportion of horticulture farming land that is not assessed as having a high salinity risk. Table 10 shows the results by NAP region.

Table 10 Area of land under horticulture that was assessed as 'high salinity risk' and associated summary measures by National Action Plan for Salinity and Water Quality (NAP) region, 2000

NAP region	Total area under horticulture assessed as 'high salinity risk or hazard' (ha)	Total area under horticulture (ha)	Summary measure (proportion of horticulture land not assessed as 'high salinity risk')
Avoca-Loddon-Campaspe	100	5 600	0.98
Avon	400	500	0.20
Border Rivers	0	5 000	1.00
Burdekin-Fitzroy	0	5 000	1.00
Condamine-Balonne-Maranoa	0	1 200	1.00
Darwin-Katherine	0	600	1.00
Glenelg-Hopkins-Corangamite	300	3 400	0.91
Goulburn-Broken	0	12 000	1.00
Lachlan-Murrumbidgee	200	19 200	0.99
Lockyer-Burnett-Mary	0	25 800	1.00
Lower Murray	0	29 900	1.00
Macquarie-Castlereagh	0	2 400	1.00
Midlands	500	6 000	0.92
Mt Lofty-Kangaroo Island-Northern Agricultural District	200	7 200	0.97
Mt Lofty-Kangaroo Island-Northern Agricultural District-Lower Murray	0	1 700	1.00
Murray	300	3 700	0.92
Namoi-Gwydir	0	500	1.00
Northern Agricultural Region	0	700	1.00
Ord	0	1 500	1.00
South East	0	2 600	1.00
South Coast	200	800	0.75
South West	1000	6 100	0.84
Total NAP regions	**3200**	**141 400**	**0.98**

Source: Whitworth et al (2007a)

Table 10 shows that 98% of horticulture land is not assessed as 'high salinity or hazard risk'. The only regions that have a significant proportion of horticulture land categorised as high salinity risk are the Avon (80%), South Coast (25%) and South West (16%) regions of Western Australia.

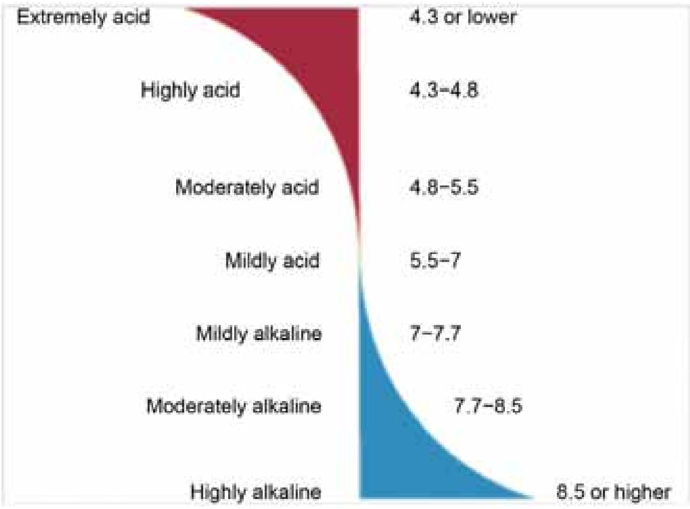
The main options for managing dryland salinity in high-risk areas are to reduce water recharge and to manage discharge sites through the conservation of existing vegetation and revegetating appropriate areas.

Soil acidity (Whitworth et al 2007b)

Soil acidification (the accumulation of acid in the soil) is a natural process that may be accelerated by farming. Soil acidity affects the availability of nutrients and creates toxic elements (eg aluminium) in the soil which can limit plant growth and resulting crop yields.

Acidity is measured by topsoil pH, with soils having a lower pH being more acidic as shown in Figure 9. A neutral pH is seven, and each pH unit below seven is ten times more acidic. Conversely, soils with pH values above seven become progressively more alkaline (NLWRA 2001).

Figure 9 Soil pH range[a]



a pH measured in 0.1 M $CaCl_2$
Source: Whitworth et al (2007b)

Although soils with a pH below 7 are considered to be acidic, Signposts uses a pH of 5.5 or less as a threshold of acidity below which there is increased likelihood of soil mineral degradation. This is associated with the loss of basic cations and a reduction in the cation exchange capacity of the soil, which may lead to production loss.

A pH below 4.8 may cause significant limitations on plant growth due to increased solubility of toxic aluminium and manganese ions and fixation of phosphorus. Highly alkaline soils (pH above 8.5) are also considered undesirable for plant growth due to reduced solubility of a number of essential cations.

The Audit data suggest that soil acidity is an issue in almost half of the horticulture production area (Tables 11 and 12). Soil is inherently variable and the amount of soil affected within any location will vary considerably. The proportion of horticulture land with soil pH above 5.5 is lowest in Western Australia and southern Victoria. Acidity is not a major issue in northern Australia or South Australia. There are some areas of moderately or highly alkaline soils in South Australia.

Table 11 Soil pH of horticulture farming land by National Action Plan for Salinity and Water Quality (NAP) region, 2000

NAP region	Horticulture land with suitable pH pH > 5.5 (ha)	Total horticulture area (ha)	Summary measure (proportion of horticulture land with pH > 5.5)
Avoca-Loddon-Campaspe	3 200	5 600	0.57
Avon	0	500	0.00
Border Rivers	1 100	5 000	0.22
Burdekin-Fitzroy	3 600	5 000	0.72
Condamine-Balonne-Maranoa	1 100	1 200	0.92
Darwin-Katherine	100	600	0.17
Glenelg-Hopkins-Corangamite	300	3 400	0.09
Goulburn-Broken	9 900	12 000	0.83
Lachlan-Murrumbidgee	7 400	19 200	0.39
Lockyer-Burnett-Mary	7 800	25 800	0.30
Lower Murray	29 200	29 900	0.98
Macquarie-Castlereagh	200	2 400	0.08
Midlands	0	6 000	0.00
Mt Lofty-Kangaroo Island-Northern Agricultural District	7 200	7 200	1.00
Mt Lofty-Kangaroo Island-Northern Agricultural District-Lower Murray	1 700	1 700	1.00
Murray	2 700	3 700	0.73
Namoi-Gwydir	500	500	1.00
Northern Agricultural Region	600	700	0.86
Ord	1 100	1 500	0.73
South Coast	0	800	0.00
South East	2 500	2 600	0.96
South West	300	6 100	0.05
Total all regions	**80 500**	**141 400**	**0.57**

Source: Whitworth et al (2007b)

Table 12 Area in each pH class[a] for horticulture farming land by National Action Plan for Salinity and Water Quality (NAP) region, 2000

NAP region	pH class							Total area (ha)
	≤ 4.3	4.3–4.8	4.8–5.5	5.5–7	7–7.7	7.7–8.5	≥ 8.5	
Avoca-Loddon-Campaspe	0	1 800	600	2 000	1 200	0	0	5 600
Avon	0	100	400	0	0	0	0	500
Border Rivers	0	400	3 500	1 100	0	0	0	5 000
Burdekin-Fitzroy	0	0	1 400	3 200	400	0	0	5 000
Condamine-Balonne-Maranoa	0	0	100	1 100	0	0	0	1 200
Darwin-Katherine	500	0	0	100	0	0	0	600
Glenelg-Hopkins-Corangamite	200	2 400	500	200	100	0	0	3 400
Goulburn-Broken	0	400	1 700	9 900	0	0	0	12 000
Lachlan-Murrumbidgee	100	4 500	7 200	7 300	100	0	0	19 200
Lockyer-Burnett-Mary	0	4 000	14 000	7 800	0	0	0	25 800
Lower Murray	100	600	0	3 900	9 700	15 000	600	29 900
Macquarie-Castlereagh	0	1 600	600	200	0	0	0	2 400
Midlands	0	1 700	4 300	0	0	0	0	6 000
Mt Lofty-Kangaroo Island-NAD	0	0	0	1 300	4 100	1 700	100	7 200
Mt Lofty-Kangaroo Island-NAD-Lower Murray	0	0	0	900	600	200	0	1 700
Murray	0	100	900	2 000	700	0	0	3 700
Namoi-Gwydir	0	0	0	200	300	0	0	500
Northern Agricultural Region	0	100	0	600	0	0	0	700
Ord	0	0	400	1 100	0	0	0	1 500
South Coast	0	700	100	0	0	0	0	800
South East	0	0	100	1 800	600	100	0	2 600
South West	100	1 900	3 800	300	0	0	0	6 100
Total All Regions	**1000**	**20 300**	**39 600**	**45 000**	**17 800**	**17 000**	**700**	**141 400**

NAD = Northern Agricultural District

a pH ≤4.3 = extremely acid; 4.3–4.8 = highly acidic; 4.8–5.5 = moderately acidic; 5.5–7 = mildly acidic; 7–7.7 = mildly alkaline; 7.7–8.5 = moderately alkaline; ≥8.5 = highly alkaline

Source: Whitworth et al (2007b)

Soil acidity can be corrected by applying lime in the form of agricultural lime (calcium carbonate) or dolomite (calcium-magnesium carbonate). Currently, there are no suitable data available for liming in horticulture, although it is a generally accepted practice.

Policy and management responses to soil health issues in the horticulture industry

Soil quality issues for horticulture include erosion, compaction, structure decline, salinisation, acidification and pollution by toxic chemicals. Horticulture Australia Ltd is currently funding a number of projects in the soil health area, including research into soil structure, nutrition and soil-borne disease. The industries that have undertaken soil research include strawberries, citrus, bananas, blueberries, deciduous orchards, macadamias, nursery, potatoes, processing tomatoes, turf and vegetables.

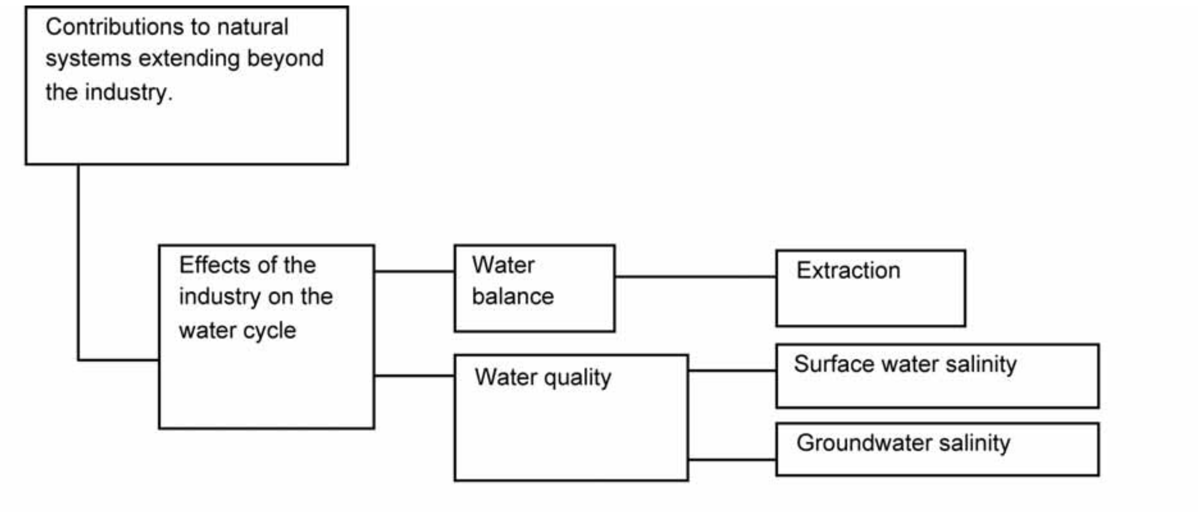
The vegetable industry has implemented a healthy soils project that includes a practical guide for soil management, *Soil Interpretation Ute Guide* (to be carried around in the ute or tractor); an instructional CD/DVD based on the ute guide for those growers with limited English; and a soil interpretation and management course. The course is to assist vegetable growers learn about their soil profile, to identify and interpret soil structure and chemistry, to restore or improve the health of the soil and to select the appropriate crop types for the soil with the least impact on the broader environment.

Source: Horticulture Australia Ltd (http://www.horticulture.com.au/delivering_know-how/Environment/themes.asp#a_201)

Water

Signposts addresses water in terms of the contributions to natural systems extending beyond the industry as shown in Figure 10.

Figure 10 Effects of the horticulture industry on the water cycle



Water extraction and use (Norton 2007a)

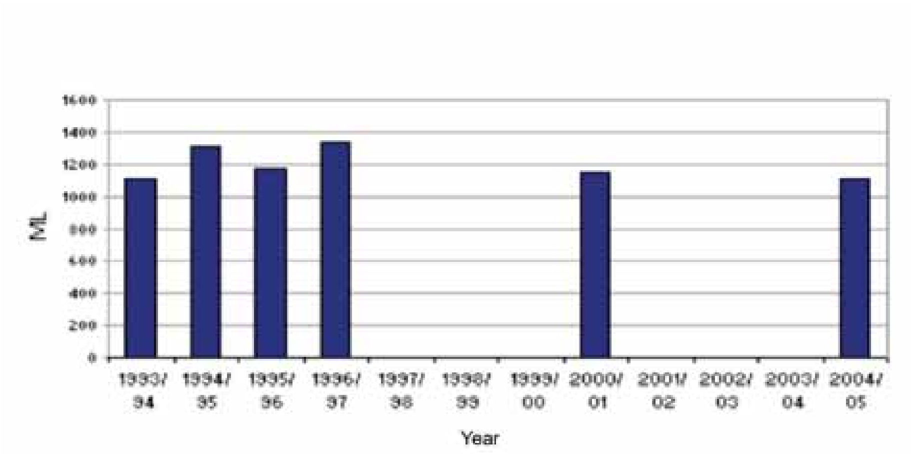
Water that is extracted from surface water bodies and groundwater for irrigation is one of the most important factors influencing the national water balance. The *Water Account* for 2004–05, published by the Australian Bureau of Statistics (ABS) showed agriculture accounting for 65% of the total national consumption for that year (ABS 2006).

Ensuring secure and reliable irrigation water supply is a strategic imperative for the industry's future. Horticulture is largely dependant on access to sufficient water for its intensive production systems and for the long-term survival of perennial tree crops. Water use in the horticulture industry accounted for almost 6% of national consumption in 2004–05.

Signposts uses net water consumption as the indicator for water use in horticulture. Net water consumption is defined by the ABS as water extracted by the industry itself, water extracted and distributed by water suppliers and water from regional reuse schemes. It is identical to total water extraction, since there is no measured discharge from horticulture to other users or back into water bodies.

Figure 11 shows annual water consumption in the fruit and vegetable industries for selected years for which data are available. Data are not available for the whole horticulture industry.

Figure 11 Annual water consumption for the horticulture industry, 1993–94 to 2004–05



ML = megalitre
Source: Norton (2007a)

The year-to-year variation in water consumption is largely related to seasonal conditions, although an apparent downward trend since 1996–97 may reflect more efficient water use driven by pressure on water allocations:

- 1993–94 consumption was 1 107 000 ML (5.9% of total national water consumption)
- 1996–97 consumption was 1 339 000 ML (6.2% of total national water consumption)
- 2000–01 consumption was 1 152 000 ML (5.3% of total national water consumption)
- 2004–05 consumption was 1 103 000 ML (5.9% of total national water consumption).

There are a range of management practices for improving on-farm water-use efficiency. These include:

- modernising irrigation technology:
  - upgrading sprinklers
  - converting to drip and subsurface
  - converting to centre pivots on larger areas
  - installing soil moisture monitoring and weather stations linked to controllers
- improving irrigation scheduling
- improving nutrient and management.

At the industry level, HAL established the Horticulture Water Initiative in 2003 to respond to water issues on behalf of the horticulture industry. Other initiatives include research into new technologies, grower education in improved management practices, and the replacement of aged on-farm and off-farm irrigation and drainage infrastructure. HAL partners in research and development with a number of key water industry bodies, such as the National Program for Sustainable Irrigation, the Cooperative Research Centre for Irrigation Futures and Irrigation Australia.

Water quality (Norton 2007b)

Water quality refers to the chemical, physical and biological characteristics of water. These determine the suitability of water for irrigation. Water quality also affects the biodiversity of aquatic ecosystems. The quality of Australia's water resources is an issue of increasing importance due to climate variability and change, overextraction of water in some areas and pollution.

The horticulture industry primarily has an impact on water quality through:

- water extraction from surface and groundwater resources
- return flows associated with irrigation
- erosion by water runoff
- nutrient runoff, particularly after fertilisation
- leaching of nutrients.

Signposts provides some qualitative data on surface and groundwater salinity collected from a survey of horticulture producers in 1999, but considers these data to be suboptimal.

Surface water salinity (Norton 2007c)

The level of surface water salinity is influenced by natural factors and human activity. The natural level of salinity is determined by the degree to which salts in surface rocks and soil dissolve in the water that has contact with them. Australian rocks and soils are weathered and create relatively high and variable levels of natural salinity in Australian surface waters.

The impact of horticulture on surface water salinity is through runoff associated with overirrigation, flood-irrigation and rainfall shortly after irrigation. In addition, it may be associated with deep drainage from irrigated paddocks and seepage connected with irrigation supply channels. A more recent issue has arisen from the increasing use of recycled water in horticultural irrigation, which may contain elevated salt concentrations.

Salinity is a significant surface-water quality issue in much of southern Australia and affects river basins in the majority of drainage divisions. For example, it is estimated that return flows from irrigation-related activities to the Murray-Darling system alone are about 300 GL per year, leading to steadily increasing salinity levels downstream of irrigation areas.

Drainage divisions that do not show significant salinity problems at present are most coastal river basins in the North East Coast and South East Coast drainage divisions, many basins of the upper Murray-Darling and some near-coastal basins in the South West drainage division.

Surface water salinity becomes an environmental issue if it has an impact on freshwater riverine ecosystems.

Groundwater salinity (Norton 2007d)

Salts in groundwater may also be due to natural factors or human activities. Natural leaching from the chemical breakdown of rock and soils resulting from rainfall is a natural contributor of minute quantities of salts. Aquifers near the sea often have direct connection to seawater, are recharged by tidal rivers, or contain fossil seawater in the sediment.

Human activities that contribute to groundwater salinity include deep drainage of surplus irrigation water, if this contains salts from fertilisers or if it mobilises salt that has accumulated in top soil. Leaching of irrigation water into groundwater is an effect commonly associated with overirrigation, irrigation of unsuitable soils or the lack of appropriate drainage infrastructure.

Saline groundwatertables are not a natural resource management problem if they are more than two metres below the soil surface and the water is not intended to be used for irrigation.

Policy and management responses to water use and quality in the horticulture industry

1. Horticulture Water Initiative

The Horticulture Water Initiative was established in response to water issues by Horticulture Australia Limited in 2003 on behalf of the horticulture industry.

Strategies include:

- the demonstration of the economic and social contribution that irrigated horticulture makes to the wider community
- innovation related to efficient and environmentally responsible water use through eight case studies (nursery, citrus, summerfruit, processing tomato, potatoes, apples, bananas, avocados/mangoes)
- policy analysis and support to water management decision makers regarding horticulture's water service needs.

2. Reclaimed Water Development in Horticulture

Agriculture uses the largest volume of recycled water, accounting for 82% (423 gigalitres) of all recycled water used in Australia. The horticulture industry is a key contributor to the use of recycled water and will become a larger user in future. In response, the industry has initiated a research and extension project to help coordinate reclamation and reuse of urban wastewater in Australian horticulture. The project also provides the resources to improve public understanding of reclaimed water and achieve greater acceptance and use, and plays a significant role in the coordination of research into the use of reclaimed water for horticultural production.

There are many potential benefits from irrigation with recycled water:

- It is a safe, renewable, reliable and quality water resource.
- There are significant associated environmental benefits, which can be included in quality assurance environmental management programs.
- Technically, it is a feasible means of developing an additional and sustainable water resource for horticulture.
- There are well-developed and targeted codes of practice to assist in adoption of best practice for the industry.
- Increased monetary returns for irrigators are likely.
- It can be part of the implementation of semivoluntary environmental management programs, preventing trade barriers (unacceptable environmental practices) that lead to market rejection of produce.
- It contributes to the maintenance of ground and surface water quality.
- It can lead to an improvement of soil salinity from good irrigation practice.

Source: HAL (http://www.horticulture.com.au/delivering_know-how/Environment/themes.asp#a_197)

Natural capacity to provide ecosystem services

The current Signposts profile refers to the provision of biodiversity services and the impacts of the industry on greenhouse gas emissions.

Biodiversity conservation

Biodiversity conservation relates to the capacity of land held by the industry to conserve native biodiversity. It is an issue of national and state consideration and is reflected in the National Strategy for the Conservation of Australia's Biological Diversity (DEST 1996) and at state level through laws and regulations that include controls on land clearing.

The industry's Horticulture NRM Strategy identifies native biodiversity as a compelling issue. It aims to minimise any negative impacts on native biodiversity (eg as a result of vegetation clearance), manage production losses from native animals (eg birds and fruit bats) and optimise contributions to the local environment (eg using native plants for integrated pest control and as windbreaks and buffers, or establishing nesting boxes in wetlands).

Greenhouse gas emissions/carbon sequestration (Lizzio and Whitworth 2007)

The HAC addresses the issue of greenhouse gas emissions in its Natural Resource Management Policy. It notes that 'the reduction of greenhouse gas emissions while protecting Australia's competitive advantages is critical to the sustainability of horticulture and all agricultural industries'.

HAC states as 'Australia and the world work to reduce impacts of climate change, a carbon-constrained future is inevitable'. It points out that climate change has a direct impact on horticulture in a very immediate way by even relatively small variations in climate.

Agricultural industries, including horticulture, play a key role in Australia's profile of greenhouse gas as a significant emitter. Greenhouse gases may also be sequestered (removed from the atmosphere and stored by plants, soil and water) by the horticulture industry. This is particularly through permanent plantings that act as carbon sinks.

Sources of greenhouse gas emissions in horticulture include:

- agricultural soils — nitrous oxide (N_2O)
- field burning of agricultural residues — methane (CH_4) and nitrous oxide (N_2O)
- energy consumption — carbon dioxide (CO_2)
- land-use change — CO_2 and N_2O.

Agricultural soils: This source refers to a variety of sources or activities that add nitrogen compounds to the soil and the subsequent emissions that stem from these additions. It includes:

- direct nitrous oxide emissions, which occur when residues from crops (peanuts), and hence nitrogen, are returned to the soil
- indirect nitrous oxide emissions, which result from the atmospheric deposition when agricultural residues are burnt in the field
- direct nitrous oxide emissions, which result from the addition of synthetic nitrogen-based fertiliser to horticultural crops
- indirect nitrous oxide emissions, which result from nitrogen leaching and runoff when fertiliser is applied to horticultural crops.

Field burning of agricultural residues: This source refers to the nitrous oxide and methane emissions that are released into the atmosphere when crops are burnt.

Energy consumption: This source refers to both the indirect carbon dioxide emissions from electricity generation occurring at the power station and direct emissions from fossil fuels, such as when diesel tractors are used.

Land-use change: This source refers to emissions that stem from changes in the flux of carbon dioxide uptake from plant photosynthesis and releases from respiration, decomposition and oxidation of organic material, which may be affected by changes to land use (eg deforestation or conversion of forest to crop land) or activities such as tillage. It also refers to emissions of nitrous oxide as a byproduct of nitrification and denitrification, which results from soil disturbance.

Data on most of these sources are either not available or the resulting greenhouse gas emissions cannot be directly attributed to horticulture. Although the industry seeks to 'minimise the generation of greenhouse gas emissions through energy use, cultivation and fertiliser management' (HAL 2006), Signposts only provides data on greenhouse gas emissions (gigagrams of CO_2e) arising from nitrogen leaching and runoff, crop residues and synthetic fertiliser application.

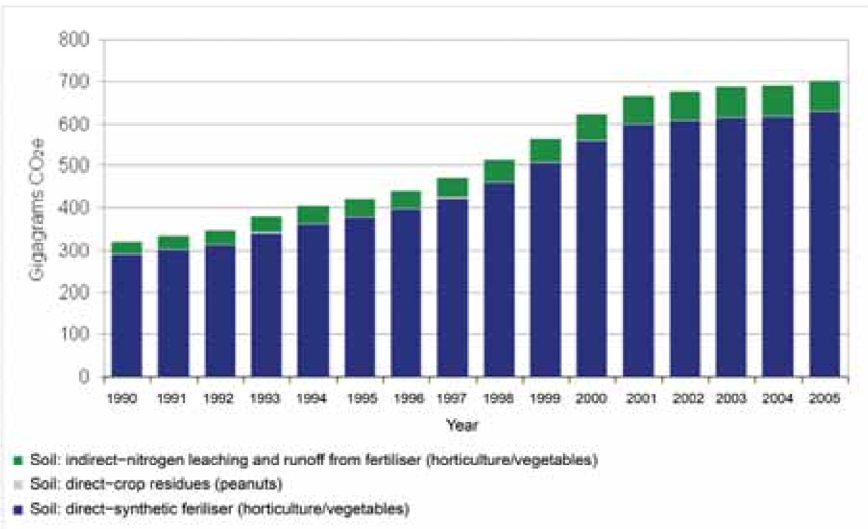
In this respect, the horticulture industry emitted approximately 698 gigagrams (0.7 million tonnes) of CO_2e in 2005, which was around 0.8% of total agricultural emissions. Horticulture emissions doubled between 1990 and 2001.

Figure 12 shows horticulture emissions by source in 2005:

- 625 gigagrams of CO_2e were emitted via direct nitrous oxide emissions from soils, resulting from the addition of synthetic nitrogen-based fertiliser to horticultural crops — these emissions were 117% higher than in 1990
- 70 gigagrams of CO_2e were emitted via indirect nitrous oxide emissions from soils, which result of nitrogen leaching and runoff from the addition of synthetic nitrogen-based fertiliser onto horticultural crops (including vegetables) — these emissions were 140% higher than in 1990
- 2.9 gigagrams of CO_2e were emitted from agricultural soils when crop residues from peanuts were returned to the soil — these emissions were 37% higher than in 1990.

Although the majority of emissions from the three sources are from synthetic fertiliser application, the rate of increase has declined from 2001.

Figure 12 Estimated greenhouse gas emissions (gigagrams CO_2e) from the horticulture industry, by source



CO_2e = carbon dioxide equivalent
Source: Compiled by BRS from AGO data (AGO 2007)

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

Some growers are members of the Greenhouse Challenge Plus, a program that enables companies to form working partnerships with the Australian Government to improve energy efficiency and reduce greenhouse gas emissions. Specific objectives are to:

- reduce greenhouse gas emissions (including promotion of awareness of greenhouse gas abatement opportunities in industry)
- accelerate the uptake of energy efficiency practices
- integrate greenhouse issues into business decision making
- provide more consistent reporting of greenhouse gas emissions levels.

The benefits of participating in Greenhouse Challenge Plus are to:

- cut costs by reducing a grower's energy use and greenhouse gas emissions (monitoring greenhouse gas emissions often reveals opportunities for reducing waste and saving energy)
- network with other businesses and benefit from their experiences
- access industry advisers, workshops and online tools, and a range of communication material, such as fact sheets and regular newsletters showcasing achievements and suggestions
- gain recognition for the company's greenhouse gas emissions management from the public and government.

In relation, to the broader impact of climate change on horticulture, HAL commissioned a scoping study seeking recommendations for future research and development. Most of the anticipated climate changes suggest the need for a very high standard of crop management in response. 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.

The social contribution

Figures 13 and 14 show in conceptual form the contributions the industry makes to social systems, thereby increasing or decreasing human and social capital or assets (Chesson 2007).

Figure 13 Value of human and social capital held by the industry — the Signposts framework of the social contribution of the horticulture industry

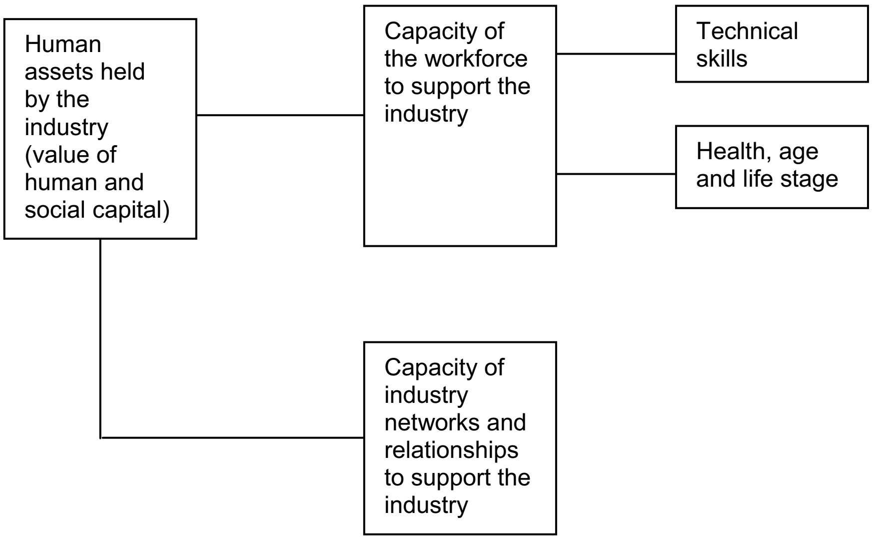
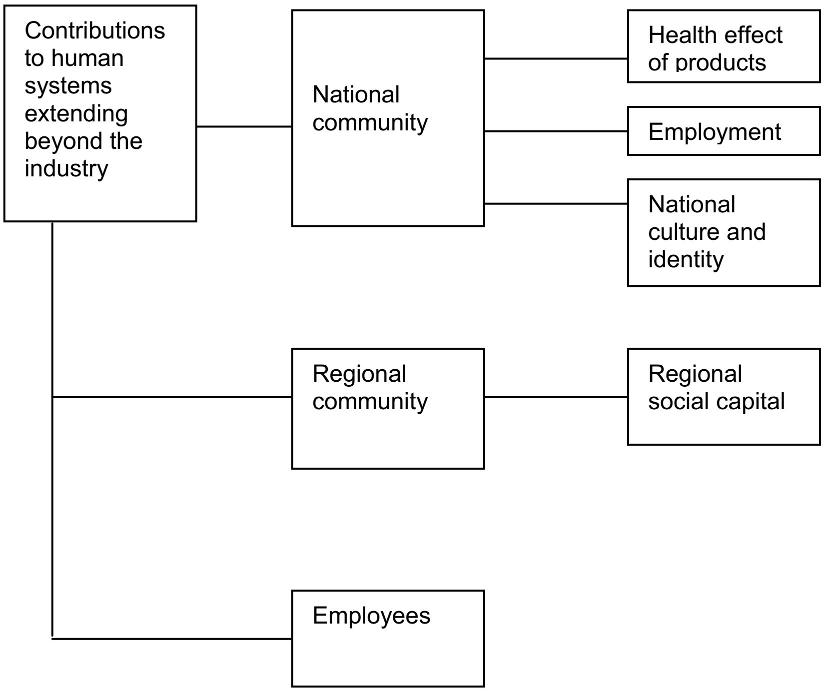


Figure 14 Contributions to human systems extending beyond the industry — the Signposts framework of the social contribution of the horticulture industry



Signposts notes that the industry can contribute in two ways — through changes in the value of its own human and social capital or by changing the value of human and social capital held by others.

Human capital

The industry's own stock of human capital is defined in terms of the capacity of the industry's workforce to support the industry. Attributes of the human capital component that will be measured by Signposts include technical skills, and health, age and life stage.

The level of industry-related technical skills is considered to be one of the characteristics of the industry's workforce that is thought to influence capacity to make decisions, achieve output, adapt to new situations and adopt new practices.

'Health, age and life stage' is considered to be one of the characteristics of the industry's workforce that is thought to influence the capacity to make decisions, achieve output, adapt to new situations and adopt new practices. An indicator considered by Signposts is the median age of farmers, which when monitored over time, may be indicative of the degree of new recruitment to the industry.

The 2001 *Census of Population and Housing* showed that the median age of growers and enterprise managers in the fruit and vegetable industries was 47 years (Table 13). This is younger than in industries such as grains, beef and dairy.

Table 13 Median age of growers and enterprise managers in the fruit and vegetable industries, 2001

	Median age (years)
Australian Capital Territory	52
New South Wales	48
Northern Territory	48
Queensland	48
South Australia	47
Tasmania	47
Victoria	46
Western Australia	47
Australia	**47**

Source: ABS (2002)

Social capital

Social capital is defined in terms of group relations, partnerships, norms and networks, which facilitate the diffusion of knowledge and innovation, provide support during structural adjustment and promote cooperative behaviour.

The horticulture sector has well-developed industry structures that provide a wide range of services. The primary peak industry bodies for the whole of the horticulture industry are Horticulture Australia Limited (HAL) and Horticulture Australia Council (HAC).

HAL is an industry-owned company that provides services to the Australian horticulture industry. These services cover national research, development and marketing. HAL invests almost $80 million annually in projects in partnership with the horticulture sector covering a diversity of topics including: market access, market research, export marketing, domestic marketing, supply chain management, quality assurance, food safety, skills development, industry communication, biotechnology, biosecurity, breeding, plant health, pesticide regulation, agronomy, crop regulation, physiology, irrigation and sustainable practices.

HAC represents 19 peak industry bodies for the advancement and prosperity of Australian horticulture. It deals with whole-of-horticulture issues, develops policy and facilitates change through advocacy for the industry. HAC also seeks to develop and encourage the adoption of policies, procedures, standards and codes of practice that will achieve the advancement and prosperity of Australian horticulture. In addition, it assists and supports the production and dissemination of information about the industry.

Contributions to social systems extending beyond the industry

The other aspect of the social contribution of the Australian horticulture industry relates to that extending beyond the industry itself and includes contributions to the national community, regional communities and employees.

National community

The contributions that the industry makes to social systems at the national scale, include employment, the national culture and identity, and the health effects of products.

Employment

Employment in horticultural production includes individuals who nominated themselves in the 2001 *Census of Population and Housing* as being employed in this industry, for all ABS 'occupation' types. Relevant data from the 2006 *Census of Population and Housing* are yet to be published. The total number of persons employed in the horticulture industry in 2001 was 69 683, which represented 24% of employment in agriculture.

Table 14 Total number of persons employed in horticulture production, 2001

	No. persons employed	% of total
Australian Capital Territory	135	<1
New South Wales	14 849	21
Northern Territory	578	1
Queensland	18 408	26
South Australia	11 590	17
Tasmania	6385	9
Victoria	15 438	22
Western Australia	2300	3
Total	**69 683**	**100**

Source: ABS (2002)

Queensland had the largest proportion of employees engaged in horticulture growing (26% of total industry employment in 2001) followed by Victoria, New South Wales, South Australia, Tasmania and Western Australia.

Farm owners and managers made up 40% of those employed in the industry, with a large proportion of the remainder made up of skilled workers, particularly in harvesting and in associated areas such as transport, handling and marketing.

National culture and heritage

Australian agriculture forms a significant part of the nation's cultural heritage, and horticulture is part of that heritage through its history and stories of the contribution of growers.

In recent times, industries are increasingly being required to account for their contribution and impacts. This situation has arisen from community expectations for socially and environmentally responsible business, market preferences for products and services produced in a sustainable and healthy way, and international and domestic regulations requiring compliance with social and environmental best practice or standards.

Most agricultural industries now identify community perceptions as a strategic imperative and address the following issues in their planning, reporting and communications:

- community trust in the industry's production methods and products
- a high level of industry integrity in meeting community expectations and regulations concerning environmental stewardship, food safety and employment practices.

The National Farmers' Federation (NFF) has, as a part of a strategic plan (2006–09), identified 'increasing community perception and awareness of Australian agriculture' as one of their main goals. This has driven a comprehensive communications strategy to reposition farming in the mindset of all Australians and overcome many misconceptions about the sector.

The NFF undertook market research in November 2006 with metropolitan and farmer focus groups. The results of this market research showed previous attitudes held by Australia's largely urban population about farmers, and farming, being 'antiquated', 'irrelevant' and 'raping the environment' have dissipated dramatically.

Human nutrition and health

Horticultural produce is consumed by every person in the country as well as by consumers internationally. It contributes to the nation's nutrition, health and, in the longer term, to food security.

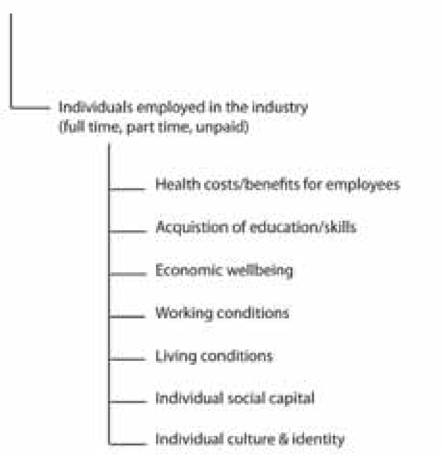
Regional community

Signposts notes that local and regional communities may receive many social benefits from the horticulture industry, via the development of unique cultures, businesses, production chains and communities related to an industry (Schirmer 2006).These benefits include employment and contributions to community networks, such as Landcare and to community heritage which may attract tourism.

Employees

This aspect of the profile includes contributions to individuals employed in the industry (Figure 15). It covers the economic benefits and impacts on health as well as less tangible components such as individual culture and identity.

Figure 15 Contributions to employees — the Signposts framework of the social contribution of the horticulture industry



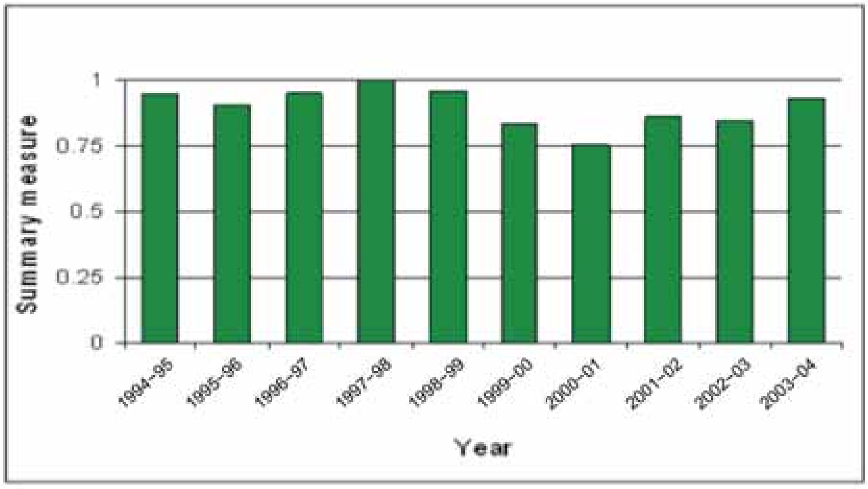
Occupational health

This aspect of the profile relates to the impact of the industry on the health of individuals involved in the industry. Signposts states that the most direct impact is through injuries on farms, but there are also other potential impacts. These include the potentially hazardous long-term effects of working with chemicals and exposure to the sun, and the beneficial impacts of an active outdoor lifestyle.

The desired outcome is that the negative impacts of the industry on the health of individuals involved in it are reduced. Signposts uses a summary measure that shows the extent to which the desired outcome is being achieved on a scale of 0 to 1. A score of 1 for the most recent year means that occupational injuries are at their lowest level to date.

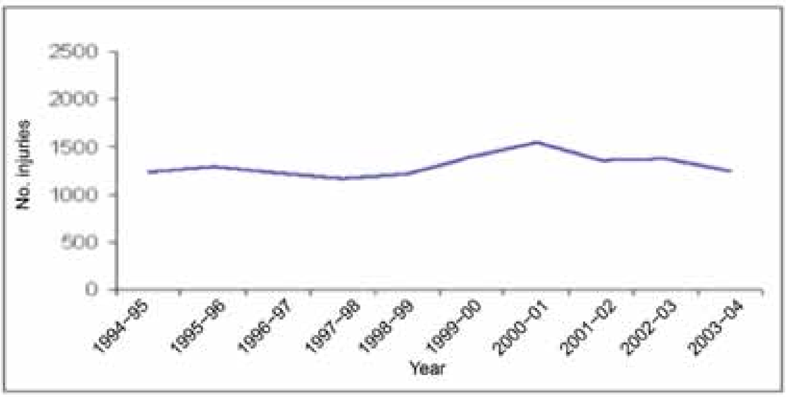
Figure 16 shows improved performance in the indicator since 2000–01, although injuries had not reached the low levels of the late 1990s. The summary measure is based on the indicator value from compensation statistics shown in Figure 17.

Figure 16 The Signposts summary measure for occupational health, 1994–95 to 2003–04



Source: Norton and Whitworth (2007)

Figure 17 Number of reported occupational health and safety injuries on horticulture farms, 1994–95 to 2003–04



Source: Norton and Whitworth (2007)

Assessment of the horticulture industry's contribution to ecologically sustainable development

Over the past decade, the Australian horticulture industry has made major advances in its productive capacity, natural resource management, environmental conservation, and human and social capital. This has been driven by:

- investment in research and development and high returns on that investment
- the capacity of farmers to change through adopting the results of research and development, and improving their own management skills
- the development of the industry's capacity through the organisations that provide services to the industry
- the increasing expectations of the market and the general community for safe and healthy products which are produced in a sustainable way.

Table 15 provides an overall assessment of the horticulture industry's contribution to ecologically sustainable development, opportunities and threats, and industry actions in response.

Table 15 Overall assessment of the contribution of the horticulture industry to ecologically sustainable development

Contribution	Signposts component	Overall assessment	Threats	Industry opportunities to address issues	Progress — industry actions in response
Economic contribution	Productive capacity (GVP)	• rising GVP, with significant variability • third-largest agricultural industry	• impact of climate variability and water access on production and profitability • imports winning domestic market share	• improved climate variability risk management tools • large-scale investment in water recycling schemes, irrigation infrastructure and irrigation technology • importance of horticulture to human nutrition and countering increasing health problems	• *Future Focus* strategic planning initiative to increase the productive and marketing capacity of Australian horticulture • Horticulture Water Initiative • R&D partnerships with water R&D funders • partnerships with health agencies
	Marketing	• overall weak performance • proportionate share of world trade less than share of world production • net importer for fruit and vegetables • stronger export performance for some products and regions	• increasing imports • export market share losses to competitors	• rising global demand for food due to world economic growth • rising world food prices • research indicating a 10% increase in export demand may be worth double a 10% increase in domestic demand • global food shortages reducing trade barriers	• *Future Focus* and other specific industry strategic plans having strong export focus • increased investment in export market R&D

Contribution	Signposts component	Overall assessment	Threats	Industry opportunities to address issues	Progress — industry actions in response
	Net worth	• little industry data • net worth indicators for vegetables show sound underlying position for farm capital, equity and rates of return	• lack of industry data on financial performance of horticultural farms • the majority of small-scale farms unable to achieve the demonstrated superior financial performance of larger-scale horticulture	• availability of tested methodologies and skills to collect industry financial performance data • availability of demonstrated business models to build scale and attract investment	• *Future Focus* strategies to improve the financial performance of Australian horticultural businesses
	Productivity	• little industry data • lack of strong export performance indicates lower productivity growth in comparison with Australia's export oriented industries	• lack of industry data on industry productivity • declining terms of trade • rapid rise in input costs, particularly fertiliser and fuel	• availability of tested methodologies and skills to collect industry productivity data • propensity of growers to be quick adopters of new technology	• investment in R&D to improve on-farm productivity
Environmental contribution	Soil fertility	• low natural levels of N and P in soils requires the addition of these elements for optimum production in most regions • available data shows excess application of N and P in relation to removal by plants for most crops	• excess fertiliser applications leading to degradation of surface and groundwater with nutrient runoff and leaching; soil acidification; and greenhouse gas emissions • rapidly rising cost of fertiliser	• available soil nutrient and sap testing technology in association with GPS for optimising fertiliser application for plant requirements in different soil types and locations	• best practice fertiliser management through HAL *Guidelines for Environmental Assurance in Australian Horticulture*

Contribution	Signposts component	Overall assessment	Threats	Industry opportunities to address issues	Progress — industry actions in response
	Soil degradation	• dryland salinity is not a significant NRM issue for the industry • irrigation-induced salinity due to over and under-irrigation may be of greater consequence • soil acidity is an issue in almost half of the horticulture production area	• lack of industry data on irrigation-induced salinity • reduced yields due to soil salinity	• adoption of best management irrigation practice and liming can resolve soil salinity and acidity issues, respectively	• HAL Horticulture Water Initiative • HAC NRM policy
	Water extraction and quality	• access to reliable water supply for permanent and annual planting is a key NRM issue for the industry • horticulture water use is around 6% of total national water consumption • potential of excess fertiliser application to degrade surface and groundwater	• lack of data on industry water sources, use and irrigation methods • lack of data on industry impact on water quality • climate change reducing irrigation water availability	• large-scale investment in water recycling schemes, irrigation infrastructure and irrigation technology	• HAL Horticulture Water Initiative • On-farm irrigation efficiency program of the National Plan for Water Security • HAC water policy

Contribution	Signposts component	Overall assessment	Threats	Industry opportunities to address issues	Progress — industry actions in response
	Biodiversity conservation	• data are not available on the impact of the industry on biodiversity conservation	• community and market sensitivity to the industry's impact on biodiversity conservation	• potential EMS to enhance community and market perceptions of the industry's environmental stewardship	• participation of Mount Lofty Range apple, pear and cherry growers in the National EMS Pilot Program
	Greenhouse gas emissions and sequestration	• the horticulture industry is not a significant emitter of greenhouse gas (GHG) — only 0.8% of total agricultural emissions in 2005 (excluding fossil fuel use) • there are no data on the industry's GHG sequestration	• increasing GHG emissions	• potential for more effective fertiliser management and improving energy use efficiency to reduce emissions • development of carbon markets may, over time, provide business opportunities for growers	• participation of some growers in Greenhouse Challenge Plus, a partnership with the Australian Government to increase energy efficiency and reduce GHG emissions
Social contribution	Human capital	• need to collect industry data on aspects of the industry's human capital: • employment, technical and business skills; health, age and life stage of participants • contribution to community nutrition and health	• lack of community and market understanding of the contribution the horticulture industry to Australia's human capital	• potential to build community trust and perceptions of the integrity of the horticulture industry in its contribution to human capital in Australia	• Signposts initiative to collect industry data on human capital

Contribution	Signposts component	Overall assessment	Threats	Industry opportunities to address issues	Progress — industry actions in response
	Social capital	• need to collect industry data on aspects of the industry's social capital: • participation in industry and government programs • membership of industry servicing institutions • contributions to rural and regional communities	• lack of community and market understanding of the contribution the horticulture industry to Australia's social capital	• potential to build community trust and perceptions of the integrity of the horticulture industry in its contribution to human capital in Australia	• Signposts initiative to collect industry data on social capital

EMS = environmental management systems, GHG = greenhouse gas, GPS = global positioning system, GVP = gross value of production, HAC = Horticulture Australia Council, HAL = Horticulture Australia Ltd, N = nitrogen, NRM = natural resource management; P = phosphorous, R&D = research and development

References

ABARE (Australian Bureau of Agricultural and Resource Economics) (2006). *International Competitiveness of the Australian Vegetable Production Sector*, ABARE eReport 06.5, ABARE, Canberra.

ABARE (Australian Bureau of Agricultural and Resource Economics) (2007a). *Australian Commodity Statistics*, December, ABARE, Canberra.

ABARE (Australian Bureau of Agricultural and Resource Economics) (2007b). *Australian Vegetable Growing Industry — An Economic Survey*, Research Report 07.17, ABARE, Canberra.

ABARE (Australian Bureau of Agricultural and Resource Economics) (2008). *Australian Commodity Statistics*, March, 08.1, ABARE, Canberra.

ABS (Australian Bureau of Statistics) (2002–06). International Trade, Electronic Data Service Catalogue No. 5465.0.

ABS (Australian Bureau of Statistics) (2008). *Value of Principal Agricultural Commodities Produced: Preliminary, 2006–07*, Catalogue No. 7501.0, ABS, Canberra.

AGO (Australian Greenhouse Office) (2007). *National Greenhouse Gas Inventory 2005: Data from the Australian Greenhouse Emissions Information System*, AGO, Canberra.

Carlisle D (2007). *Signposts for Australian Agriculture — Horticulture Industry Profile: Exports*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/others-assets/contributions-to-economic-systems-extending-beyond-the-industry/national-income/exports/index_html (Accessed January 2008)

CIE (Centre for International Economics) (2007a). *Horticulture: The Big Drivers? Part 1 Edibles Discussion Paper for Industry Consultation*, CIE, Canberra. http://www.futurefocus.org.au (Accessed January 2008)

CIE (Centre for International Economics) (2007b). *Horticulture: The Big Drivers? Part 2 Non-edibles Discussion Paper for Industry Consultation*, Canberra. http://www.futurefocus.org.au (Accessed January 2008)

Chesson J (2007). *Signposts for Australian Agriculture — Horticulture Industry Profile: Human and Social Assets Held by the Industry*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/industry-assets/human-and-social-assets-held-by-the-industry-value-of-human-and-social-capital/ (Accessed January 2008)

Council of Australian Governments (1992). *National Strategy for Ecologically Sustainable Development,* Council of Australian Governments, Australian Government Publishing Service, Canberra.

DEST (Department of the Environment, Sport and Territories) (1996). *National Strategy for the Conservation of Australia's Biological Diversity*, DEST, Canberra. http://www.environment.gov.au/biodiversity/publications/strategy/index.html (Accessed January 2008)

Kiri-ganai Research (2005). *Accelerating the Adoption of Intensive Orchard Systems: A Summary*, Kiri-ganai Research, Canberra.

Lovell J (ed) (2006). *Guidelines for Environmental Assurance in Australian Horticulture*, Horticulture Australia Ltd, Sydney.

McArthur Agribusiness and Sinclair Knight Merz (2001). *Horticulture: productivity and sustainability*, Horticultural Research and Development Corporation and National Land & Water Resources Audit, Canberra.

NFF (National Farmers' Federation) (2008). *Farmers Sow Seeds for 'Climate Action' with Garnaut and Government*, 14 January, NFF, Canberra. http://www.nff.org.au/read/2447043674.html (Accessed January 2008)

NLWRA (National Land and Water Resources Audit) (2001). *Australian Agriculture Assessment 2001*, NLWRA, Canberra.

NLWRA (National Land and Water Resources Audit) (2004). *Signposts for Australian Agriculture*, NLWRA, Canberra. http://www.nlwra.gov.au/Natural_Resource_Topics/Signposts_for_Australian_Agriculture/index.aspx (Accessed January 2008)

Lizzio J and Whitworth B (2007). *Signposts for Australian Agriculture — Horticulture Industry Profile: Greenhouse Gas Emissions*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/others-assets/contributions-to-bio-physical-systems-extending-beyond-the-industry/effects-of-the-industry-on-atmosphere-and-climate/greenhouse-gas-emissions/index_html/ (Accessed January 2008)

Norton G (2007a). *Signposts for Australian Agriculture — Horticulture Industry Profile: Water Extraction*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/others-assets/contributions-to-bio-physical-systems-extending-beyond-the-industry/effects-of-the-industry-on-the-water-cycle/water-balance/extraction/index_html/ (Accessed January 2008)

Norton G (2007b). *Signposts for Australian Agriculture — Horticulture Industry Profile: Water Quality*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/others-assets/contributions-to-bio-physical-systems-extending-beyond-the-industry/effects-of-the-industry-on-the-water-cycle/water-quality/index_html/ (Accessed January 2008)

Norton G (2007c). *Signposts for Australian Agriculture — Horticulture Industry Profile: Surface Water Salinity*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/others-assets/contributions-to-bio-physical-systems-extending-beyond-the-industry/effects-of-the-industry-on-the-water-cycle/water-quality/salinity/index_html/ (Accessed January 2008)

Norton G (2007d). *Signposts for Australian Agriculture — Horticulture Industry Profile: Groundwater Salinity*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/others-assets/contributions-to-bio-physical-systems-extending-beyond-the-industry/effects-of-the-industry-on-the-water-cycle/water-quality/groundwater-salinity/index_html/ (Accessed January 2008)

Norton G and Srivastava S (2007a). *Signposts for Australian Agriculture — Horticulture Industry Profile: Soil Nitrogen*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/industry-assets/bio-physical-assets-held-by-the-industry-value-of-natural-capital/capacity-of-land-to-produce-food-and-fibre/soil/soil-nitrogen/index_html/ (Accessed January 2008)

Norton G and Srivastava S (2007b). *Signposts for Australian Agriculture — Horticulture Industry Profile: Soil Phosphorus*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/industry-assets/bio-physical-assets-held-by-the-industry-value-of-natural-capital/capacity-of-land-to-produce-food-and-fibre/soil/soil-phosphorus/index_html (Accessed January 2008)

Norton G and Whitworth B (2007). *Signposts for Australian Agriculture — Horticulture Industry Profile: Health Costs/Benefits*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/others-assets/contributions-to-social-systems-extending-beyond-the-industry/employees/health/index_html (Accessed January 2008)

Whitworth B, Srivastava S and Norton G (2007a). *Signposts for Australian Agriculture — Horticulture Industry Profile: Soil Salinity*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/industry-assets/bio-physical-assets-held-by-the-industry-value-of-natural-capital/capacity-of-land-to-produce-food-and-fibre/soil/soil-salinity/index_html (Accessed January 2008)

Whitworth B, Norton G and Srivastava S (2007b). *Signposts for Australian Agriculture — Horticulture Industry Profile: Soil Acidity*, NLWRA, Canberra. http://signposts4ag.com/signposts-horticulture/industry-assets/bio-physical-assets-held-by-the-industry-value-of-natural-capital/capacity-of-land-to-produce-food-and-fibre/soil/soil-acidity/index_html/ (Accessed January 2008)

About the Signposts for Australian Agriculture Report Series

The *Signposts for Australian Agriculture* project is a partnership between the Department of Agriculture, Fisheries and Forestry, Research and Development Corporations, and the National Land & Water Resources Audit.

The Signposts project aims to inform policy development by assessing and reporting on the environmental, economic and social contributions of Australian agricultural industries.

Six industry Signpost reports have been produced covering the following industries:

- Grains
- Beef
- Dairy
- Horticulture
- Wine
- Cotton