Environmental Assessment of the Vegetable Industry

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Project Number: VG13057

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Purpose of this report: This final report provides a summary of the environmental assessment of the Australian vegetable industry.

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Contents

Summary

The Australian vegetable industry is located in regions with high environmental value. Growers have for many years aimed to adopt sustainable management practices that minimise the impact on the environment, and the industry has promoted efficient management practices and environmental assurance programs with the flagship program being EnviroVeg. Whilst these programs are popular, the industry as a whole has done minimal reporting on its environmental performance and achievements.

An environmental assessment was therefore undertaken to measure the performance of the industry with regard to good environmental practices and also the impact it is having on the environment around it. The aims of this national environmental assessment were to inform the vegetable growers and other interested groups of the environmental performance of the sector, provide a baseline for future assessments and inform future strategic industry investments.

Consultation with industry participants, the supply chain and government groups, identified a great interest for the industry to monitor its environmental performance and work towards improving this performance over time. A framework (or structure) was developed which describes what is important to monitor and how it should be measured. The framework focuses on the monitoring of practices in the short-term and the measurement of medium-term indicators (physical condition of assets). The framework demonstrates that by improving these management practices and medium term outcomes, the industry will achieve its longer-term environmental objectives.

The performance report for 2015 includes an assessment against identified indicators for each of the environmental themes. Importantly, the analysis describes what information needs to be collected at the short-term and medium-term outcome levels.

At a short-term outcome level, good information was provided on the broad adoption of management practices for each theme from EnviroVeg data. More specifically at this short-term outcome level, 49 management practices were identified in the framework for ongoing monitoring. In this first assessment, national data was available for the vegetable industry for only ten of the 49 management practices from the ABS Land Management and Farming in Australia survey[1]. This data was purchased and analysed for these ten management practices. Data was not available for the remaining 39 management practices however, it is possible that this data could be available through sources including EnviroVeg in the future. The framework now exists to utilise future collection of information at the short-term outcome level.

The framework describes 22 indicators to be monitored at the medium-term outcome level. Of these 22 areas, information has been analysed and presented for nine of the indicators in this current assessment. There are 13 indicators for which insufficient quantitative data was available at a national scale.

The environmental performance of the vegetable industry at the medium-term outcome level was good to very good for:

- Water use and waterway management – industry water use (ML) and water use per area (ML/ha)
- Soil and nutrient management – organic carbon (t/ha)
- Air quality management - tonnes of carbon dioxide equivalent (CO_2e) per year (from greenhouse gases) and tonnes of CO_2e per year specifically from nitrous oxide (N_2O) emissions
- Energy use management – electricity costs.

Environmental performance for the industry was rated as poor for:

- Biodiversity management – area and condition of native vegetation
- Energy use management – fuel, oil and grease costs.

It is almost impossible to assess impacts of the vegetable industry at the long-term outcome level due to lack of data but also because of the challenge of attributing impacts to a particular source (e.g. what is the relative impact of the vegetable industry on sedimentation in Port Phillip and Westernport). The framework therefore relies on achieving the desired outcomes at the short-term and medium-term level. It is expected that changes at these levels will lead to the longer-term positive outcomes for the environment.

The industry case studies (snapshots) describe the work that is being done in achieving positive environmental outcomes. These case studies were developed where quantitative information was not available. They tell a story about the steps that the industry is making towards positive environmental management.

This performance report provides the first environmental assessment for the vegetable industry. The report highlights the important environmental issues that were identified by different stakeholder groups and important issues that these groups see emerging.

A suite of recommendations has been developed to address the gaps in knowledge identified and assist the completion of future environmental assessments. In addition a communication strategy has been established focusing on who the environmental assessment needs to be described to, the important messages and best approaches.

Importantly, the project has provided a structure and approach to enable the industry to continue this environmental assessment in the future. It is expected that this first report will provide the baseline for further assessments and the methodology to ensure that a consistent approach is applied.

Keywords

Consultation: discussion with identified groups to determine their views on a particular issue**.** Different methods can be used to undertake consultation including surveys, interviews and group discussions.

Framework: description of a structured approach, process or methodology. The framework provides the structure around which future environmental assessments can be undertaken. The building blocks of the framework include the program logic, the outcomes and the indicators.

Environmental audit: assesses the nature and extent of harm, or risk of harm, to the environment posed by an activity. Environmental audit is a general term that can reflect various types of evaluations intended to identify environmental compliance, impacts on the environment and/or environmental management (system) implementation gaps, along with related corrective actions.

Environmental assessment: a formal assessment of the impact an activity may have on the environment.

Environmental assets: naturally occurring entities that provide environmental "functions" or services and are considered to have significant value to the community. An asset is the thing we hope to protect, improve or manage better.

Monitoring, Evaluation and Reporting (MER):

> **Monitoring -** the regular collection and analysis of information to measure changes over time (e.g. salinity levels of a waterway, use of soil testing to assist fertiliser decisions).
>
> **Evaluation -** periodic assessment of the impact of activities (e.g. change in river salinity over time).
>
> **Reporting -** communication of the findings to different audiences (e.g. condition of particular waterways including Great Barrier Reef and Murray Darling Basin).

Outcomes:

> **Short-term outcomes:** outcomes to be achieved in 1-5 years; focus on management practices.
>
> **Medium-term outcomes:** outcomes to be achieved with a lag of 5-10 years; focus on change in asset condition e.g. reduction in erosion or improvement of soil organic matter levels or water quality.
>
> **Long-term outcomes:** aspirational outcomes to be achieved in 10+ years. Difficult to measure and attribute to a particular activity or cause.

Performance indicators: metrics used to help define and measure progress towards achieving objectives, critical success factors or desired outcomes.

Program logic: outlines the anticipated cause-and-effect relationships between program outputs and outcomes. The program logic aims to explain what will occur as a result of specific actions. It is sometimes referred to as a 'roadmap'. From this roadmap, you can monitor whether you keep to the road, or deviate, and if you do deviate, why this may have occurred.

Quantitative: quantitative data are measures of values or counts and are expressed as numbers.

Qualitative: qualitative data are measures of 'types' and may be represented by a name, symbol, or a number code.

Vision: the act or power of anticipating that which will or may come to be.

Abbreviations

ABS – Australian Bureau of Statistics

AFSA – Australian Fertiliser Services Association

APVMA – Australian Pesticides and Veterinary Medicines Authority

ASPAC – Australasian Soil and Plant Analysis Council

BMPs – Best Management Practices

CO_2 – Carbon dioxide

CO_2e – Carbon dioxide equivalent is a measurement factor that includes the following GHGs; carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), perfluorocarbons (PFC), hydrofluorocarbons (HFC), sulphur hexafluoride (SF_6)

CSIRO – Commonwealth Scientific and Industrial Research Organisation

EPA – Environment Protection Authority

GHG – Greenhouse Gas

HIA – Horticulture Innovation Australia Limited

ICP – Integrated Crop Protection

IPM – Integrated Pest Management

LPG – Liquefied Petroleum Gas

MER – Monitoring, Evaluation and Reporting

MITC – Methyl isothiocyanate

N – Nitrogen

N_2O – Nitrous oxide (which can be measured as CO_2e)

NRM – Natural Resource Management

P – Phosphorus

PV – Photovoltaic

QA – Quality Assurance

R&D – Research and Development

RD&E – Research, Development and Extension

SARP – Strategic Agrichemical Review Process

VAST – Vegetation Assets, States and Transitions

1 Introduction

1.1 Background

Australia is a continent of vast natural diversity. The landscapes, soils, vegetation types, river systems and oceans vary greatly from one end of the continent to the other. The climate too is variable. It is this natural environment and its diverse climate, soils, waterways and vegetation that underpins Australia's vegetable industry, enabling the production of a broad range of crops across the country. Indeed, the quantity and quality of food we produce is directly affected by the condition of natural resources – including soil, water, and native vegetation[2].

Not surprisingly Australia's major vegetable growing regions, whilst scattered across the nation, are generally all located in areas of high environmental value. This includes near rivers, waterways and groundwater reserves which provide reliable access to fresh water; on nutrient-rich, well-draining soils; and near areas of native vegetation that provide shelter and habitat for pollinating insects and biological control agents. Many of these environments are highly sensitive, such as the Murray Darling Basin and the receiving catchments of the Great Barrier Reef.

Given that food production in Australia relies so heavily on the health of the natural environment, increasing environmental degradation is concerning[3]. To ensure the continuation of a diverse and productive vegetable industry in Australia, it is fundamental that the natural systems that sustain vegetable production are well managed.

The protection of these natural systems relies on minimising the off-site impacts of growing vegetables whilst maximising profitability. Examples of important assets that require protection include:

- Waterways such as the Murray Darling Basin and the Snowy River that can degrade through over extraction of water and reduced flows
- Rivers and coastal waterways including the Hawkesbury-Nepean rivers, Great Barrier Reef and the Peel-Harvey Estuarine System that can be poorly impacted by high levels of nutrients, salts and chemicals
- Highly fertile soils in areas including West Gippsland and northern Tasmania that are subject to soil erosion and decline in fertility
- Native vegetation such as the Brigalow Forest ecological community which can be harmed from poor management of pest animals.

Vegetable growers have been working for many years towards production systems that have minimal impact on the environment. This has included the use of efficient practices including:

- Irrigation scheduling that provides the plant with the right amount of water and reduces the amount of drainage from the farm
- Spray technology that targets specific pests/diseases and minimizes the amount of chemicals moving off-site
- Adoption of integrated pest management resulting in the use of fewer and less harmful chemicals
- More targeted and precise use of fertilisers supported by testing of soils and plants.

There has been significant progress over the past decade towards better environmental management with a large sector of the industry adopting sustainable management practices and environmental assurance programs with the flagship program being EnviroVeg.

Whilst the vegetable industry has been proactive in adopting improved environmental management, there has been a lack of reporting on these achievements. An environmental assessment aims to measure the performance of the industry with regard to good environmental practices and also the impact it is having on the environment around it. By measuring the environmental performance of the industry, it can continue to improve and demonstrate its environmental credentials to markets, government and consumers.

1.2 This project

This project aimed to conduct a nation wide environmental assessment of the vegetable sector that would identify and prioritise key environmental issues facing this multifaceted sector. It was also intended that the project would develop a process to gather objective evidence of how well industry in certain regions, and as a whole, is dealing with these issues and communicate actions to vegetable growers that will allow them to remain sustainable, compliant where required, and profitable.

This environmental assessment was undertaken to:

- Inform the vegetable growers nationally of the environmental performance of the sector
- Provide a baseline for subsequent assessments in the future
- Inform future strategic industry investments, and
- Provide stakeholders and the public with documentation of the performance of the vegetable industry's environmental management and provide evidence of further progress via subsequent assessments following an established process.

The project was designed to address these aims focusing on:

- Understanding the context of environmental management within and external to the industry
- Establishing a structured process (framework or methodology) for undertaking objective environmental assessments of the sector for this baseline check and subsequent assessments
- Measuring the environmental performance of the vegetable industry nationally and also allowing a look at some regional differences
- Providing recommendations to the vegetable sector on how to maintain or improve environmental management without sacrificing profitability.

2 Approach

We have referred to these major components in the project as phases:

- Phase 1 **(understanding the context)**: included a desktop review and stakeholder consultation
- Phase 2 **(establishing a MER framework)**: included the development of a Monitoring, Evaluation and Reporting (MER) framework
- Phase 3 **(measuring environmental performance):** involved reporting on the findings from Phases 1 and 2 through the preparation of an environmental performance report, and
- Phase 4 **(synthesis and recommendations):** analysing findings, drawing conclusions and establishing next steps.

2.1 Phase 1: understanding the context

Stakeholder consultation

Consultation with key stakeholders was an important input in the scoping phase of the project. This consultation assisted in determining the important environmental issues and ensured that the environmental assessment would:

- Accurately identify the most significant environmental achievements and challenges into the future
- Meet the needs of the target audiences [vegetable growers, supply chain (consumers, processors and retailers) and government (including Natural Resource Management (NRM) bodies, policy and decision makers and Research, Development and Extension (RD&E) investors)]
- Include the best available information about the vegetable industry
- Provide a practical and useful methodology (framework) for assessing and reporting on environmental performance of the vegetable industry into the future.

Over 40 stakeholders participated in the consultation including growers, environmental assurance scheme owners, federal RD&E partners and investors, market chain participants, the Australian Government and regional natural resource management organisations.

Desktop review and analysis

The first phase of the environmental assessment involved the exploration of:

- Key industry successes with regard to environmental performance
- Opportunities for improvement with regard to environmental performance
- Most significant prospects to strengthen performance into the future
- Most significant risks/challenges with respect to the environment and the industry, and
- Consumer attitudes towards environmental performance.

2.2 Phase 2: establishing a MER framework

The second phase of the environmental assessment project involved the preparation of a MER framework. The framework established a clear vision for environmental performance in the Australian vegetable industry and a methodology for measuring progress or success against long-term goals.

The monitoring, evaluation and reporting framework comprises:

- A logical approach ('Program Logic') that allows summarising and identifying priority issues and includes documenting aspirational goals, desired outcomes, outputs, and activities to achieve outcomes and goals
- Measurable environmental performance indicators and targets for outcomes, outputs and activities. This provides a framework for a quantitative assessment of the environmental footprint of the vegetable industry now and in future
- Performance reporting approach.

2.3 Phase 3: measuring environmental performance

Performance measurement and reporting is essentially the presentation of gathered data against the items in the 'program logic' and its performance indicators and targets. A performance report provides a relative measure of progress against established targets.

The performance report for the environmental assessment of the vegetable industry has been illustrated using a traffic light approach, where a rating scale is applied to show performance against each of the indicators and targets.

Data to measure the environment performance of the vegetable industry has been drawn from a range of objective sources including:

- Purchase and analysis of quantitative, whole of industry Australian Bureau of Statistics (ABS) data on management practices for the vegetable industry by vegetable production region[4]
- Analysis of Australian native vegetation extent[5] and condition[6] data which identify the area of clearing by the industry for the vegetable production regions
- Analysis of the National Greenhouse Gas Inventory for the vegetable industry[7]
- Analysis of recently released Commonwealth Scientific and Industrial Research Organisation (CSIRO) (November 2014) data on soil carbon for the vegetable production regions[8]
- Analysis of quantitative ABS data on all relevant themes where it is readily available (e.g. ABS Water Accounts[9]) – water has the best information largely due to the decade long drought but prior to this data was scant
- Review and analysis of prior research and development (R&D) projects that contained relevant data.

There are varying scales at which information has been collected and collated. The preparation of the performance report for this project has focused on, reporting against:

- Medium-term indicators that can be monitored quantitatively at a national scale
- Short-term indicators focused on industry practices that are used as a surrogate for environmental impacts or outcomes. Actual impacts or outcomes could not be measured within the scope of this project and objective, quantitative data was not available for some medium-term indicators

- Case studies (industry snapshots) that describe medium-term and short-term outcomes in a qualitative manner i.e. the case studies illustrate the work, commitment and aspirations Australian vegetable growers show when looking after their production environment and their region.

2.4 Phase 4: synthesis and recommendations

The final phase of the project involved the synthesis of findings and development of recommendations to assist industry and growers in monitoring and reporting its environmental management in the future.

2.5 Supporting documentation

An extended report has been produced which provides:

- Additional information from the desktop review and consultation (Chapter 3)
- Background description of the framework (Chapter 4)
- A more detailed version of the performance report for each of the 8 themes (Chapter 5)
- Implementation guidelines including data sources and methods (Appendices)

This information is additional to what is required by the majority of industry participants. However, we recognise there may be interest in accessing this comprehensive document. A copy can be obtained by contacting communications@horticulture.com.au.

3 Understanding the context

The desktop review and stakeholder consultation highlighted the following points:

- Confirmation of the three drivers for environmental management of the vegetable industry being environmental stewardship, environmental assurance and resource use efficiency
- Support for the focus on the protection of environmental assets and the opportunity to engage more meaningfully with the local NRM bodies
- Recognition by industry and others of the progress that has been made with improved environmental performance particularly in relation to adoption of Best Management Practices (BMPs) and environmental assurance
- Acknowledgement of the need to improve the monitoring and reporting of environmental performance
- Agreement on the need to align with and complement the industry environmental scheme of EnviroVeg
- Recommendations for the themes where effort should be focused and suggestions for environmental indicators and targets: water use and waterway management, soil and nutrient management and chemical use management
- Identification of emerging areas of interest being waste management and energy management
- Recommendations for regions and natural assets that should be the focus of industry snapshots.

The consultation included the following groups: growers, environmental assurance scheme owners, federal RD&E partners, market chain participants, Australian government and natural resource management organisations.

4 Monitoring, Evaluation and Reporting (MER) framework

4.1 Drivers for Environmental Performance

The environmental performance assessment is based on the following drivers for implementation and demonstration of good environmental management by vegetable producers (Figure 4-1):

1. Communities' expectations of growers to look after natural resources (e.g. land, water, air) on and off farm. This requirement for **environmental stewardship** has been taken up through farmer driven initiatives such as Landcare, and government programs such as Caring for our Country and the Carbon Farming Initiative *(to be absorbed into the Emissions Reduction Fund from July 2015).* The horticulture industry has been actively involved in these programs.

2. Consumer expectation of good environmental performance and the need to demonstrate that the industry is doing the 'right thing' with respect to environmental issues. This expectation of **environmental assurance** has been driven by supply chains in response to consumer desires and has resulted in a suite of programs such as Environmental Assurance in Horticulture, EnviroVeg (and EnviroVeg Platinum), Freshcare and GlobalGAP.

3. Continued access to resources and their efficient use. Growers strive to implement sustainable farm production systems that **use resources efficiently and are environmentally sound**. The best practices are often profitable and make good environmental sense.

Figure 4-1: Drivers for environmental performance for the Australian vegetable industry

This environmental performance report has focused on:

- The three drivers for environmental performance in the vegetable industry; environmental stewardship, environmental assurance and resource use efficiency
- Alignment with existing environmental assurance programs specifically, using the industry's own EnviroVeg program themes, problem definitions and objectives to strengthen and support it
- Protection of environmental assets identified for the top 13 vegetable growing regions (NRM regions) and identification of key risks to these assets

- Understanding of industry BMPs for environmental management and integration of environmental management into general practices used for vegetable production.

4.2 Vision for environmental performance

A vision was established for the vegetable industry for monitoring environmental performance.

The Australian vegetable industry works to continuously improve its environmental performance within areas of its control. It is recognised by the Australian community, supply chains and government for its responsible stewardship of land, water, plants and animals (biodiversity) and atmospheric assets.

4.3 Environmental themes

EnviroVeg is the key environmental program owned by the vegetable industry. The environmental assessment aligned with and complemented this program using eight of the nine EnviroVeg themes that are familiar to growers (Table 4-1).

Table 4-1: Description of the eight EnviroVeg themes included in the environmental assessment

No.	EnviroVeg themes
1	Water use and waterway management
2	Soil and nutrient management
3	Pest and disease management
4	Chemical use management
5	Biodiversity management
6	Waste management
7	Air quality management
8	Energy use management

4.4 Natural Resource Management (NRM) and vegetable growing regions

The environmental assessment was undertaken to align geographically with the natural resource management regions. These overlap with the vegetable growing regions that are known to the industry.

The Australian Government, in association with state and territory governments, has identified 54 regions (bioregions/catchments) covering all of Australia. These regions were examined to derive the top ten NRM regions in terms of levy vegetable production by area and number of levy vegetable growing businesses. Combining the results highlighted 13 NRM regions, representing 67% of the area of levy vegetable production and 66% of levy vegetable production businesses (Figure 4-2).

The vegetable production regions and corresponding NRM regions are presented in Table 4-2.

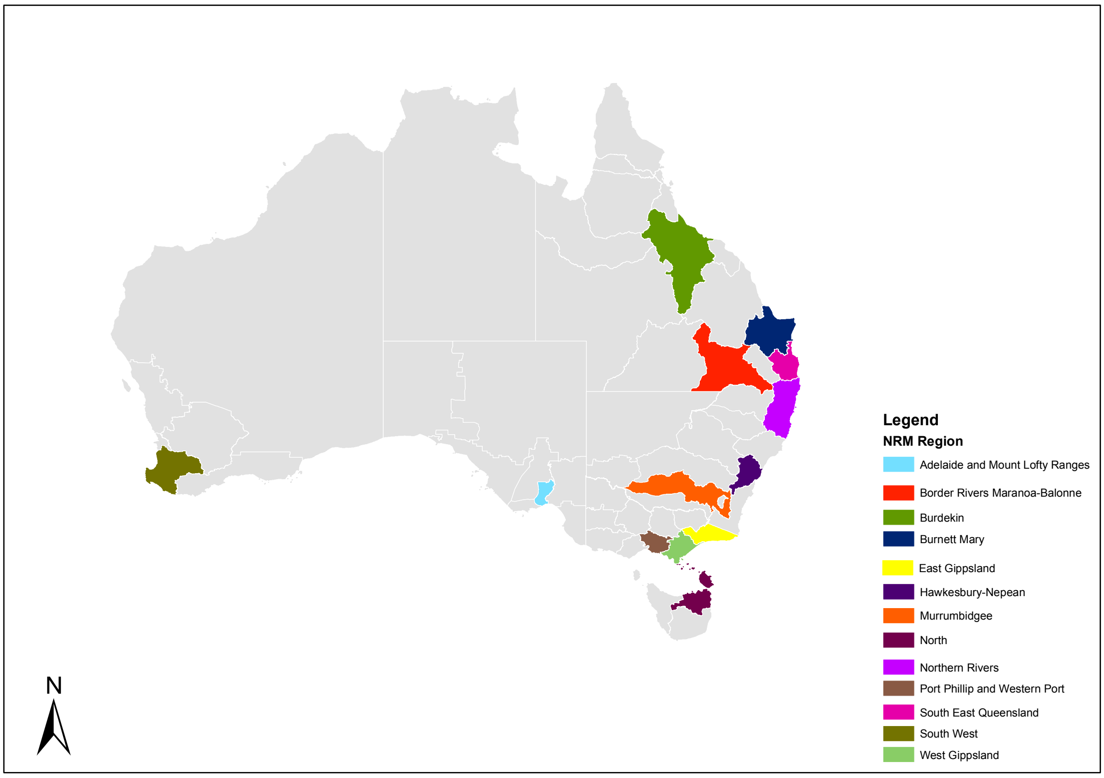

Figure 4-2: Top 13 NRM regions representing 67% of the area of levy vegetable production and 66% of levy vegetable production businesses

Table 4-2: The major vegetable production regions and corresponding NRM regions

Vegetable Growing Region	NRM Region
Werribee & Cranbourne/Koo Wee Rup	Port Phillip and Westernport (Vic)
Lockyer Valley/Fassifern	South East Queensland (Qld)
Bowen/Burdekin	Burdekin Dry Tropics (Qld)
Bundaberg	Burnett Mary (Qld)
Sale/Maffra	West Gippsland (Vic)
Lindenow	East Gippsland (Vic)
Stanthorpe	Border Rivers (Qld)
Northern Tasmania/Scottsdale	NRM North (Tas)
Sydney Basin	Hawkesbury-Nepean (NSW)
Manjimup/Pemberton & Busselton/Myalup	South West (WA)
Lismore/Armidale/Port Macquarie	Northern Rivers (NSW)
Adelaide Hills & Virginia/Adelaide plains	Adelaide and Mount Lofty Ranges (SA)
Murrumbidgee (Griffith region)	Murrumbidgee (NSW)

4.5 Program Logic

An overarching Program Logic for the environmental performance of the vegetable industry was developed describing the outcomes from each specific program logic (by EnviroVeg theme) together into one simple schematic (Figure 4-3), which forms the basis of the Environmental Performance Report.

The program logic or 'road-map' provides a pathway for the vegetable industry to ensure that its growers have a positive impact on the environment. The road-map shows how activities and practices undertaken by growers will lead to good long-term outcomes for the environment.

The 'short-term outcomes' level of the logic aims to describe the suite of BMPs necessary to achieve the 'medium-term outcomes' in the logic. The 'medium-term outcomes' level of the logic aims to describe resource use and resource condition outcomes necessary to achieve the 'long-term outcome'. Finally, the 'long-term' outcome represents the vision or aspirational goal for the environmental theme.

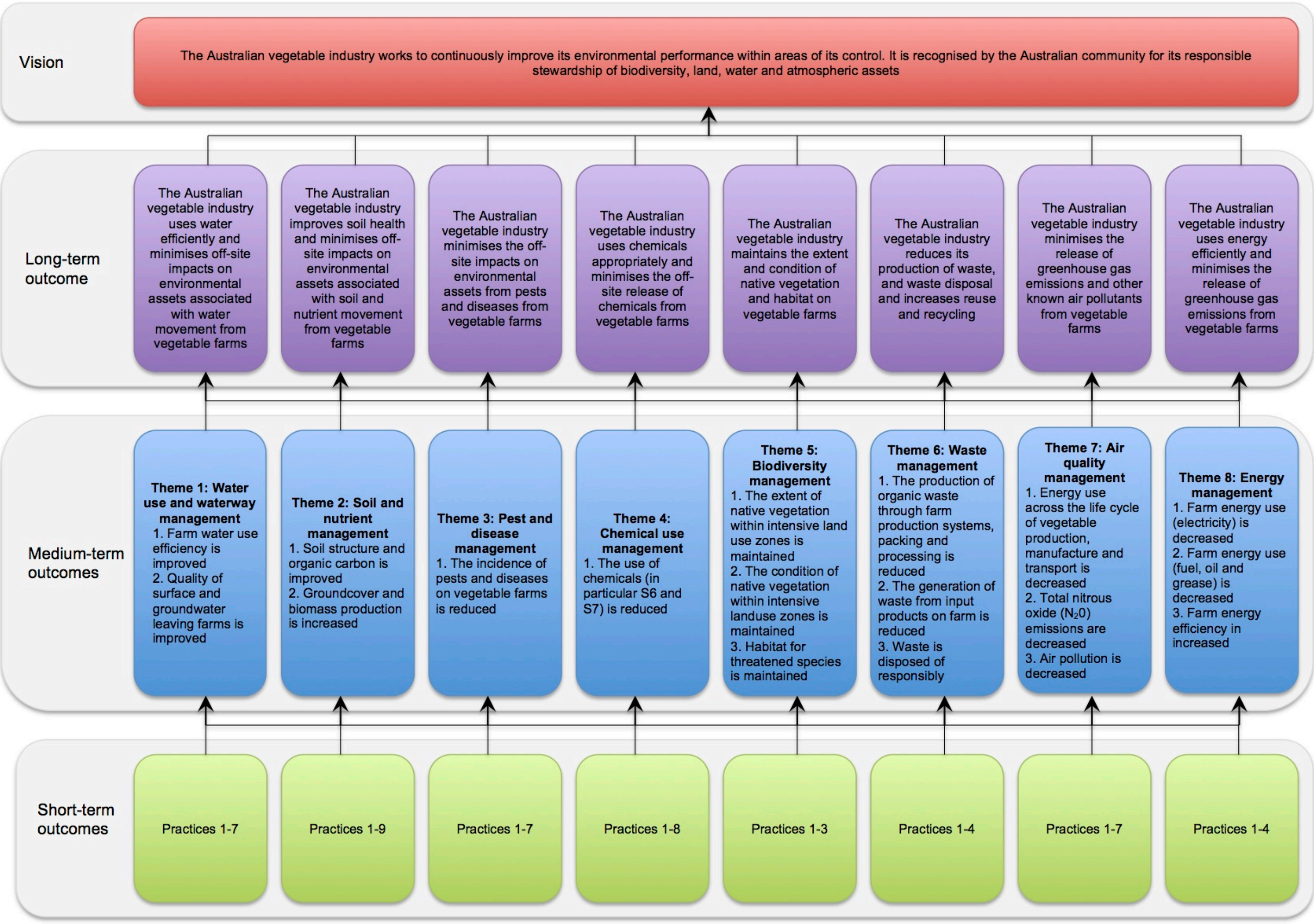

Figure 4-3: Program logic describing the environmental performance of the Australian vegetable industry including vision, long-term, medium-term and short-term outcomes

4.6 Outcomes and indicators

The program logic (or roadmap) describes outcomes at three different levels. These include:

- **Short-term outcomes:** outcomes to be achieved in 1-5 years; focus on management practices
- **Medium-term outcomes:** outcomes to be achieved with a lag of 5-10 years; focus on change in asset condition e.g. reduction in erosion or improvement of soil organic matter levels or water quality
- **Long-term outcomes:** aspirational outcomes to be achieved in 10+ years. Difficult to measure and attribute to a particular activity or cause.

At each outcome level, we aim to describe a measurement **(performance indicator)**, which can be used to define and assess progress towards achieving the desired outcomes. The performance indicator at the short-term outcome level is the use of a particular management practice. At the medium-term outcome the indicator is focused on the condition of the asset.

The report presents findings at both the short-term and medium-term outcome levels.

4.6.1 Short-term outcomes

Environmental outcomes at the **short-term** were identified based on the type of farming practices that are required to ensure that the industry is working towards minimising environmental impacts on particular assets. The focus on management practices is appropriate at this level and is often the best measure available to assess change over time. There has been significant effort by the industry to assist in the adoption of BMPs and there are some reasonable sources of information to demonstrate change as described in Section 5.1. The short-term outcomes are focused on the adoption of recommended management practices over the next one to five years.

The recommended management practices that were identified at the short-term level to be monitored for the environmental assessment are described in Table 4-3.

Table 4-3: Recommended management practices identified at the short-term outcome level

Theme	Outcome statement
Water use and waterway management	▪ Water use complies with regulatory requirements ▪ Water is recycled where possible ▪ Vegetated buffer strips are established to protect waterways ▪ Cultivation and fertiliser application is planned to avoid expected rainfall events ▪ Irrigation systems are designed and maintained to meet appropriate standards ▪ Irrigation scheduling is implemented based on monitoring of plants, soil and weather ▪ Irrigation systems are monitored to ensure optimal performance
Soil and nutrient management	▪ Soil types on vegetable farms are properly described and understood ▪ Soils are tested regularly for pH, organic matter, nutrient levels, salinity and sodicity ▪ Soil condition of eroded or degraded soil is improved ▪ Irrigation is managed appropriately ▪ Cultivation and traffic is managed appropriately ▪ Groundcover is maintained ▪ Compost and/or other organic amendments are used ▪ Appropriate fertilisers/amendments are used and applied efficiently ▪ Optimal rotations are used to protect soil condition

Theme	Outcome statement
Pest and disease management	▪ Appropriate hygiene practices are used when moving plant and equipment ▪ Pests and diseases are managed in accordance with legal requirements ▪ Major pests and diseases that affect specific crops are well understood ▪ An IPM program is used to minimise incidence and/or spread of pests ▪ Pests and beneficials are monitored regularly ▪ Pesticide resistance avoided through responsible chemical use ▪ Pests are managed in areas of native vegetation and waterways
Chemical use management	▪ Chemical use is minimised ▪ Chemicals are appropriately selected, stored, used and disposed ▪ Plans in place for managing potential spills or emergencies for each type of chemical being used ▪ Employees are trained in responsible chemical management ▪ Selection, calibration and maintenance of chemical application equipment is undertaken ▪ Pollution of soil and water is minimised ▪ All chemical treatments are monitored and recorded and withholding periods observed ▪ Chemical management meets legal requirements
Biodiversity management	▪ Vegetation is managed in accordance with legal requirements ▪ Existing areas of remnant native habitat and vegetation (including wildlife corridors, riparian areas, lakes, wetlands or significant water habitat) are protected ▪ Native habitat and vegetation is restored, increased and connected where possible
Waste management	▪ Types and amounts of wastes produced on farm are identified and recorded ▪ Development and implementation of a waste management plan to guide reuse, recycling & disposal ▪ Wastes are stored to ensure there is: o No litter, offensive odour or pests created by the waste o No runoff from stored waste into waterways or groundwater ▪ Unusable wastes are disposed of responsibly
Air quality management	▪ Energy use on farm is minimised ▪ Appropriate fertilisers/amendments are used and applied efficiently ▪ Cultivation and traffic is managed appropriately ▪ Refrigeration equipment is maintained ▪ Methane emissions (from composting processes) are reduced ▪ Carbon sinks are established or maintained ▪ Odour, dust, smoke, noise and light are minimised
Energy use management	▪ Use and efficiency of machinery is regularly reviewed to minimise fuel use ▪ Efficiency of on-farm buildings and sheds is maximised by: o Using energy efficient lighting o Turning off machinery and equipment when not in use o Conducting regular maintenance on equipment and machinery ▪ Irrigation systems are monitored to ensure optimal performance ▪ Renewable energy sources are used where possible

4.6.2 Medium-term outcomes

The industry is working to achieve the following **medium-term outcomes** over the next 5-10 years. These outcomes are focused on describing the condition of the assets and are assessed via the nominated indicators (Table 4-4). The indicator describes what needs to be measured to determine how the industry is tracking in relation to that particular outcome. The environmental performance at the medium-term outcome level is described in Section 5.2.

Table 4-4: Outcomes and indicators to be measured at the medium-term outcome level

Theme	Outcome statement	Indicator
Water use and waterway management	1. Farm water use efficiency is improved	Total industry water use (ML)
		Water use / area (ML/ha)
		Water use efficiency (%) (Evapotranspiration/ rainfall + irrigation)
	2. Quality of surface and groundwater leaving farms is improved	Water quality of surface runoff and groundwater
Soil and nutrient management	1. Soil structure and organic carbon is improved	Soil structure
		Organic carbon
	2. Groundcover and biomass production is increased	Ground cover (%)
		Biomass production (Tonnes)
Pest and disease management	1. The incidence of pests and diseases on vegetable farms is reduced	Pest and disease distribution in vegetable growing regions
Chemical use management	1. The use of chemicals (in particular S6 and S7) is reduced	Pesticide sales, in tonnes of active ingredients
Biodiversity management	1. The extent of native vegetation within intensive landuse zones is maintained	Area of native vegetation within intensive land use zones
	2. The condition of native vegetation within intensive landuse zone is maintained	Condition of native vegetation within intensive land use zones
	3. Habitat for threatened species is maintained	Current extent of threatened species
Waste management	1. The production of organic waste through farm production systems, packing and processing is reduced	Organic waste (tonnes, % of total production)
	2. The generation of waste from input products on farm is reduced	Input product waste (tonnes)
	3. Waste is disposed of responsibly	Landfill (tonnes)
Air quality management	1. Energy use across the life cycle of vegetable production, manufacture and transport is decreased	Tonnes of CO_2e per year
	2. Total nitrous oxide (N_2O) emissions are decreased	Tonnes of CO_2e per year from N2O emissions
	3. Air pollution (from odour, dust, smoke, noise and light) is decreased	Air pollution
Energy use management	1. Farm energy use (electricity use) is decreased	Electricity cash costs
	2. Farm energy use (fuel, oil and grease) is decreased	Fuel, oil and grease cash costs
	3. Farm energy efficiency is increased	Energy per tonne and/or per hectare

4.6.3 Long-term outcomes

The **long-term outcomes** are those the industry is aspiring to achieve in 10+ years. These outcomes are difficult to measure and attribute to a particular activity and/or industry (Table 4-5).

Table 4-5: Aspirational outcomes identified at the long-term outcome level

Theme	Long-Term Outcome Statement: *The Australian vegetable industry:*
Water use and waterway management	Uses water efficiently and minimises off-site impacts on environmental assets associated with water movement from farms
Soil and nutrient management	Improves soil health and minimises off-site impacts on environmental assets associated with soil and nutrient movement from farms
Pest and disease management	Minimises the off-site impacts on environmental assets from pests and diseases from farms
Chemical use management	Uses chemicals appropriately and minimises the off-site release of chemicals from farms
Biodiversity management	Maintains the extent and condition of native vegetation and habitat on farms
Waste management	Reduces the production of waste and waste disposal and increases reuse and recycling
Air quality management	Minimise the release of greenhouse gas emissions and other known air pollutants from farms
Energy use management	Uses energy efficiently and minimises the release of greenhouse gas emissions from farms

5 Environmental performance report

The vegetable industry was assessed for its environmental assessment against each of the themes and at each of the outcome levels.

A summary of information is provided for all of themes focusing on the short-term outcome level (management practices) (Table 5-1) and medium-term outcome level (quantitative assessment considering the condition of the assets) (Table 5-2).

A more detailed assessment for each theme at the short-term and medium-term outcome level is provided in Section 5.3.

5.1 Environmental performance at the short-term outcome level

At a short-term outcome level good information was provided on the broad adoption of management practices for each theme from EnviroVeg data.

More specifically at the short-term outcome level, 49 management practices were identified in the framework for ongoing monitoring (Table 5-1). In this first assessment, national data from ABS was available for the vegetable industry for only ten of the 49 management practices using the Land Management and Farming in Australia survey[4]. This data was analysed for the ten management practices. Data was not available for the remaining 39 management practices.

Table 5-1: Summary of environmental performance of the vegetable industry at the short-term outcome level for all environmental themes

Management practice	Performance (proportion of vegetable growing business)[4]
Water use and waterway management	
1. Water use complies with regulatory requirements	*Data not available*
2. Water is recycled where possible	*Data not available*
3. Vegetated buffer strips are established to protect waterways	14% are establishing or retaining existing vegetation to protect waterways, covering 882 ha
4. Cultivation and fertiliser application is planned to avoid expected rainfall events	*Data not available*
5. Irrigation systems are designed and maintained to meet appropriate standards	*Data not available*
6. Irrigation scheduling is implemented based on monitoring of plants, soil and weather	*Data not available*
7. Irrigation systems are monitored to ensure optimal performance	*Data not available*
Soil and nutrient management	
1. Soil types on vegetable farms are properly described and understood	*Data not available*
2. Soils are tested regularly for pH, organic matter, nutrient levels, salinity and sodicity	8% undertake soil tests for moisture content 28% undertake soil tests for nutrient levels 25% undertake soil tests for organic matter levels 30% undertake soil tests for pH 22% undertake soil tests for salinity levels
3. Soil condition of eroded or degraded soil is improved	*Data not available*
4. Irrigation is managed appropriately	*Data not available*
5. Cultivation and traffic is managed appropriately	22% implementing controlled traffic farming, covering 69,532.54 ha
6. Groundcover is maintained	14% leave crop residue in tact, covering 55,989.38 ha
	8% met ground cover target for 0-6 months of year, covering 33,916 ha 3% met ground cover target for 7-9 months of year, covering 45,192 ha 3% met ground cover target for 10-11 months of year, covering 24,591 ha 6% met ground cover target for 12 months of year, covering 27,293 ha
	Average minimum ground cover target set is 75.1%

Management practice	Performance (proportion of vegetable growing business)[4]
	35% use alternative or cover crops to maintain groundcover 23% use mulching and/or matting to maintain groundcover
7. Compost and/or other organic amendments are used	*Data not available*
8. Appropriate fertilisers/amendments are used and applied efficiently	29% make fertiliser decisions based on consultant recommendations 17% make fertiliser decisions based on leaf or stem sampling 31% make fertiliser decisions based on soil tests
9. Optimal rotations are used to protect soil condition	*Data not available*
Pest and disease management	
1. Appropriate hygiene practices are used when moving plant and equipment	*Data not available*
2. Pests and diseases are managed in accordance with legal requirements	*Data not available*
3. Major pests and diseases that affect specific crops are well understood	*Data not available*
4. An IPM program is used to minimise incidence and/or spread of pests	*Data not available*
5. Pests and beneficials are monitored regularly	*Data not available*
6. Pesticide resistance avoided through responsible chemical use	*Data not available*
7. Pests are managed in areas of native vegetation and waterways	9% undertake pests or feral animal control to protect native vegetation, covering 43,585 ha 12% undertake weed control to protect native vegetation, covering 43,194 ha 5% undertake pests or feral animal control to protect rivers and creeks, covering 3,367 ha 9% undertake weed control to protect rivers and creeks, covering 7,718 ha
Chemical use management	
1. Chemical use is minimised	*Data not available*
2. Chemicals are appropriately selected, stored, used and disposed	*Data not available*
3. Plans in place for managing potential spills or emergencies for each type of chemical being used	*Data not available*
4. Employees are trained in responsible chemical management	*Data not available*
5. Selection, calibration and maintenance of chemical application equipment is undertaken	*Data not available*
6. Pollution of soil and water is minimised	*Data not available*
7. All chemical treatments are monitored and recorded and withholding periods observed	*Data not available*
8. Chemical management meets legal requirements	*Data not available*

Management practice	Performance (proportion of vegetable growing business)[4]
Biodiversity management	
1. Vegetation is managed in accordance with legal requirements	*Data not available*
2. Existing areas of remnant native habitat and vegetation (including wildlife corridors, riparian areas, lakes, wetlands or significant water habitat) are protected	36% of native vegetation is protected for conservation purposes 29% of businesses protect native vegetation for conservation purposes
3. Native habitat and vegetation is restored, increased and connected where possible	15% have revegetated with native vegetation, covering 29,113 ha
Waste management	
1. Types and amounts of wastes produced on farm are identified and recorded	*Data not available*
2. Development and implementation of a waste management plan to guide reuse, recycling & disposal	*Data not available*
3. Wastes are stored to ensure there is: • No litter, offensive odour or pests created by the waste • No runoff from stored waste into waterways or groundwater	*Data not available*
4. Unusable wastes are disposed of responsibly	*Data not available*
Air quality management	
1. Energy use on farm is minimised	*Data not available*
2. Appropriate fertilisers/amendments are used and applied efficiently	29% make fertiliser decisions based on consultant recommendations 17% make fertiliser decisions based on leaf or stem sampling 31% make fertiliser decisions based on soil tests
3. Cultivation and traffic is managed appropriately	*Data not available*
4. Refrigeration equipment is maintained	*Data not available*
5. Methane emissions (from composting processes) are reduced	*Data not available*
6. Carbon sinks are established or maintained	15% have revegetated with native vegetation, covering 29,113 ha
7. Odour, dust, smoke, noise and light are minimised	*Data not available*
Energy use management	
1. Use and efficiency of machinery is regularly reviewed to minimise fuel use	*Data not available*
2. Efficiency of on-farm buildings and sheds is maximised by: • Using energy efficient lighting • Turning off machinery and equipment when not in use • Conducting regular maintenance on equipment and machinery	*Data not available*
3. Irrigation systems are monitored to ensure optimal performance	*Data not available*
4. Renewable energy sources are used where possible	*Data not available*

5.2 Environmental performance at the medium-term outcome level

The framework describes 22 indicators to be monitored at the medium-term outcome level. Of these 22 areas, information has been analysed and presented for nine of the indicators in this current assessment (Table 5-2). There are 13 indicators for which insufficient quantitative data was available at a national scale.

The environmental performance of the vegetable industry at the medium-term outcome level was good to very good for:

- Water use and waterway management – industry water use (ML) and water use per area (ML/ha)
- Soil and nutrient management – organic carbon (t/ha)
- Air quality management - tonnes of CO_2e per year and tonnes of CO_2e per year from N2O emissions
- Energy use management – electricity costs.

Environmental performance for the industry was rated as poor for:

- Biodiversity management – area and condition of native vegetation
- Energy use management – fuel, oil and grease costs.

Table 5-2: Summary of environmental performance of the vegetable industry at the medium-term outcome level for all environmental themes

Outcome Statement	Measurement	Performance (grade)			
		Very Poor	Poor	Good	Very Good
Water use and waterway management					
1. Farm water use efficiency is improved	**Total industry water use (ML)**[10] Total water use in 2012-13 was 392,411 ML, which was 3.5% of total irrigated agriculture water consumption. This represented a return of $6,996/ML.				
	Water use / area (ML/ha)[10] In 2012-13 the vegetable average water use per hectare was 3.8 ML/ha, below the average of 4.7 ML/ha for all irrigated crop and pasture water use. Water use per hectare varied between State/Territories – 2.9-6.9 ML/ha				
	Water use efficiency (%)	*Insufficient quantitative data available*			
2. Quality of surface & groundwater leaving farms is improved	**Water quality of surface runoff and groundwater** Case Study *"Vegetable growers join forces to improve water quality in Watson Creek"*	*Insufficient quantitative data available*			
Soil and nutrient management					
1. Soil structure and organic carbon is improved	**Soil Structure**	*Insufficient quantitative data available*			
	Organic Carbon (%)[8] Soil carbon in topsoil averages 2.65% across the top 13 vegetable growing NRM regions. This result is significantly higher than the national average of 0.94%, and supports the finding that horticulture and irrigated horticulture have the largest average organic C stocks in comparison to other agriculture. Case Study *"Garden organic compost improves soil quality in the Sydney Basin"*				
2. Groundcover & biomass production is increased	**Groundcover (%)**	*Insufficient quantitative data available*			
	Biomass production (tonnes)	*Insufficient quantitative data available*			
Pest and disease management					
1. The incidence of pests & diseases on vegetable farms is reduced	**Pest and disease distribution** Case Study *"An Integrated Pest Management (IPM) approach in Brassica crops"*	*Insufficient quantitative data available*			
Chemical use management					
1. The use of chemicals (in particular S6 & S7) is reduced	**Pesticide sales** Case Study *"Alternative to chemical fumigants in the Adelaide Plains region"*	*Insufficient quantitative data available*			
Biodiversity management					
1. The extent of native vegetation is maintained	**Area of native vegetation**[5] The current extent of native vegetation averages 52% of its pre 1750 extent across the top 13 vegetable growing NRM regions.				

2. The condition of native vegetation is maintained	**Condition of native vegetation (vegetation group)**[6] The proportion of each major vegetation group classified in VAST categories I or II (unchanged or modified) averages 35% across the top 13 vegetable growing NRM regions.				
3. Habitat for threatened species is maintained	**Extent of threatened species** Case Study *"Enhancing biodiversity values in the Lockyer Valley"*	*Insufficient quantitative data available*			
Waste management					
1. The production of organic waste through farm production systems, packing and processing is reduced	**Organic waste (tonnes, % of total production)**	*Insufficient quantitative data available*			
2. The generation of waste from input products on farm is reduced	**Input product waste (tonnes)** Case Study *"Managing plastic waste in the Australian vegetable industry"*	*Insufficient quantitative data available*			
3. Waste is disposed of responsibly	**Landfill (tonnes)** Case Study *"Feasibility of generating biogas from organic waste in the vegetable industry"*	*Insufficient quantitative data available*			
Air quality management					
1. Energy use across the life cycle of vegetable production, manufacture and transport is decreased	**Tonnes of equivalent carbon dioxide (CO_2e)**[11] Preliminary estimation of the total vegetable industry on-farm emissions was 1.114 Mt CO_2e (2008). This was just 1.32% of the total agricultural emissions (84.5 Mt CO_2e). When manufacture and distribution of vegetables is included the estimated emissions for the vegetable supply chain is 7.25 Mt CO_2e.				
2. Total nitrous oxide (N_2O) emissions are decreased.	**Tonnes of CO_2e from N_2O emissions**[12] A preliminary estimation of N_2O emissions from applied N fertiliser use in 2008 was 188,000 t CO_2e (17% of total emissions for the year).				
3. Air pollution (from odour, dust, smoke, noise and light) is decreased	**Air pollution**	*Insufficient quantitative data available*			
Energy use management					
1. Farm energy use (electricity use) is decreased	**Electricity costs**[13] The average energy overhead per farm was 2.46% in 2011-12 (range 1.68-3.51% depending on the State/Territory). The electricity overhead per farm was similar for 2012-13 (3.44%) and 2013-14 (3.54%).				
2. Farm energy use (fuel, oil and grease) is decreased	**Fuel, oil and grease costs**[14] The average overhead per farm was 5.63% in 2011-12 (range 4.07-8.75% depending on the State/Territory). The overhead per farm was up from 2010-11 (4.75%), but lower than for 2012-13 (6.27%) and 2013-14 (6.43%).				
3. Farm energy efficiency is increased	**Energy output (tonne and/or ha)** Mean energy consumption was 2.1GJ per tonne of processed vegetables (based on energy audit of 22 vegetable growers in 2014). Case study *"Case studies of on farm power generation"*	*Insufficient quantitative data available*			

5.3 Detailed assessments

A more detailed assessment of the environmental performance for the vegetable industry is provided in the following sections. This assessment considers information that was analysed at the short and medium term levels and also in some instances where minimal information was available an industry case study (snapshot) is provided.

5.3.1 Presentation of information

The performance report was developed based on the available information. Assessment was made as to the overall performance and the quality of the data used (Table 5-3).

The performance report for each theme includes:

- Target for the environmental indicator – increasing, decreasing or maintaining
- Performance (grade) for the environmental indicator based on current measurement – very poor, poor, good and very good
- Trend for the measured indicator (provided with the grade to give an overall performance) – improving, deteriorating, stable, unclear
- Confidence in the grade and the trend – adequate high quality evidence, limited evidence, evidence too limited to make an assessment

Table 5-3: Legend used to describe the target, performance (grade), trend and confidence in grade/trends trends associated with data

Target	Definition	Performance				Confidence	Definition
		Grade	Definition	Trend	Definition		
↗	Increasing		Very poor	↗	Improving	✔	Adequate high-quality evidence
↙	Decreasing		Poor	↙	Deteriorating	✚	Limited evidence
→	Maintaining		Good	→	Stable	✖	Evidence too limited to make an assessment
			Very good	★	Unclear		

5.3.2 Water use and waterway management

Significant risks to water and waterway assets were identified in the environmental risk assessment completed for the top 13 vegetable growing regions. These risks can be grouped into two categories; risks to water availability and water quality.

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows an increasing trend in the adoption of recommended practices specified in the Water Use and Waterway Management component of the EnviroVeg self-assessment (increase from 83.6% in 2012 to 86.7% in 2014). Analysis of recommended practices using ABS Land Management and Farming data specific for vegetable growers is provided (Table 5-4).

Table 5-4: Environmental performance of the vegetable industry at the short-term outcome level for water use and waterway management

Management practices	Performance (proportion of vegetable growing businesses)[4]
Vegetated buffer strips are established to protect waterways	14% are establishing or retaining existing vegetation to protect waterways, covering an area of 882.4 ha

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-5.

Table 5-5: Environmental performance of the vegetable industry at the medium-term outcome level for water use and waterway management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement[10]	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. Farm water use efficiency is improved	Water use (ML)	↗	Total industry water use in 2012-13 was 392,411 ML, which was 3.5% of total irrigated agriculture water consumption. This represented a return of $6,996/ML				↗	✔	✔
	Water use per hectare (ML/ha)	↗	In 2012-13 the vegetable average water use per hectare was 3.8 ML/ha, below the average of 4.7 ML/ha for all irrigated crop and pasture water use. Water use per hectare varied between State/Territories – 2.9-6.9 ML/ha			↗		✔	✚
	Water use efficiency (%)	↗		Insufficient quantitative data available					
2. Quality of surface and groundwater leaving farms is improved	Water quality of surface runoff and groundwater	↗	Presented as a case study ***"Vegetable growers join forces to improve water quality in Watson Creek"***	Insufficient quantitative data available					

Summary

Agriculture is the largest user of water in Australia – representing 59% of Australia's water consumption in 2011-12[15]. Between 2009-10 and 2012-13, the volume applied and application rates for agriculture increased (68% and 29% respectively). In comparison, the vegetable industry had a decline in volume of water applied and its application rate (-6% and -5% respectively). The vegetable industry is a high-value user of water with the gross value return in 2011-12 being $6,996 per ML (significantly higher than the gross value across irrigated agriculture).

Limited availability of water in many vegetable production regions of Australia has led to improvements in water application through improved irrigation scheduling and fertigation systems. Total vegetable industry water use in 2012-13 was 392,411 ML, which was 3.5% of total irrigated agriculture water consumption. Water use per hectare was 3.8 ML/ha, which was up from 3.6 ML/ha in 2011-12 but still below the average of 4.7 ML/ha for all irrigated crop and pasture in Australia in 2012-13.

Case Study: Vegetable growers join forces to improve water quality in Watson Creek

Watson Creek has been identified by the EPA as one of Victoria's dirtiest creeks[16]. Located on the Mornington Peninsula, southeast of Melbourne, Watson Creek flows through a relatively small catchment dotted with market gardens. The creek ends at the Yaringa Marine National Park in Western Port Bay. Yaringa Marine National Park is an internationally recognised Ramsar site valued for its habitat for migratory birds and includes extensive mangrove, saltmarsh, seagrass and mudflat communities.

The 'very poor' condition of Watson Creek has been identified as a high risk to the Yaringa Marine National Park[17] and vegetable farms along Watson Creek are thought to be significant contributors to water quality. Vegetable growers are now taking action to improve the condition of Watson Creek. The Watson Creek Agreement was established in 2007 taking a 'no blame and equal responsibility' approach to improving water quality and was signed by 18 stakeholders including public and private land managers, vegetable growers, industry and community groups.

A water-monitoring program along the entire length of the creek monitors the links between landholder activity and water quality, the outcomes of which are used to prioritise engagement with landholders and nutrient reduction activities. This has resulted in vegetable growers undertaking riparian erosion works, weed removal and revegetation activities. Additionally a number of EnviroVeg certified growers on the creek have reviewed their crop management and drainage systems to protect the creek.[18]

The Watson Creek project is now well regarded as a template for community and stakeholder engagement on issues of sensitive waterways that is suitable for vegetable growers all over Australia. The project has also prepared practice guides for vegetable farming near sensitive waterways and material on vegetable crop nutrient requirements[19].

5.3.3 Soil and nutrient management

Australia's soils and their condition vary greatly across Australia. Soil condition is the result of complex interactions between three key soil properties (physical, chemical and biological), which are influenced by environmental factors, inherent soil properties, land use type and management practices. Measuring the condition and trends of soils is currently difficult as a result of their diversity and the availability of data.

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows an increasing trend in the adoption of recommended practices specified in the Soil and Nutrient Management component of the EnviroVeg self-assessment (increase from 89.6% of EnviroVeg members in 2012 to 91.3% in 2014). ABS data reports evidence of increasing trends of the adoption of practices, which contribute to improved soil health (Table 5-6). This includes regular testing of soil to inform management decisions, implementing controlled traffic and actively maintaining groundcover.

Table 5-6: Environmental performance of the vegetable industry at the short-term outcome level for soil and nutrient management

Management practices	Performance (proportion of vegetable growing businesses) [4]
Soils are tested regularly for pH, organic matter, nutrient levels, salinity and sodicity	8% undertake soil tests for moisture content 28% undertake soil tests for nutrient levels 25% undertake soil tests for organic matter levels 30% undertake soil tests for pH 22% undertake soil tests for salinity levels
Cultivation and traffic is managed appropriately	22% implementing controlled traffic farming, covering an area of 69,532 ha
Groundcover is maintained	14% leave crop residue in tact, covering an area of 55,989.38 ha
	8% met their ground cover target for 0-6 months of the year, covering 33,916 ha 3% met their ground cover target for 7-9 months of the year, covering 45,192 ha 3% met their ground cover target for 10-11 months of the year, covering 24,591 ha 6% met their ground cover target for 12 months of the year, covering 27,293 ha
	Average minimum ground cover target set is 75.1%
	35% use alternative or cover crops to maintain groundcover 23% use mulching and/or matting to maintain groundcover
Appropriate fertilisers/amendments are used and applied efficiently	29% make fertiliser decisions based on consultant recommendations 17% make fertiliser decisions based on leaf or stem sampling 31% make fertiliser decisions based on soil tests

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-7.

Table 5-7: Environmental performance of the vegetable industry at the medium-term outcome level for soil and nutrient management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement[8]	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. Soil structure and organic carbon is improved	Soil structure	↗		Insufficient quantitative data available					
	Organic carbon	↗	Soil carbon in topsoil averages 2.65% across the top 13 vegetable growing NRM regions. This result is significantly higher than the national average of 0.94%, and supports the finding that horticulture and irrigated horticulture have the largest average organic C stocks in comparison to other agriculture. Presented as a case study ***"Garden organic compost improves soil quality in the Sydney Basin"***			★		✔	✖
2. Groundcover and biomass production is increased	Groundcover (%)	↗		Insufficient quantitative data available					
	Biomass production (tonnes)	↗		Insufficient quantitative data available					

Summary

The carbon content of soil is a key indicator of its health, and is a variable that controls many processes (e.g. nutrient cycling, development of soil structure, water storage). The average amount of organic C in Australian topsoil (0–30 cm) is estimated to be 29.7 t/ha or 0.94%. An analysis of organic C for types of land use shows that areas that are under horticulture and irrigated horticulture have the largest average organic C stock. Their total stocks, however, are small reflecting their small areas. Soil carbon in topsoil averages 2.65% across the top 13 vegetable growing regions[20]. This is significantly higher than the national average of 0.94%, highlighting high organic C stocks of horticulture.

Case Study: Garden organic compost improves soil quality in the Sydney Basin

The Sydney basin has a long history of vegetable production contributing 42.5% of the value of NSW's total vegetable production. Conventional vegetable farming systems in Sydney commonly involve frequent tillage and high inputs of poultry manure and inorganic fertilisers.[21] Over time, surveys have identified significant soil degradation as a result of these practices, in particular depletion of organic carbon and accumulation of extractable phosphorous (P).[22]

A field trial was established in the Sydney Basin (between 2005 and 2013) to evaluate the effectiveness of garden organic compost as an alternative soil input for vegetable production in the Sydney basin. The trial demonstrated that large applications of blended garden organic compost significantly improved soil quality (soil structure, chemistry, biology) and increased the ability of the soil to hold cations, improved structural stability, reduced the rate of soil acidification and improved the buffering capacity of the soil compared to conventional farmer's practice.[23]

5.3.4 Pest and disease management

The key risk identified in the environmental risk assessment completed for the top 13 vegetable growing regions was the impact of pest plants and animals on biodiversity assets on or surrounding vegetable growing properties. There is little information available on the distribution of pests and diseases in vegetable growing regions at a national scale. Consequently, environmental performance has focused on the change in management practices including the greater emphasis on monitoring of pests and diseases, more targeted use of chemicals and the adoption of IPM.

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows an increasing trend in the adoption of recommended practices specified in the Pest and Disease Management component of the EnviroVeg self-assessment (increase from 84.7% in 2012 to 86.6% in 2014).

Further analysis of the adoption of recommended practices using ABS Land Management and Farming data specific for vegetable growers is provided (Table 5-8).

Table 5-8: Environmental performance of the vegetable industry at the short-term outcome level for pest and disease management

Management practices	Performance (proportion of vegetable growing businesses)[4]
Pests are managed in areas of native vegetation and waterways	9% undertake pests or feral animal control to protect native vegetation, covering 43,585 ha 12% undertake weed control to protect native vegetation, covering 43,194 ha 5% undertake pests or feral animal control to protect rivers and creeks, covering 3,367 ha 9% undertake weed control to protect rivers and creeks, covering 7,718 ha

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-9.

Table 5-9: Environmental performance of the vegetable industry at the medium-term outcome level for pest and disease management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. The incidence of pests and diseases on vegetable farms is reduced	Pest and disease distribution in vegetable growing regions		Presented as a case study *"**An Integrated Pest Management (IPM) approach in Brassica crops**"*	Insufficient quantitative data available					

Summary

There is minimal information available on the incidence of pests and diseases in the vegetable growing regions of Australia. However, the management of pests and diseases is integral to the on-going sustainability and profitability of the industry. Whilst there has been considerable progress in the adoption of improved practices associated with understanding how pest and disease ecology and IPM, there is still significant room for improvement.

The management of weeds continues to be an area that the industry needs to focus on, as is ensuring that pests, diseases and weeds have minimal impact on areas of native vegetation and waterways.

Case Study: An Integrated Pest Management (IPM) approach in Brassica crops[24]

Pest and disease management has changed significantly over the past decade. Traditionally the management of pests and diseases relied on the use of chemicals to eliminate the problem and minimise the impact on crop production. As reliance on chemicals increased however, so did the development of resistance by specific pests to chemical complexes.

Increasing incidence of resistance and concerns on the impacts of chemicals on the environment prompted the industry to consider alternative approaches. Researchers and growers have worked collaboratively to develop solutions to the management of pests and diseases that involves targeted application of chemicals at specific times and a more detailed understanding of the pest growth patterns and their biological enemies. This has been referred to as Integrated Pest Management (IPM).

IPM involves a more sophisticated level of management involving:

- Consideration of specific chemical complexes
- Monitoring of pests and beneficial insects to assess populations over time
- Release of beneficial insects as predators of the specific pests
- Targeted application of chemicals at specific times.

The implementation of IPM has changed how pests and diseases are managed by vegetable growers leading to:

- Focus on economic thresholds and incidence rather than removal of pests
- Reduced reliance on chemicals
- Decline in the resistance of pests.

5.3.5 Chemical use management

A significant risk associated with chemical use is the movement of chemicals with water or wind into waterways - where they become potential pollutants, or surrounding native vegetation - where they can impact on native species. The community places a high priority on the responsible management of chemicals. Inappropriate chemical use can be a significant cause of conflict with neighbours and the wider community. Chemical use is also strictly controlled by legislation.

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows an increasing trend in the adoption of recommended practices specified in the Chemical Use Management component of the EnviroVeg self-assessment (increase from 92.7% in 2012 to 97.1% in 2014).

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-10.

Table 5-10: Environmental performance of the vegetable industry at the medium-term outcome level for chemical use management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. The use of chemicals (in particular S6 and S7) is reduced	Pesticide sales, in tonnes of active ingredients	↙	Presented as a case study ***"Alternative to chemical fumigants in the Adelaide Plains region"***	Insufficient quantitative data available					

Summary

There is minimal information available on the performance of the industry with respect to management of chemicals. However, the EnviroVeg information suggests that growers are generally adopting good practices in relation to chemical use management. Ideally, the monitoring of the use of S6 and S7 chemicals over time would provide evidence for how the industry is performing from an environmental perspective. It is possible that this type of information could be collected and collated by the chemical suppliers and/or the Australian Pesticides and Veterinary Medicines Authority (APVMA) in the future.

Case Study: Alternative to chemical fumigants in the Adelaide Plains region

The Adelaide Plains is home to around 1200 greenhouse farms producing capsicums, cucumbers, tomatoes and eggplants. The majority of these farms are still growing vegetables “in soil” (as opposed to “above soil” set-ups) and the application of “old style” broad-spectrum fumigants such as metham sodium for disease and pest control remains common practice.

Metham sodium is commonly used as a soil fumigant, pesticide, herbicide and fungicide in intensive vegetable crops and in greenhouse production systems. Affordability, ease-of-application and perceived effectiveness in the control of nematodes, soil borne diseases and weeds are key drivers for its use[25]. Consumer demand for low cost, good quality, nice-looking vegetables and a decrease in soil quality and inherent disease suppressing soil properties also drives a reliance on chemical fumigants.

The environmental and human health implications of metham sodium are however widely reputed and the chemical is now banned in many European Union countries. Metham sodium has a high mobility in the soil; it’s effectiveness and longevity in the soil is uncertain and it may leach to groundwater and/or runoff to nearby waterways. Metham sodium can also impact important nitrogen cycling microorganisms in the soil. In the United States, metham sodium is listed as a carcinogen and development toxicant and can cause a wide variety of human health effects. In Australia metham sodium is considered a Schedule 7 (Dangerous poison).

There are other concerns too. In the Adelaide Plains, greenhouse growers have experienced enhanced biodegradation of metham sodium, a common issue whereby specialist microbes inactivate the active ingredient MITC quickly, rendering the chemical largely ineffective. The application of metham sodium is also often poorly understood leading many growers to apply it incorrectly through irrigation infrastructure and in greater quantities than is required. This can be costly.

In response, a shift is occurring in the Adelaide Plains with around 10% of growers now experimenting with more integrated pest management approaches. This includes introducing cover crops, often brassicas, in between rotations to provide natural biofumigant assistance, and applying a quality compost to boost organic soil carbon. Local grower Phuong Vo has not fumigated for four years but has experienced a 66% yield improvement. He attributes this to the introduction of crop rotations such as barley and sorghum and applying quality compost, among other practices.[26]

There is still a long way to go before a more widespread shift is seen in the Adelaide Plains, but there is a feeling that the region is on the verge of a big change. Growers, such as Phoung, are leading the way in demonstrating the benefits of shifting from chemical reliance to a more integrated approach that boosts yields, reduces costs, improves organic soil carbon and benefits the environment.

5.3.6 Biodiversity management

Biodiversity is the variety of life. Australia's biodiversity is globally significant in both the terrestrial and marine environments. Many of the major vegetable growing regions in Australia are associated with high value environmental assets such as areas of native vegetation that provide shelter and habitat for pollinating insects and biological control agents or threatened native vegetation communities. These important assets are threatened by vegetation clearing, causing further fragmentation of remaining native vegetation and loss of habitat for native species. The spread of weeds and pest animals as well soil erosion and salinity also further degrade the quality of remaining biodiversity assets.

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows an increasing trend in the adoption of recommended practices specified in the Biodiversity Management component of the EnviroVeg self-assessment (increase from 77.5% in 2012 to 86.6% in 2014). Further analysis of recommended practices using ABS Land Management and Farming data specific for vegetable growers is provided (Table 5-11).

Table 5-11: Environmental performance of the vegetable industry at the short-term outcome level for biodiversity management

Management practices	Performance (proportion of vegetable growing businesses)[4]
Existing areas of remnant native habitat and vegetation (including wildlife corridors, riparian areas, lakes, wetlands or significant water habitat) are protected	36% of native vegetation is protected for conservation purposes
	29% of businesses protect native vegetation for conservation purposes
Native habitat and vegetation is restored, increased and connected where possible	15% of businesses have revegetated with native vegetation, covering an area of 29,113 ha

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-12.

Table 5-12: Environmental performance of the vegetable industry at the medium-term outcome level for biodiversity management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement[27]	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. The extent of native vegetation is maintained	Area of native vegetation within intensive land use zones	→	The current extent of native vegetation averages 52% of its pre 1750 extent across the top 13 vegetable growing NRM regions.		★			✔	✖
2. The condition of native vegetation is maintained	Condition of native vegetation within intensive land use zones	→	The proportion of each major vegetation group classified in VAST categories I or II (unchanged or modified) averages 35% across the top 13 vegetable growing NRM regions.		★			✚	✖
3. Habitat for threatened species is maintained	Current extent of threatened species	→	Presented as a case study ***"Enhancing biodiversity values in the Lockyer Valley"***	Insufficient quantitative data available					

Measuring the state and trends of biodiversity is currently difficult as a result of data limitations. Information on individual species, groups of species and habitat quality remains very poor, although information on extent and condition of broad vegetation types is good in many respects and improving.

Australia's native vegetation has been modified to varying degrees by different land uses and management practices throughout the country's human history. Since European settlement, some 13% has been completely converted to other land uses, and a further 62% is subject to varying degrees of disturbance. The extent of remnant native vegetation averages 52% of its pre 1750 extent across the top 13 vegetable growing regions. This result is comparable to intensive-use zones of the eastern and southern mainland, and the midlands and north of Tasmania.[28]

Vegetation condition has been assessed by examining the degree of vegetation modification. In the top 13 vegetable growing regions, an average of 35% of vegetation is classified as Vegetation Assets, States and Transitions (VAST) category I or II (unchanged or modified). The greatest extent of least-modified vegetation is in the north and centre of the continent, along the eastern and south-western ranges of mainland Australia, and in the eastern ranges and south-west Tasmania. In these zones, an average of 80% of vegetation is classified as VAST category I or II (unchanged or modified).

Summary

Biodiversity decline is most commonly associated with vegetation clearing for crops resulting in species and habitat loss and fragmentation of remaining remnant native vegetation. Other threats include cultivation and traffic, sediment movement, pesticide and fertiliser drift, and weeds and pest animals. Positively, there is increasing awareness of practices, which contribute to protection and enhancement of biodiversity on vegetable farms, and evidence of increasing trends of the adoption of practices which contribute to this goal.

Case study: Enhancing biodiversity values in the Lockyer Valley

The Lockyer Valley is one of the most fertile agricultural regions in Australia and grows the most diverse commercial range of vegetables and fruit of any region in the country.[29] Horticulture in the Lockyer Valley is underpinned by rich natural resources such as the dark alluvial soil, good quality water and ideal growing climate[30].

Biodiversity values within the Lockyer Valley are also high. There are a number of distinct ecosystems ranging from fringing forests to blue gum woodlands on the alluvial plains to brigalow and dry scrub communities on elevated alluvial terraces and patches of rainforest and semi evergreen vine thickets in escarpment areas.[31]. Native vegetation plays a crucial role in sustaining vegetable production systems, providing a number of important ecosystem services. This includes nutrient cycling, competition for weed species, shelter from weather, and buffers to slow runoff and absorb nutrients such as nitrogen and phosphorous. Native vegetation is also important for providing habitat for beneficial insects and pollinators.

Growers in the Lockyer Valley are beginning to recognise the important ecosystem services that native vegetation provides to their production systems undertaking revegetation and restoration works on their properties. The value of the revegetation works is two-fold. Not only are the revegetation works enhancing local biodiversity values and providing important habitat for flora and fauna species, they are also contributing to improved water quality, soil retention and bank stabilisation along the creek.

5.3.7 Waste management

Vegetable production can result in the creation of large amounts of unwanted materials or waste products. Waste can create problems for growers (related to disposal), the community more general and the environment. Specific risks to natural assets are diffuse and indirect, with the potential to impact the health of all natural assets, and ecological function as a whole. The primary aim associated with good waste management is that waste products are avoided, minimised, reduced, reused or recycled wherever feasible or are disposed in a manner in line with community expectations and legislation[32]. There are two main sources of waste being organic waste generated through the production and processing of vegetables and waste related to inputs used in vegetable production systems (e.g. plastics, chemicals).

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows a stable trend in the adoption of recommended practices specified in the Waste Management component of the EnviroVeg self-assessment (90.0% in 2012 and 2014).

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-13.

Table 5-13: Environmental performance of the vegetable industry at the medium-term outcome level for waste management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. The production of organic waste through farm production systems, packing and processing is reduced	Organic waste (tonnes, % of total production)	↙		Insufficient quantitative data available					
2. The generation of waste from input products on farm is reduced	Input product waste (tonnes)	↙	Presented as a case study ***"Managing plastic waste in the Australian vegetable industry"***	Insufficient quantitative data available					
3. Waste is disposed of responsibly	Landfill (tonnes)	↙	Presented as a case study ***"Feasibility of generating biogas from organic waste in the vegetable industry"***	Insufficient quantitative data available					

Summary

It is estimated that over 277,000 tonnes of the major vegetable lines[a], representing around 25% of production, is 'lost' each year, at a cost to growers of $155million. There is minimal information available on the scale of this issue and whether it is becoming greater. The industry has considered the feasibility of alternative use of vegetable waste on-farm (such as electricity generation), for human consumption (such as extraction of volatile compounds and food flavours), for animal feed (such as fish food), and/or processing and reuse of waste as soil amendment (such as biochar)[33].

Similarly, there is minimal information on the generation of waste from input products. However, recent analysis would suggest that plastic waste products are a significant problem for the industry with estimates of 2,600 tonnes/year of drip irrigation and 1,550 tonnes/year of plastic mulch being produced[34]. Recycling and alternative products are options currently considered by the industry.

Case Study: Managing plastic waste in the Australian vegetable industry[34]

The quantity of plastic used in the agricultural sector is a small component of overall plastics consumed nationally. In 2012-13 a total of 1,477,800 tonnes of plastics were consumed in Australia. Of this total tonnage the agricultural sector consumed 4%, or 59,112 tonnes. A total of 307,300 tonnes, or 20.8%, of the total plastics consumed were recycled, 145,600 tonnes of which was recycled in Australia. Of the plastics recycled within Australia the agricultural sector generated 3,800 tonnes or 2.6%.

A modelling analysis determined that:

- Drip irrigation is the largest component of plastic use with a total of approximately 2,600 tonnes/year (48%)
- Mulch sheeting comprises 28% of total plastic use on-farm (approximately 1,550 tonnes/year)
- Permanent irrigation is a small component of plastic use with 945 tonnes/year (17%)
- The remaining 7% (403 tonnes/year) is comprised of miscellaneous other plastic such as protective/flooring sheeting, labels and clips.

Plastics recycling in the vegetable sector is particularly challenged by the geographical spread of farms and their distance to ports or recycling centres, the timing of that plastic availability which may differ by farm and by crop, the contamination load or cost of decontamination, and lack of information in the supply chain.[b]

Case study: Feasibility of generating biogas from organic waste in the vegetable industry[35]

There is significant interest within the vegetable industry in maximising value from waste streams. Previous analysis has suggested that generating biogas from on-farm vegetable waste could be a cost-effective option for vegetable farms. Biogas is methane and carbon dioxide produced from the bacterial degradation of organic waste. Using anaerobic digestion, the process produces electricity, heat and a residual organic product.

An analysis was undertaken highlighting that:

- Feasibility is highly variable but is potentially feasible for larger operations
- Other factors contribute to feasibility such as crop type, consistency of waste supply and energy use, and the current costs of waste management
- Regulatory burden is not excessive
- Digestate use and management will require careful consideration.

The feasibility of biogas on-farm will depend upon the specifics of each operation including scale of operation, type of waste, electricity value, nature of current waste management and consistency in feedstock and electricity use.

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[a] Key vegetable lines: Carrots, capsicums, cauliflower, sweet corn, cabbage, baby leaf – transplant (TP), lettuce, broccoli, beans, beetroot, and baby leaf – direct seed (DS).

[b] Growers may not have information about parties interested in retrieving plastics from their farm, and plastics collectors may be unaware of each farm's plastic waste on a supply route.

5.3.8 Air quality management

Air quality is a measure of the concentration of selected pollutants in the atmosphere. Risks associated with air quality are diffuse and indirect, with the potential to impact the health of all natural assets, and ecological function as a whole. Potential threats to the environment from air quality include air pollution in the form of dust, noise, spray-drift, odour, light and greenhouse gas (GHG) emissions.

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows an increasing trend in the adoption of recommended practices specified in the Air Quality Management component of the EnviroVeg self-assessment (increase from 85.5% of EnviroVeg members in 2012 to 91.7% in 2014). Further analysis of recommended practices using ABS Land Management and Farming data specific for vegetable growers is provided (Table 5-14).

Table 5-14: Environmental performance of the vegetable industry at the short-term outcome level for air quality management

Management practices	Performance (proportion of vegetable growing businesses)[4]
Appropriate fertilisers/amendments are used and applied efficiently	29% make fertiliser decisions based on consultant recommendations 17% make fertiliser decisions based on leaf or stem sampling 31% make fertiliser decisions based on soil tests
Carbon sinks are established or maintained	15% have revegetated with native vegetation, covering an area of 29,113 ha

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-15.

Table 5-15: Environmental performance of the vegetable industry at the medium-term outcome level for air quality management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement[11]	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. Energy use across the life cycle of vegetable production, manufacture and transport is decreased	Tonnes of equivalent carbon dioxide (CO_2e) per year	↙	Estimation of the total vegetable industry on-farm emissions was 1.114 Mt CO_2e in 2008. This was just 1.32% of the total agricultural emissions (84.5 Mt CO_2e). When manufacture and distribution of vegetables is included the estimated emissions for the supply chain is 7.25 Mt CO_2e.			★		✚	✚
2. Total nitrous oxide (N_2O) emissions are decreased	Tonnes of CO_2e per year from N_2O emissions	↙	Estimation of N_2O emissions from applied N fertiliser use in 2008 was 188,000 t CO_2e (or 17% of total emissions for the year).			★		✚	✚
3. Air pollution (from odour, dust, smoke, noise and light) is decreased	Air pollution	↙	The impact by vegetable production is highly localised – whereby a specific practice may cause very localised air pollution, such as dust movement or spray-drift.	Insufficient quantitative data available					

Greenhouse gas emissions are presented as carbon dioxide equivalent (CO_2e) including carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), perfluorocarbons (PFC), hydrofluorocarbons (HFC) and sulphur hexafluoride (SF_6). Greenhouse gas emissions from vegetable production have been estimated with the total vegetable industry emissions for 2005 being 1.05 Mt CO_2e in 2005[36] and 1.114 Mt CO_2e in 2008[37]. This equated to 1.2-1.3% of the total agricultural emissions for both years (87.9 Mt CO_2e and 84.5 Mt CO_2e respectively[38]).

The amount of nitrogen fertiliser applied increases the potential for nitrate production and N_2O emissions. A study conducted in 2010[37] estimated that emissions from applied N fertiliser use were 188,000 t CO_2e (or 17% of total emissions for the year). The rate of denitrification is also influenced by the amount of water and available carbon with higher levels leading to greater N_2O production.

There is currently no comprehensive measure for the contribution of vegetable production to air quality at an industry level. The impact by vegetable production is often too localised – whereby a specific practice may cause very localized air pollution, such as dust movement or spray-drift.

Summary

Although vegetables are a small contributor of GHGs at the national level, and low in comparison to some other food types, they utilise intensive farming practices and there are likely to be opportunities to reduce emissions on a production basis. There are also opportunities for efficiencies across the supply chain, such as selection of refrigeration equipment and maintenance measures.

High nutrient input, irrigation and cultivation can cause rapid oxidation of stable soil carbon (C) and nitrogen (N), which leads to elevated CO_2 and N_2O emissions. Managing nitrogen in an intensive crop production system requires continual analysis and monitoring of the yield and quality of each crop, together with the consideration of the soil type and local environment. This needs to be balanced with efficient irrigation and soil management practices.

Good soil health and cropping practices, such as minimum tillage, are encouraged to improve soil carbon levels and build good soil structure required for root growth and water holding capacity. These practices also have the potential to address other forms of localized air pollution, such as dust, smoke and odour.

The data provided in relation to management practices would suggest that growers have improved their practices but that there still significant opportunity to do better.

5.3.9 Energy use management

On-farm energy efficiency is becoming increasingly important in the context of rising energy costs and concerns over greenhouse gas emissions. Australian vegetable growers are major consumers of electricity with on-farm irrigation, heating and cooling processes and, for larger growers, processing and packing plants creating significant power demands. The risks associated with energy use, are diffuse and indirect, with the potential to impact the health of all natural assets, and ecological function as a whole.

Short-term outcome level

Analysis of EnviroVeg data over the last three years shows an increasing trend in the adoption of recommended practices specified in the Energy Use Management component of the EnviroVeg self-assessment (increase from 83.8% in 2012 to 87.2% in 2014).

Medium-term outcome level

The environmental performance of the vegetable industry at the medium-term outcome level is described in Table 5-16.

Table 5-16: Environmental performance of the vegetable industry at the medium-term outcome level for energy use management (refer to Table 5-2 for definition of symbols)

Outcome	Indicator	Target	Measurement[39]	Performance					
				Grade				Confidence	
				Very poor	Poor	Good	Very good	In grade	In trend
1. Farm energy use (electricity use) is decreased	Electricity cash costs	↙	The average energy overhead per farm was 2.46% in 2011-12 (range 1.68-3.51% depending on the State/Territory). The electricity overhead per farm was similar for 2012-13 (3.44%) and 2013-14 (3.54%).			★		✔	✜
2. Farm energy use (fuel, oil and grease) is decreased	Fuel, oil and grease cash costs	↙	The average fuel, oil and grease overhead per farm was 5.63% in 2011-12 (range 4.07-8.75% depending on the State/Territory). The overhead per farm was up from 2010-11 (4.75%), but lower than for 2012-13 (6.27%) and 2013-14 (6.43%).		★			✔	✜
3. Farm energy efficiency is increased	Energy per tonne output and/or per hectare	↗	Mean energy consumption was 2.1GJ per tonne of processed vegetables. This was based on energy audit of 22 vegetable growers in 2014. Presented as a case study *"**Case studies of on farm power generation**"*						

The average energy overhead per vegetable farm in 2011-12 was 2.46% for electricity and 5.63% for fuel, oil and grease. These overheads are small compared to the three highest cash costs per farm in 2011-12 - hired labour (16.86%), contracts paid (9.66%) and fertilizer (8.98%).

Variability also exists for estimates of energy efficiency. The mean consumption of energy was estimated at 2.1 GJ per tonne of processed vegetables[40]. However, this was estimated using a small sample of growers and highlighted a significant range in energy use across these businesses.

Summary

It is clear that the vegetable industry is already addressing the opportunities for energy efficiency on-farm. There is large variation in energy efficiency across all aspects of grower operations and therefore opportunities for those with high energy consumption to reduce this and improve business viability. Building on recent studies (in the areas of energy benchmarking, biogas, on-farm power generation), the vegetable industry is well positioned to advance adoption of energy efficiency practices.

Case study: Case studies of on farm power generation[41]

A recent study developed case studies in which the technical and financial performance of different forms of on farm power generation were analysed. The following forms of on-site power generation were analysed.

1. **Solar photovoltaics (PV):** Analysis of two existing solar PV plants confirms the attractive financial performance of these investments due in one case to relatively low capital expenditure and the high price of the network electricity that it displaces. The price of the displaced network electricity is critical.
2. **Battery storage:** Two battery storage case studies were considered – the first involving storage of solar PV generated electricity that is currently not consumed on-site and the second assumed installation of a battery storage system in combination with additional solar PV. The analysis found that the likely financial performance of the first battery storage plant was very poor. However, battery storage in combination with additional solar PV installation appeared to have significantly better prospects, although it is still currently likely to be a poor investment.
3. **Simple and cogeneration using a LPG or natural gas fuelled reciprocating engine generators:** Three types of on-site power generation using reciprocating engines were considered; simple (i.e. electricity only) generation, cogeneration of electricity and process heat, and cogeneration of electricity and process cooling. All of these three types of power generation performed very poorly if LPG was used as the fuel.
4. **Wind turbines:** Several growers in Tasmania, New South Wales and Western Australia already have wind turbines on their farms. These turbines are of a wide range of sizes and featured a wide range of financial performance. The most favourable installations have already demonstrated attractive financial performance through a combination of using second hand, and thus cheaper, turbines and acceptable local wind resource. Since local wind conditions are so variable and uncertain, caution is therefore warranted.

Viewed as a whole, these case studies demonstrate significant potential for on farm power generation, particularly from solar PV, wind and cogeneration. Nonetheless, care must be taken when examining the likely performance of any of these investments, with the following particularly important:

- The assumed capital expenditure of any form of on farm power generation should be that required to fully install and operate the plant. This expenditure is almost always significantly higher than the uninstalled plant cost alone, and usually has a significant impact on the plant's viability.
- The financing of the plant needs to be carefully considered, particularly in terms of the tax implications for the entity owning the plant and the proportion of debt financing. Indeed, 100% debt financing may be preferable, and is a common practice amongst the growers interviewed.
- Growers commonly use the payback period as the sole measure of the performance of an investment. Whilst this is a clear and useful metric, it can result in attractive investments being overlooked, particularly if the required payback period is too short.

6 Discussion

There are strong drivers for the industry to monitor its environmental performance. For the industry to improve its performance and minimise the impact on the environment it needs to be able to measure trends over time and report on these to different audiences.

It is also critical that assessment can be made at different scales being:

- Individual farm – particularly to monitor change in attitudes and practices
- Regional – to assess impacts on key environmental assets
- Industry – to determine the performance at a whole of industry level.

A framework has been developed to undertake this monitoring for the industry over time. The framework focuses on short-term indicators (management practices) and medium term indicators (physical condition of assets).

The framework provides a structure that will address the needs of the different stakeholder groups relevant to the vegetable industry. Through the initial consultation, these groups stated that the industry has made progress in demonstrating its environmental performance but there is still some work to be done. The industry Environmental Assurance and BMP programs were highlighted as providing a strong foundation. However, the need to further demonstrate that industry participants are good environmental custodians and provide evidence and information to consumers and retailers was strongly supported by growers and the supply chain participants.

The key themes that the stakeholders considered to be important issues of focus were:

- Water use and waterway management
- Soil and nutrient management
- Chemical use management.

Issue that were of interest but to a lesser extent were:

- Waste management
- Energy management.

The performance report describes the important indicators to measure to assess the environmental performance of the industry for each of the eight themes. Where possible information was collected against each of the environmental themes for both the short-term and medium-term indicators.

The analysis highlighted that there are significant information gaps at both these levels due to the lack of nation wide data which is collected and collated.

When considering the adoption of management practices (short-term outcomes) the analysis relied on high level information from EnviroVeg and more detailed analysis from ABS Land Management and Farming. It should be noted that the data collected from EnviroVeg is biased towards those that are interested in environmental management issues. However, as the growers involved in EnviroVeg constitute a large proportion of the vegetable production area, we consider that this data is of relevance and will continue to be so as more growers become involved. The ABS data represents the entire vegetable production businesses and is therefore more robust. Whilst this initial assessment reported on a small proportion of management practices, the framework now exists to utilise future collection of information through EnviroVeg and ABS data.

At the medium-term outcome there were again gaps in information relating to the condition of assets. However, where data was available, the analysis demonstrated that the industry was performing strongly and there were indications that trends were in the right direction.

The environmental performance of the vegetable industry was good to very good for:

- Water use and waterway management – industry water use (ML) and water use per area (ML/ha)
- Soil and nutrient management – organic carbon (t/ha)
- Air quality management - tonnes of CO_2e per year and tonnes of CO_2e per year from N_2O emissions
- Energy use management – electricity costs.

Environmental performance for the industry was rated as poor for:

- Biodiversity management – area and condition of native vegetation
- Energy use management – fuel, oil and grease costs.

Notably, water use and waterway management, soil nutrient management and energy use management are issues that were nominated during the consultation with industry stakeholders as high priority.

The industry case studies (snapshots) describe the work that is being done in achieving positive environmental outcomes. These case studies were developed where quantitative information was not available. They tell a story about the steps that the industry is making towards positive environmental management.

This performance report provides the first environmental assessment for the vegetable industry. The report:

- Highlights the important environmental issues for different stakeholder groups and issues that are emerging
- Confirms a structure for reporting on these environmental issues
- Provides a methodology to repeat the environmental assessment
- Identifies gaps in our information.

The industry is now aware of what information needs to be collected in order to report on its environmental performance and with recommendations on how to fill these gaps.

Significant gaps in environmental reporting were identified in the monitoring of chemical use and waste management at both the short-term and medium-term outcome level.

The framework provided to industry will enable it to report on its environmental performance and work productively with environmental managers, the market and other stakeholders to promote its environmental credentials.

The industry will need to work with other stakeholders to establish monitoring methods to fill gaps in reporting and identify practices that will improve the performance of the industry in some areas. Recommendations have been provided to facilitate this next step.

7 Next steps

7.1 Recommendations

A number of recommendations have been developed to address the gaps in knowledge identified whilst undertaking the environmental assessment and assist completion of future environmental assessments.

7.1.1 Promoting good performance

Summary

Environmental performance at the medium-term outcome level was good to very good for:

- Water use and waterway management
- Soil and nutrient management
- Air quality management
- Energy use management (electricity).

Recommendation

In order to benefit from the performance of the industry it is recommended that the industry:

- Promote the areas of good performance using the information provided and the industry snapshots (case studies) to government organisations and retailers
- Stress the point that the industry is ‘self-regulating’ and through the expansion of the EnviroVeg program will maintain or further improve performance in these areas.

7.1.2 Improving performance

Summary

Environmental performance at the medium-term outcome level was rated as poor for:

- Biodiversity management
- Energy use management (fuel, oil and grease).

Recommendation

To ensure that growers continues to improve their performance it is recommended that the industry:

- Provide information to vegetable growers on benefits of vegetation on farms such as Integrated Pest Management (IPM), reduced wind and water stress on crops and reduced loss of soil carbon. Current CSIRO research may be used to underpin these aspects. Data on financial benefits of on-farm biodiversity management should be included as available. Importantly, NRM regions often offer financial assistance in the area of biodiversity management, especially if a landscape scale approach is taken.
- Much of energy used on vegetable farms is for running irrigation pumps, tillage and coolrooms. There are considerable efforts at the moment in providing growers with information on how to conduct an energy audit and especially how to measure and increase pump efficiency. Current extension work on soil condition management and Integrated Crop Protection (ICP) will help in reducing tillage needs and tractor usage for crop protection purposes. Information and tools that assist growers in improving their energy management are critical.

7.1.3 Gaps in knowledge

a) Environmental themes

Summary

The monitoring highlighted that there are serious gaps in data associated with a number of themes. Of particular relevance to industry stakeholders were:

- Nutrient management
- Chemical management
- Waste management.

Recommendation

To address the significant gaps in information in specific themes the following approaches are suggested:

- Information gaps on nutrient management may be filled by continuing discussions with Australasian Soil and Plant Analysis Council (ASPAC) about the potential use of soil testing data and talking to the fertiliser industry association of Australia about their data capture on sales to vegetable farm. The focus for this information should be on nitrogen (N) and phosphorus (P)
- Promote the fact that waterway quality in vegetable production areas is good, suggesting that vegetable production has minimal offsite impacts. If water quality is an issue in any catchment or subcatchment there is an opportunity to run nutrient management courses for vegetable growers. Several are planned as part of the current extension project on soil condition management (VG13076) and growers and advisers identified nutrient management as areas they want to know more about. There may be potential to work with the NRM region in resourcing and delivery of these courses
- Indirect information on chemical management data may be obtained via the national residue survey. However this does not inform about potential off-site impacts. Currently, a pilot project is planned on using reference farms to collect data on pest, disease and weed issues and data on pesticide use may be included in data collection. Discussion with CropLife Australia may be helpful in determining how the AgChem industry may assist in data collection.
- The Strategic Agrichemical Review Process (SARP) may be used in future to obtain data e.g. on the use of S6 and S7 chemicals.

b) Short-term outcomes

Summary

Short-term outcomes are listed in Table 4-3 and Table 5-1. This level focused on an analysis of quantitative and qualitative data including on farm management practices collected and collated at a national scale. Data included:

- Purchase and analysis of ABS data on management practices by NRM region
- Analysis of EnviroVeg data as available.

Recommendation

To address the gaps in information at the short-term outcome level it is recommended that:

- Discussions be undertaken with ABS on the potential for Horticulture Innovation Australia (HIA)/AUSVEG to purchase additional questions for the ABS Land Management and Farming survey for particular management practices of interest to the vegetable industry
- EnviroVeg data be analysed at the management practice level and included in the next environmental assessment. The opportunity exists to analyse the information that is/has been collected during the life of this vegetable levy funded program. Whilst EnviroVeg data currently may not be as statistically robust as ABS data it could provide some important trends. Given the program is accepted by one of the major retailers (EnviroVeg Platinum), the program's information could be used to strengthen its credibility with retailers, consumers and government agencies. Using the data to promote the industry's credentials would further strengthen the relevance of the program. The environmental assessment framework created as part of this project therefore links directly to the EnviroVeg themes and management practices. This link was created to ensure that the information from this project is highly relevant to previous and existing investments and efforts by and for the vegetable industry.

c) Medium-term outcomes

Summary

Medium-term outcomes are listed in Table 4-4 and Table 5-2. This level focused on the analysis of existing quantitative data sources that are collected and collated at a national scale using statistically adequate methods. This data can be analysed on a national level or by NRM regions and included:

- Analysis of Australian native vegetation extent and condition data
- Analysis of recently released CSIRO (November 2014) data on soil carbon
- Analysis of ABS data on many other themes consistent with EnviroVeg themes where it is readily available (e.g. ABS Water Accounts)
- Review and analysis of prior R&D projects that contained relevant data.

A number of other potential sources of data (e.g. Quality Assurance (QA) schemes, chemical import shipping data, ASPAC) were pursued but were not suitable for inclusion due to: insufficient data and or national coverage to allow statistically valid, defendable quantitative analyses, data not specific to the vegetable industry, data not collated or in a useable format (database) and/or confidentiality issues.

Recommendation

To address the gaps in information at the medium-term outcome level it is recommended that:

- Continue discussion with ABS on collection of quantitative data for a range of environmental issues. ABS will continue to develop national reporting for different environmental themes as has occurred with water reporting over the past decade.
- Other potential sources of data continue to be pursued by the industry with the potential of resourcing relevant bodies to collect information for example: ABS (practices on farm); ASPAC (nitrogen, phosphorus and salinity levels); Australian Fertiliser Services Association (AFSA)[c]; CropLife Australia[d]; CSIRO (soil data); NRM bodies (data they collect for the purpose of reporting to the federal government on natural resource condition e.g. water quality, soils, vegetation).

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[c] AFSA, is the industry body for professionals who manufacture, distribute, sell, store, transport, spread or provide advice on the use of fertilisers or soil ameliorate products. Formed in 1972, having a national structure with members in all states, AFSA is recognised by federal and state governments, as well as other key industry stakeholders.

[d] CropLife's member companies manufacture synthetic crop protection products as well as those based on natural chemicals and minerals. CropLife members are committed to safety, stewardship and quality.

7.1.4 Repeating the assessment

Summary

The industry is in a strong position to report positively on its environmental performance and work productively with environmental managers, the market, government agencies and other stakeholders to promote its environmental credentials. The base information is there and this environmental performance report provides baseline information aligned with the industry's environmental flagship program.

To ensure that trends in good practices and condition of resources can be assessed over time it is important that this assessment be repeated using the framework established by this project and any additions to quantitative data capture recommended here. This report provides the method for undertaking and strengthening the assessment in the future.

Recommendation

To build on the findings from the first assessment it is suggested that:

- The environmental assessment be repeated within 5 years. The review of medium-term outcomes should be done then whilst short-term outcomes could be assessed every 2-3 years.
- Each assessment should focus on addressing the information gaps and collecting additional data as recommended in Section 7.1.3.

7.1.5 Grower survey

Summary

Our methodology and focus on the analysis of statistically valid quantitative data, did not consider the use of a random, grower survey based on voluntary participation to collect objective data that would be accepted by retailers or government organisations. Information that was sought required statistical rigour and independence as provided by the ABS. The regular ABS surveys/census are the most robust form of monitoring farm practices that are currently available. There is an existing mechanism in place and we would strongly suggest that this process be used to ensure continued monitoring of data over time via a consistent methodology (refer to Section 7.1.3).

However, there may be potential to undertake a survey of growers to determine their aspirations and attitudes to environmental management.

Recommendation

Given the interest in understanding the views of growers we suggest the following be undertaken:

- Explore the design of a grower survey that investigates current grower views and changes in attitudes and knowledge about environmental management issues at the short-term level. For a grower survey to be unbiased and have any statistical relevance, about 400 responses[42] would be required (this is a minimum if further data breakdown by regions, crops or business size was not needed).

7.2 Communication strategy

The following communication strategy was developed as a key output of the project. It focuses on who the environmental assessment needs to be described to, the important messages and best approaches.

7.2.1 Stakeholder groups

The three target audiences identified during the project were:

1. Government and its agencies (Federal, State, Regional)
2. Market/ consumers
3. Industry.

A summary of the target audience, the message that should be conveyed to them and also the key communication products are described in Table 7-1

Table 7-1: An overview of the target audiences, overarching message and communication products

Drivers	Target Audience	Overarching message	Communication products
Environmental stewardship	**1. Government and its agencies (Federal, State, Regional)** 2. Market/ consumers 3. Industry	Industry practices are contributing to effective management of Australia's natural resources, mitigation of climate change and building resilience to climate variability	▪ Performance Report ▪ Fact Sheets ▪ Summary snapshots
Environmental assurance	1. **Market/ consumers** 2. Government and its agencies (Federal, State, Regional) 3. Industry	Australian vegetable products are produced in an environmentally sustainable manner	▪ Media releases ▪ Fact Sheets ▪ Summary snapshots
Resource efficiency	**1. Industry** 2. Government and its agencies (Federal, State, Regional) 3. Market/ consumers	Environmentally sustainable practices contribute to improved productivity and profitability	▪ Content for industry publications ▪ Fact Sheets ▪ Summary snapshots ▪ Conferences and events

7.2.2 Key messages

The following (Table 7-2) provides a more detailed assessment of the key messages that each stakeholder group will be interested in and the critical results.

Table 7-2: Key messages to be conveyed to each of the target audiences in relation to the vegetable industry environmental assessment

Target Audience
General
▪ Vegetable production is under increasing pressure from competition for land and water, the effects of changing rainfall and temperature patterns, the impacts of consumer food choices and increasing community expectations ▪ Consumers care about the environment and want to see improvements in environmental management over time. Consumers have an expectation that what they purchase is being managed environmentally sustainably ▪ The vegetable industry has responded to market demands and government policies for sustainable production practices through investment in natural resource management research, development and extension (RD&E) programs, best management practice resources, and environmental self-assessment tools to support farmers in adopting best practice ▪ There has been significant progress over the past decade with a large sector of the industry adopting sustainable management practices and environmental assurance programs with the flagship program being EnviroVeg ▪ Within the vegetable production systems, environmental stewardship refers to incorporating practices such as efficient water application and monitoring systems, increasing ground cover to reduce erosion and soil loss, increasing soil organic matter to reduce reliance on chemical inputs, nutrient budgeting and soil analysis, IPM and protecting remnant revegetation ▪ An environmental risk assessment has been completed for the top 13 vegetable growing regions (by area and number of businesses) considering the threats posed by the vegetable industry to significant assets in each of these regions
Government and its agencies (Federal, State, Regional)
▪ Recent investment in the industry has focused on adoption of best management practices particularly for water management ▪ Other areas of opportunity for investment include integrated crop protection (ICP), soil health and energy use efficiency ▪ The vegetable industry is seen to be working towards minimising the impact on natural assets and using resources efficiently ▪ There has been significant progress over the past decade with a large sector of the industry adopting sustainable management practices and environmental assurance programs ▪ The industry is keen to work with NRM managers to minimise their impact on regional assets. Opportunities for industry to collaborate with agencies to work collectively towards solutions should be encouraged. This collaborative approach may also involve active monitoring of asset health (e.g. reef monitoring) and involvement of industry in this process
Markets/Consumers
▪ EnviroVeg is the key environmental program for the vegetable industry and the environmental assessment aligns with and complements this environmental assurance program. The environmental assessment aligns to eight of the EnviroVeg themes ▪ A driver for environmental performance is to increase the adoption of best practice and accountability across the supply chain, especially in the areas of integrated crop protection (ICP), soil and water health and energy use efficiency ▪ The existence of industry-supported, voluntary programs, such as EnviroVeg and Freshcare Environmental, is a great foundation for increasing adoption of environmental assurance ▪ There has been significant progress over the past decade with a large sector of the industry adopting sustainable management practices and environmental assurance programs to address these issues
Industry
▪ Having an industry-led approach to environmental assurance, backed by targeted research and development, will continue to drive adoption of on-farm environmental practices ▪ There are still opportunities for improvement, including the broadening of adoption of best practice across the industry, especially in the areas of soil health and better uptake of Integrated Crop Protection (ICP) ▪ The industry's flagship program EnviroVeg is core to the implementation and adoption of further environmental practices ▪ There is evidence and ongoing support for ensuring tools like the Vegetable Carbon Footprinting Tool are developed and made available for when growers needed them ▪ The potential exists for the industry to be more involved with the NRM bodies across Australia through the Regional Landcare Facilitators and contribute to the development of each regional Catchment Management Plan

7.2.3 Communication outputs

It is recommended that additional communication products be developed in order to communicate the key messages for the target audiences. This could include:

- Fact Sheets based on performance report and case studies
- Media releases
- Content for industry publications
- Presentations at conferences and events.

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- Members of the AUSVEG Environment Committee
- Growers
- Environmental assurance scheme managers
- Retailers
- NRM agencies
- Australian government, and
- HIA program managers.

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