HAL

Know-how for Horticulture™

Understanding the elements and adoption of environmental best practice in horticulture

Arthur Andersen

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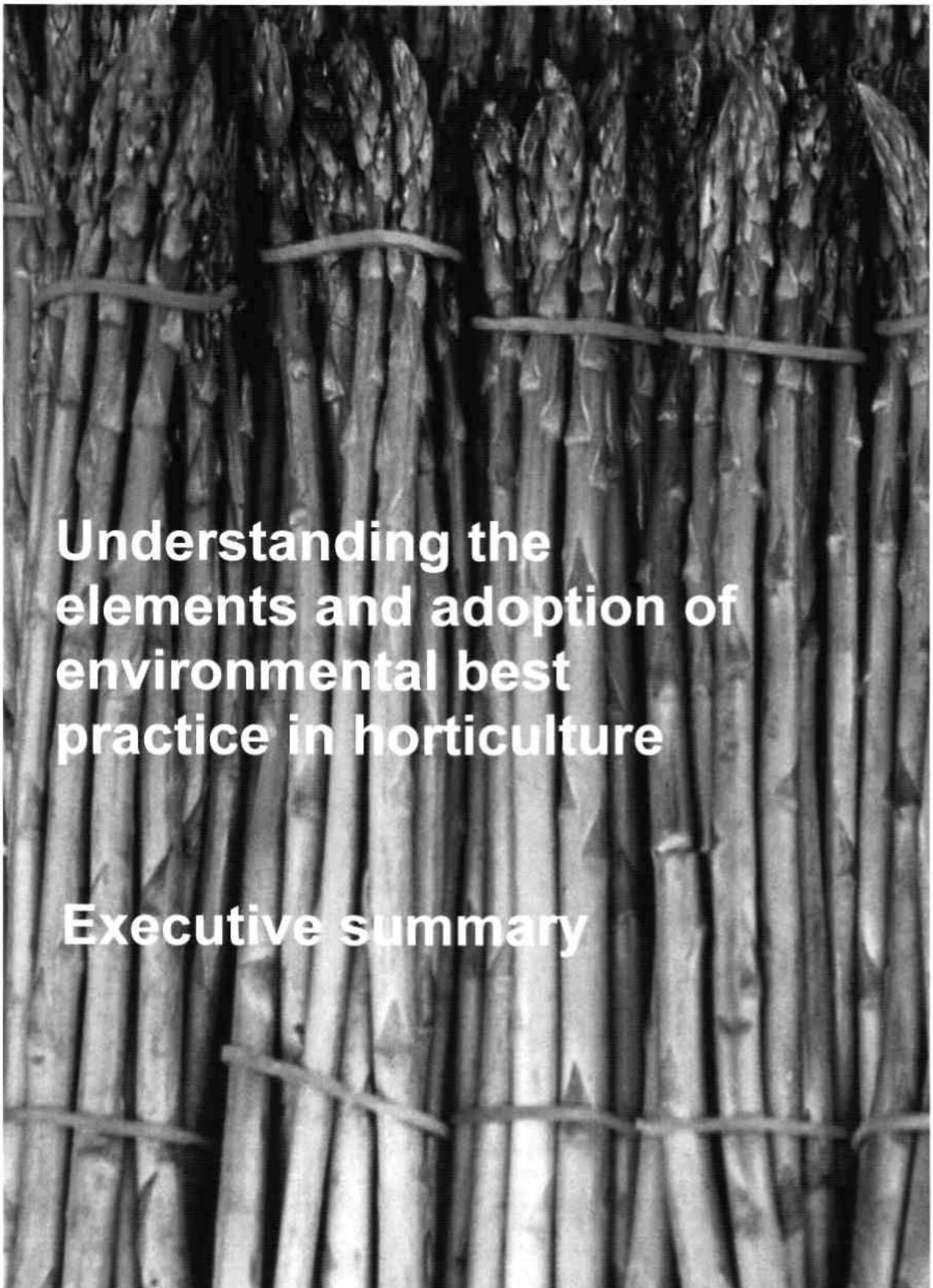


Understanding the elements and adoption of environmental best practice in horticulture

Executive summary

Introduction

'Understanding the elements and adoption of environmental best practice in horticulture' is a joint initiative of Horticulture Australia limited (HAL) and the National Land and Water Resources Audit (a Natural Heritage Trust project). This project forms part of the second stage of the 'Horticulture Environmental Audit'.

Stage 1 commenced in 1999 with the purpose of documenting the use of natural resources by horticulture, assessing the extent of current impacts on those resources, assessing the adoption of good environmental management (GEM) practices and the need for more sustainable management practices.

In commissioning Stage 2 of the project, HAL sought to build on this with two further studies:

1. Understand the nature and breadth of GEM practices and the capacity of Australian horticulture to adopt such practices (The Best Practice Study); and
2. Develop plans to increase Australian horticulture's capacity to capture, store, assess and make available relevant information on natural resource management, including information generated externally to HAL's activities (The Information Study).

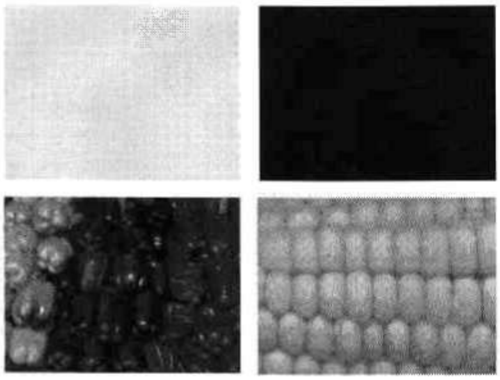
The expected outcomes of the best practice study were to:

- Gather information on management practices which help minimise the impact of Australian horticulture on the environment at industry and regional levels;
- Gain an understanding of the capacity and willingness of growers to adopt sustainable practices;
- Develop guidelines for the consistent implementation of codes of practice which embody the practices identified above;
- Develop an improved basis for comparing the benefits of horticulture to regional economies and to natural resource sustainability with those of other rural industries; and
- Assist the industry to be better positioned to negotiate policy about issues of national and international trade as they relate to the environment.

Andersen was commissioned in April 2001 to undertake the Best Practice Study. The following information summarises the approach, results and key findings of the project and identifies options that could be considered in developing a forward strategy for the horticulture sector.




Approach



The project team sought to identify principles, practices and strategies that are relevant across all horticulture groups. An emphasis was placed on the importance of understanding the target audience for guidelines, [their] specific needs and the specific environmental solutions required.

The strategic approach included a literature review, consultation program and case study appraisals as described below.

1. *A Review of Domestic and International Literature.*

The literature review included:

- Identification of the GEM practices for horticulture being applied in Australia and globally;
- Identification and exploration of documented characteristics of and approaches to change management in the rural sector; and
- Investigation of the drivers for change in horticulture.

2. National Industry Consultation.

Twenty-one meetings with growers and stakeholders were held in various locations in all states of Australia. In total 230 individuals participated in the meetings including growers, agribusiness companies, processors, agricultural supply companies, researchers (private and public), industry development officers (IDOs), representatives of industry associations, extension officers, environmental professionals and academics.

An objective of the consultation phase was to ensure as broad a range of commodity groups as possible were consulted and as such, representatives from all major horticultural groups were involved in the consultation phase. The findings from consultation have been used to develop a model of the change processes in horticulture and how best to positively influence this process.

3. Case Study Development.

During the consultation phase, case studies were identified as examples of the effective implementation of GEM. These case studies are indicative of progressive models in the principles, tools or drivers of environmental management. Three case studies have been profiled as examples of innovative environmental management:

- The *Goulburn-Broken Floodplain Rehabilitation Scheme* (case study of a regional initiative);
- The *Enviroveg* Project (case study of an industry initiative); and
- *Abbotsleigh Citrus* (case study of an award-winning enterprise).

Key Findings

Elements of Good Environmental Management

Central to achieving environmental outcomes for the horticulture sector is to ensure consistent content in environmental programs. The dominant environmental issues facing the horticulture sector in a specific region should guide the selection of content for environmental initiatives.

Elements of GEM for the horticulture sector can be summarised into decision-making frameworks and GEM practices.

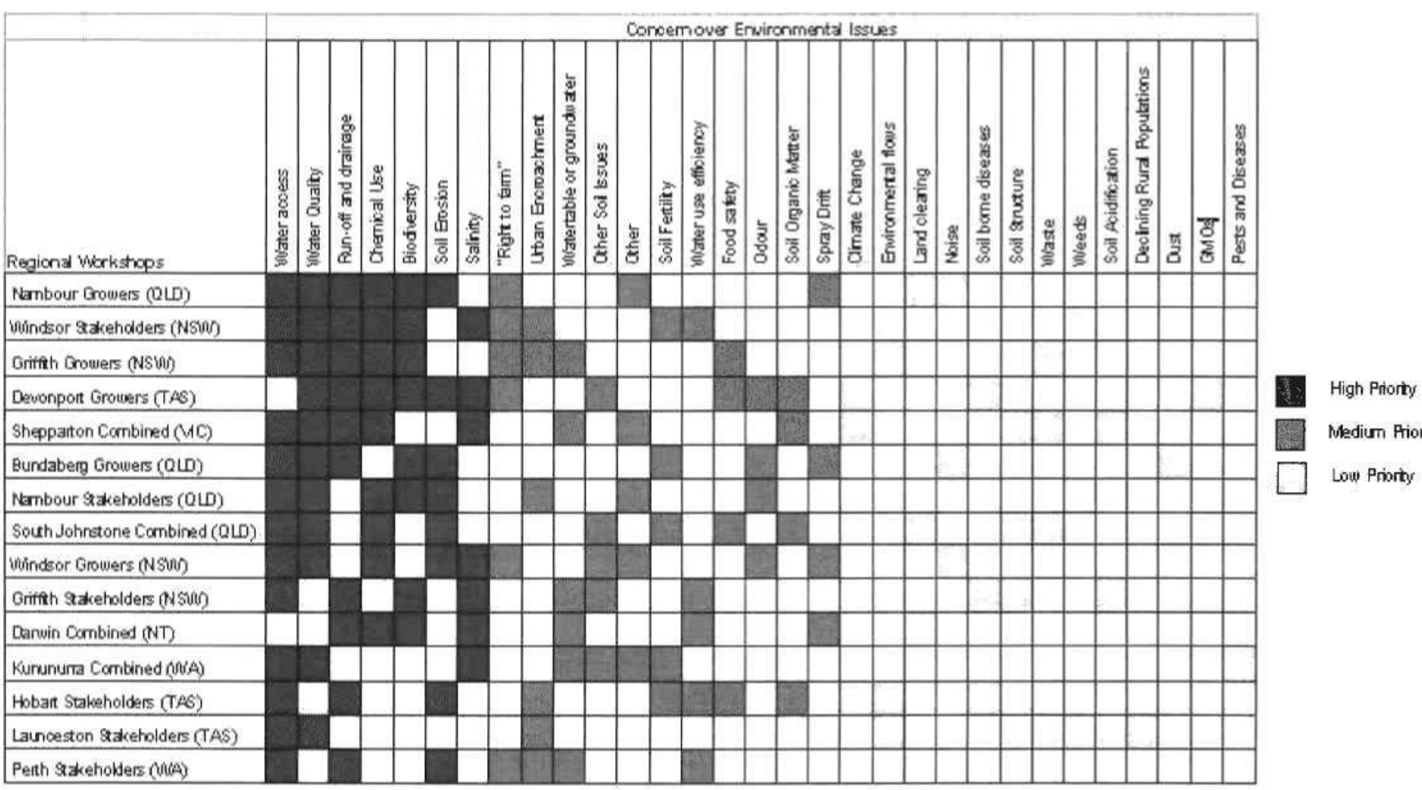
Environmental issues facing the horticulture sector

The regional workshops highlighted that water issues, chemical use, biodiversity and soil erosion (shown in red in Table 1) were of concern across Australia and should be regarded as high priority. However, other environmental issues raised demonstrated that these concerns are often regional or commodity based. For example urban encroachment often dominated discussion at meetings held on the outskirts of major cities (Windsor, Nambour, and Perth), GMOs were topical in Tasmania due to state government policies and waste disposal was of higher concern in rural production zones. While this trend may be related to awareness raised by existing environmental programs, it highlights the importance of local knowledge and information in the development of environmental programs.

Decision-making frameworks

A decision-making framework is a formalised process for assessing, managing and monitoring the financial, personal, social and environmental variables in the production process. An effective decision-making framework facilitates proper medium to long-term financial planning. This relative financial stability enables quality environmental outcomes to be achieved. Examples of decision-making frameworks include:

- Environmental management systems (EMS);
- Quality assurance (QA) programs;
- Total catchment management strategies; and
- Whole farm planning initiatives.



The selection of an appropriate decision-making framework hinges on a variety of factors but particularly scale. Some frameworks may be universally implemented (such as environmental management systems) while others require a more specialised approach that is applicable at industry or regional levels (e.g. total catchment management). A widely recognised method is a systems-based approach (Figure 1) which focuses on the:

- Type, quality and quantity of inputs;
- Complex transformation processes occurring in production; and
- Type, quality and quality of outputs.

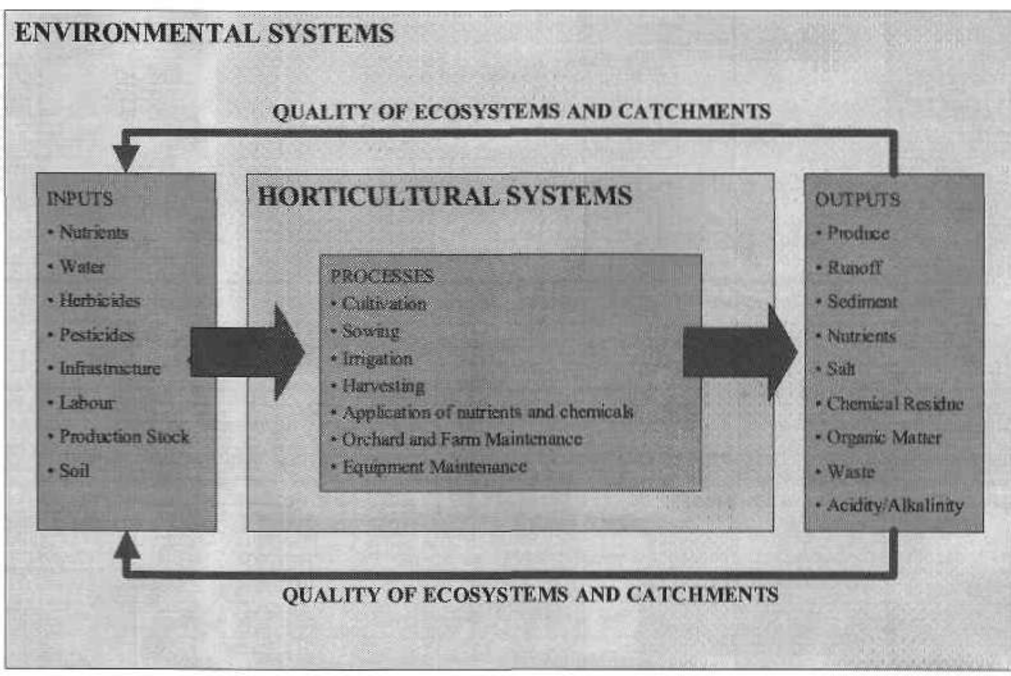
A systems approach promotes a clear understanding of the important variables affecting the horticulture sector and their external impacts. Understanding these variables and external impacts may encourage more effective farm management across the sector.

GEM practices

GEM practices in the horticulture sector fall into the following categories:

- Water;
- Soil and land management;
- Pest, insect, weed and disease management;
- Air;
- Noise;
- Waste; and
- Biodiversity.

Specific elements of GEM tend to vary based on the current critical issues affecting a region, the industry or industries involved as well as financial, social, cultural and institutional factors. Environmental management has very few generic, prescriptive solutions. Environmental programs should be tailored to the industry and region involved. Local solutions have the greatest chance of increasing on-farm adoption and achieving significant environmental outcomes. This study has found that local and industry research and consultation should be conducted to identify and / or develop GEM practices.



Understanding the GEM adoption processes of growers

Horticultural producers have unique change management characteristics that need to be identified and then integrated into any GEM implementation strategy. At all stages of an environmental program it is critical to build grower ownership and to utilise elements that readily drive change in grower behaviour. This study has defined and modelled the process by which new practices and technologies, particularly GEM practices, are adopted in the horticultural sector.

The Adoption Process

The study has developed the *Adoption Process* model (Figure 2) that describes:

- Phases of acceptance growers pass through to change their behaviour (orange boxes);
- Appropriate tools to assist the growers at different phases; and
- Motivating factors that drive growers to move from one phase in the process to the next (green arrows).

Various components of the *Adoption Process* model are described below.

Phase 1: "See the Problem"

At this stage the grower recognises a problem is present. This recognition is most effectively triggered through tangible evidence of the problem. This may occur through:

- The observation of physical signs (such as erosion on the grower's property); or
- The problem being brought to the growers' attention (for example through an industry newsletter or media attention).

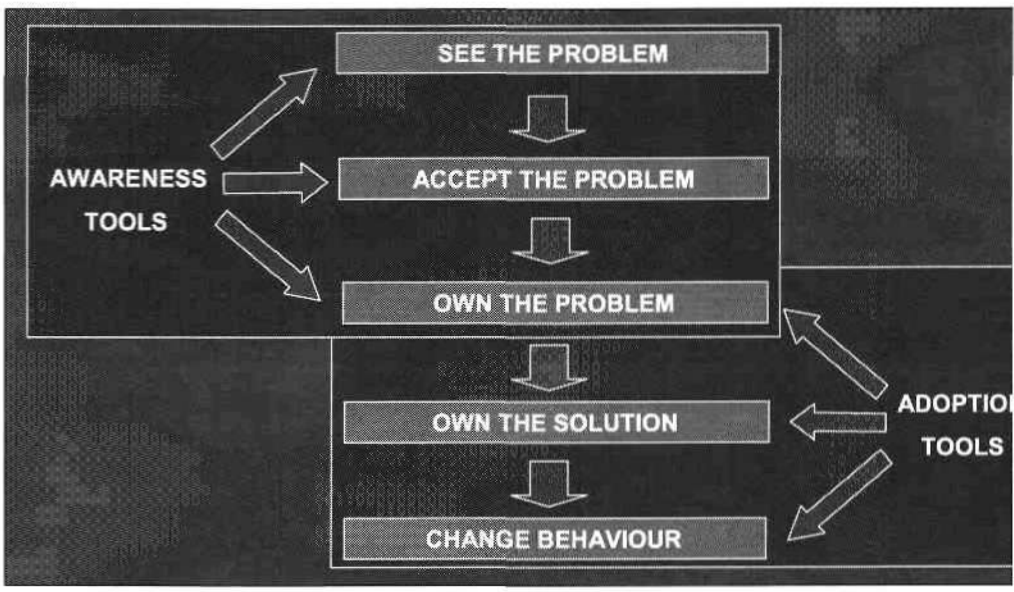
Phase 2: "Accept the Problem"

At this stage, the grower accepts that the issue is a problem and action needs to be taken to address it. Recognition of the impact of an environmental issue or productive activity is often a crucial part of this. Inherent in this phase is a heightened understanding of the problem. This stage is often reached through specific local cause-and-effect evidence to the grower. During this phase, growers will look to others to solve the problem.

Phase 3: "Own the problem"

When growers enter this phase, they have accepted a personal responsibility for addressing the problem. Growers will therefore be responsive to any information on potential solutions and may be proactive in seeking these out.

Figure 2: Adoption Process Model



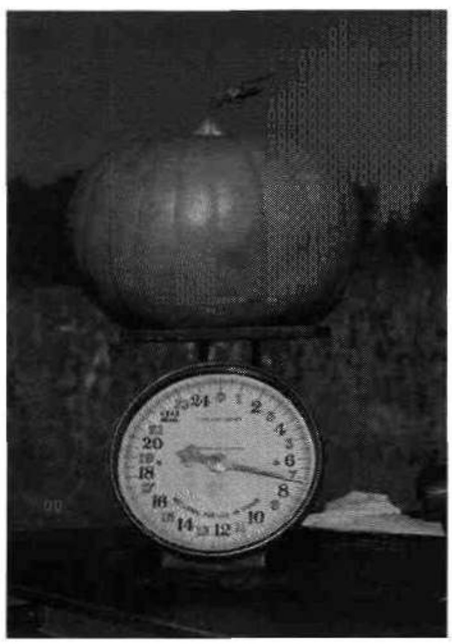
Phase 4: "Own the Solution"

For environmental measures to be readily adopted in the horticulture sector, it is important that growers feel ownership of those measures. If growers are included in research and development processes, adoption is more likely to occur. Where technologies or practices are being transferred, local trials or demonstration sites are considered important.

Phase 5: "Change Behaviour"

Guiding growers to change their behaviour and ultimately adopt GEM practices is the objective of any implementation strategy. It is important to understand that each phase of the process is required for change to occur. However, the time in each phase and the total time required to move through the *Adoption Process* varies. Environmental leaders move more rapidly through the entire process whereas change resistant individuals require significantly more time in each phase.

At any stage during the *Adoption Process*, growers may choose to 'actively reject' behavioural changes. This occurs where despite understanding all relevant information, growers choose not to change their behaviour. Active rejection occurs based on the values and beliefs of individuals and will typically occur wherever voluntary adoption is sought. Emerging research suggests that the most appropriate measure of the success of a program is to identify the proportion of the group who are receptive to change. Program success should then be measured against that proportion.



Implementing GEM practices

Different phases in the *Adoption Process* require different communication and information tools. Although raising awareness is a critical component of the *Adoption Process*, increasing understanding will not necessarily lead to changes in grower behaviour. Successful programs lead the target audience through all phases in the process with the appropriate combination of communication and information tools. Tools may be divided into two categories: *Awareness Tools* and *Adoption Tools* as described below.

Awareness Tools

Awareness Tools are used for communication and information distribution. These tools are passive, as growers are not proactively involved. Examples of awareness tools include newsletters; fact sheets; media; videos; decision support software; web-sites; and meeting with speakers.

Awareness Tools are primarily used to generate recognition and acceptance of issues, problems and potential solutions. These are most effective in Phases 1 and 2 of the *Adoption Process* and are also useful in Phase 3 to provide information on solutions. The appropriate mix of *Awareness Tools* varies greatly based on the commodity group(s), spatial distribution of growers and the general level of grower sophistication. Assessing target audience characteristics is critical to achieving consistent implementation.

Individuals in Phases 3-5 of the *Adoption Process* are proactive. *Adoption Tools* are those that actively engage growers, providing practical and technical assistance to enable the implementation of environmental measures.

A South Australian industry professional aptly surmised the role of *Adoption Tools*:

"Growers need to be more than just told they need a sediment trap. They need to be shown how to dig one" (Consultation, Virginia 31/08/01).

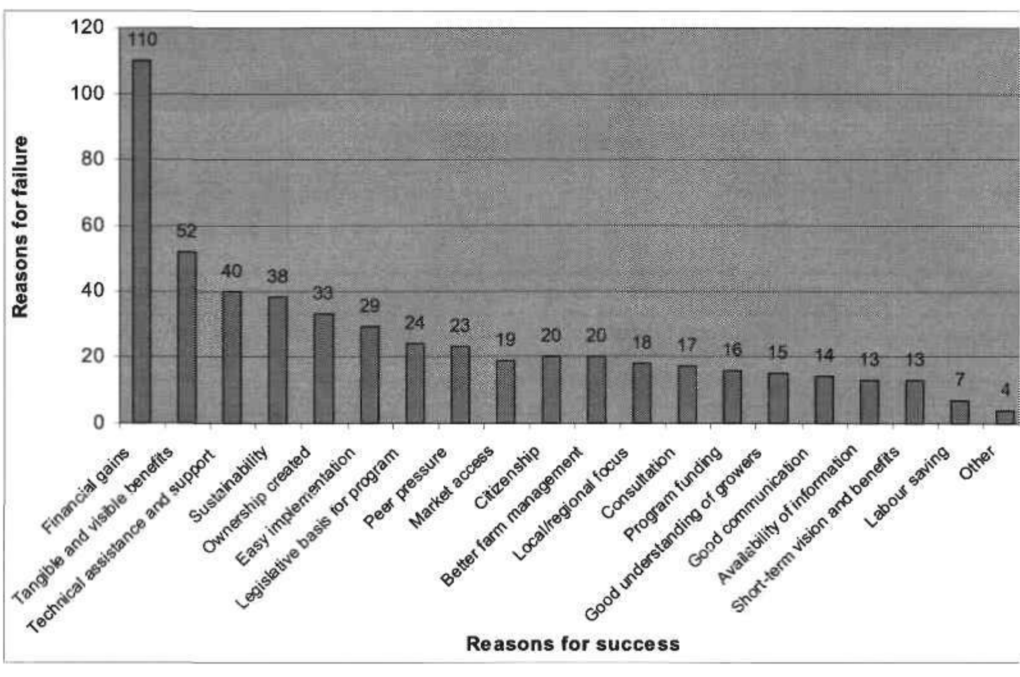
Examples of effective Adoption Tools include:

- Field days;
- Conferences;
- Demonstration sites;
- Videos;
- Individual consultation;
- Training courses; and
- Tours to regions of successful implementation.

During the consultation phase meeting participants were asked reasons why some projects succeed in increasing adoption (Figure 3). Three of the top four responses were:

- The provision of technical assistance and support;
- Ease of implementation; and
- Tangible and visible benefits.

Figure 3: Reasons why projects succeed in increasing on-farm adoption of GEM practices



These responses emphasise the importance of *Adoption Tools* as practical explanations and demonstrations of GEM practices. Workshop discussion during the consultation phase revealed that across all commodity groups and all regions, field days were the single most effective *Adoption Tool*. Field days meet all of these criteria by demonstrating and explaining practices and technologies in an interactive way. At one Tasmanian meeting, the reason for the success of field days was explained as:

"Growers are practical people, they need to see the benefits, ie: this is what I did, this is how it worked, this is the result" (Consultation, Launceston, 10/08/01).

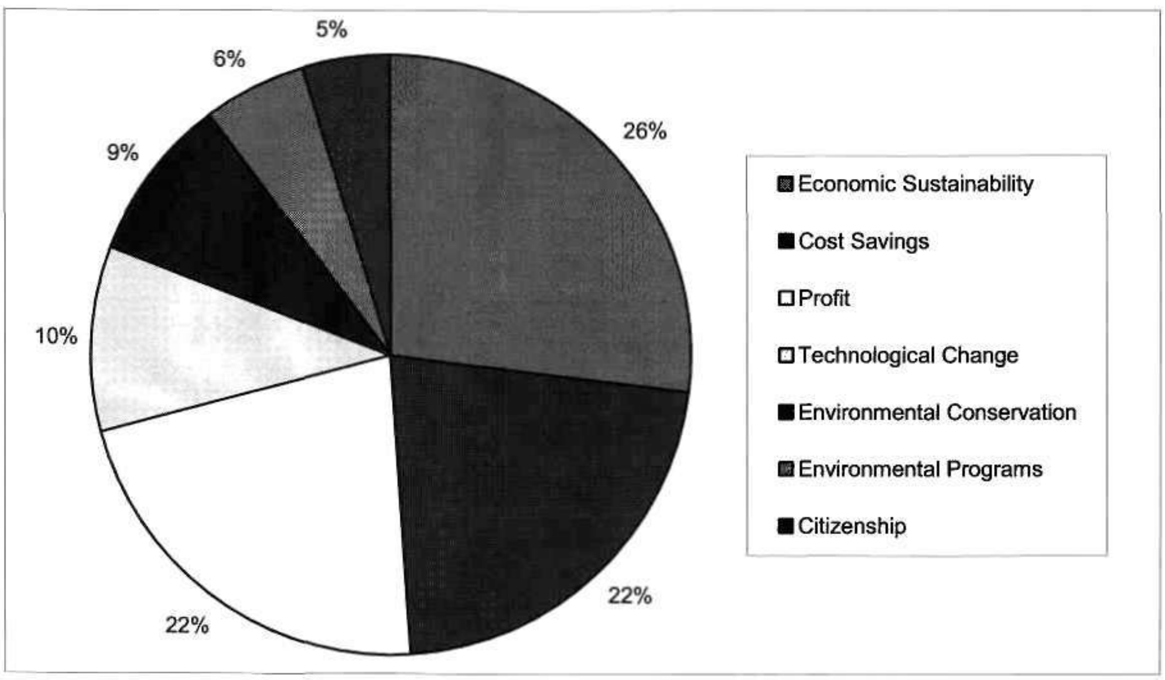
Drivers of change

The tools for increasing adoption are also most effective when they use the factors that drive change among the target audience. These factors drive the *Adoption Process*, by encouraging movement from one phase to the next. The unique suite of drivers in region or industry groups should form the focus of any implementation strategy. While the relative significance of drivers vary, a survey of meeting participants found that several drivers are dominant. These drivers (Figure 4) refer to factors that participants felt encouraged changes in their behaviour.

Economic sustainability was the major driver for the implementation of GEM practices. During the consultation phase, the concept of sustainability was shown to primarily focus on the long-term financial viability of farms. While environmental sustainability was a factor in this, profitability was the dominant concern. As such, the top three drivers were financially related (sustainability, cost savings and profit), with a combined response of 70%. In this context, both growers are stakeholders recognised that financial factors are the strongest driver for change in the industry. Direct financial drivers include: price premiums; subsidies; increased market access; and tax incentives. Indirect benefits include on-farm or at gate cost-savings.

Legislative reforms (including legislation, regulation and policy changes) were found at the workshops to be historically effective in forcing change. Legislative drivers are often appropriate where voluntary adoption of GEM is neither feasible nor likely due to a lack of financial incentives.

Figure 4: Drivers for the adoption of GEM practices



There is a trend toward increasing environmental regulation in Australia involving:

- Increased restrictions on private property use (through restrictions on land clearing, water use and chemical use);
- Pricing mechanisms for public goods and services (such as water quality);
- The use of market mechanisms to regulate the quality of environmental systems (e.g. water trading in most Australian states); and
- The use of a precautionary approach to identify and address potential environmental hazards before they occur (e.g. implementation of food safety programs and chemical application).

These trends are indicative of a broader movement in policy and legislation towards a sustainable management approach to natural resource management.

The more effectively drivers are utilised to motivate growers to adopt environmental measures, the more likely the program will succeed in changing grower behaviour. Some drivers are stronger than others and, ultimately, environmental programs need to be tailored to the needs of the target group of growers.

Comparing GEM practices in horticulture to other rural industries: case studies of GEM practice

This study developed three case studies to highlight innovative environmental management in the horticulture sector and provide a specific basis for comparison with initiatives in other rural industries:

- The *Goulburn-Broken Floodplain Rehabilitation Scheme* (case study of a regional initiative);
- The *Enviroveg* Project (case study of an industry initiative); and
- *Abbotsleigh Citrus* (case study of an award-winning enterprise).

These case studies In particular, the Goulburn-Broken Floodplain Rehabilitation Scheme, highlights an approach in which horticulture is not directly involved but is a major project beneficiary.

Abbotsleigh Citrus (case study of an award-winning enterprise)

Abbotsleigh Citrus is an environmentally innovative citrus operation located 56 km from Bundaberg (Queensland) on the Burnett River. Since its establishment in 1996, the enterprise has aimed "*to fully embrace the concept of sustainable agriculture, which includes the protection and enhancement of the environment*". This unique business philosophy has brought *Abbotsleigh Citrus* a prestigious Banksia Award in the 'Small Business Responsibility and Leadership' Category.

The operation has "*the most comprehensive and wide-ranging environmental management system for any farm in the country*" (*Landline* 22/09/01). This enterprise has been profiled as a case study to demonstrate the way in which environmental best practice can be implemented at farm level. The key elements of the *Abbotsleigh Citrus* EMS which have made the business an industry role model are:

- The adoption of a whole farm approach from start-up phase;
- Conversion of cane farming land to high value citrus production, whilst incorporating a whole farm EMS;
- Corporate farm espousing core environmental values;
- National awareness and recognition of the *Abbotsleigh Citrus* EMS, through awards, accreditation and PR;
- Dedicated, enthusiastic and experienced management and personnel;
- Clear and well articulated business philosophy; and
- Access to capital and finance.

The use of decision-making frameworks also promotes transparency and comparability. The use of EMS as an agricultural decision-making framework is rapidly growing in Australia. Initiatives such as the development of a 'National Framework for the Development of Environmental Management Systems in Agriculture' have led to a heightened awareness of EMS among rural producers. AFFA is currently developing a database of all EMS projects in Australia in their field. The 'EMS Navigator' is accessible through the AFFA web-site (www.affa.gov.au) and lists examples of EMS and projects relating to EMS research and development in Australia. Principles of an effective EMS (as outlined in the outcomes of a National Workshop on EMS in Agriculture (AFFA 2001:6)) require a clearly defined purpose and set of objectives that are criterion based, measurable, give feedback on progress and focus on continuous improvement. The main strengths of an EMS as a decision-making framework are that it formalises the process of measuring change and thus allows data to be generated for external benchmarking. It can be monitored over time and adapted to continually improve performance or respond to external changes (such as policy or market shifts).

Enviroveg *(case study of an industry initiative)*

The *Enviroveg* Project aims to voluntarily improve the environmental performance of the vegetable growers in the Werribee and south-east Melbourne areas. The project is a joint initiative of the Victorian Vegetable Growers Association and HAL with collaboration from a number of government agencies. It was developed at a grassroots level to address community and departmental concern at the perceived environmental impact of horticulture.

Enviroveg employs many of the principles necessary to generate grower ownership and increase the adoption of GEM practices. The initiative is based on issues identified by growers and developed in conjunction with them, which is fundamental to project success. *Enviroveg* has been designed to allow for adaptation and application nationally. The principles used in designing and implementing the *Enviroveg* project may prove to be a useful model for the development of environmental programs.

Lower Goulburn Broken Floodplain Rehabilitation Scheme (case study of a regional initiative)

The Goulburn Broken Catchment Management Authority (GBCMA) is implementing a scheme that will return an area of the Lower Goulburn River floodplain to its natural state. The primary purpose of the project is to reduce the cost of flood damage and improve water quality in the Murray-Darling Basin. The direct benefits to the local area are reduced infrastructure maintenance costs after flood events. Significant water quality benefits will flow to the Sunraysia and Riverland horticultural areas, downstream of the junction of the Goulburn and Murray Rivers.

This scheme has been profiled for a number of reasons:

- It is an example of innovative whole catchment environmental management;
- The Sunraysia and Riverland horticultural regions will receive significant downstream benefits in the form of improved water quality for irrigation;
- It provides clear evidence of the economic benefits that effective environmental management can provide; and
- It is an excellent example of the way in which effective consultation can be used to generate the ownership of environmental projects by rural landholders.

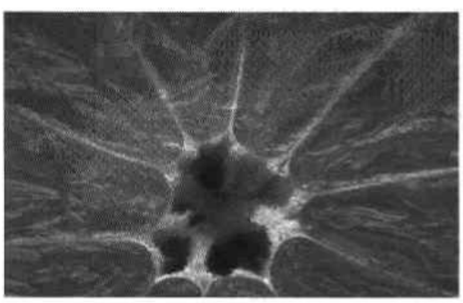
Positioning horticulture on environmental issues

Global market forces are requiring the food industry to become increasingly accountable for the integrity of its products and production methods. As consumer preference shifts towards produce grown using environmentally sound practices, it is likely that environmental elements will be required for Quality Assurance (QA) systems nationally and internationally.

During the consultation phase of this study, growers and industry professionals expressed that it would be beneficial if GEM practices could be built into existing QA systems rather than the development of entirely new systems. This need for alignment of frameworks is being increasingly recognised. For example, the ISO 9000: 2000 quality standard is closely aligned to the ISO 14001 EMS standard. Although meeting participants were critical of the way in which some QA programs had been implemented in the past, the importance of QA programs being industry driven was a key finding of the consultation meetings. One QA system that generally received positive feedback from growers and stakeholders was '*Freshcare*' (Freshcare Ltd 2000). Growers and stakeholders reported that the main strength of *Freshcare* was that it was industry led rather than imposed by the supply chain.

Another useful framework may be ISO14001, the international standard for EMS. ISO registration may be sought to ensure the EMS meets internationally recognised standards of transparency and accountability. This formal accreditation system allows EMS to be adopted for a range of purposes, from on-farm business management, the co-ordination of industry and regional environment initiatives or to demonstrate environmental performance to stakeholders and the marketplace.

While on-farm benefits of GEM practices are currently disconnected from national and international prices, it is possible that environmental standards may emerge. In order for horticulture to be effectively positioned to negotiate on environment related national and international trade issues, horticulture should foster the establishment of frameworks for demonstrating 'clean and green' produce.



Recommendations

Based on the above findings, issues that could be considered by HAL in developing a forward strategy to increase the adoption of GEM are seen to include:

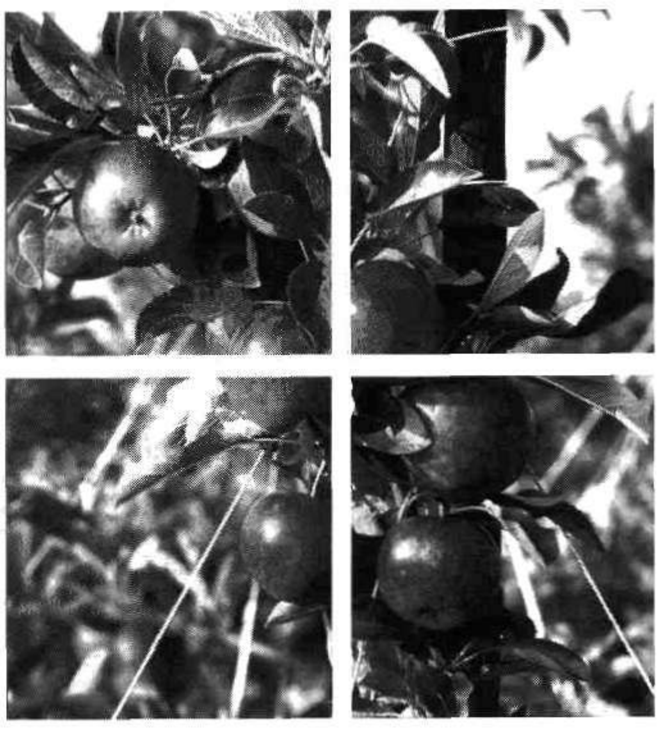
a) Restructuring R&D funding processes to include defined communication strategies as a fundamental component;

b) Given the importance of financial drivers, all future environmental programs should include clear, simple cost-benefit analyses;

c) Supplementing government funding by attracting private sector investment in GEM for the horticultural sector;

d) Encouraging governments to develop financial incentives for the adoption of GEM practices; and

e) Developing models/strategies to better promote the inclusion of environmental issues into the business decision-making tools.



Summary

Encouraging adoption of GEM in the horticulture sector is a complex and challenging task. It involves a strong understanding of:

- Environmental issues facing horticulture (local, regional and national levels);
- Environmental best practice for the specific commodity and region in which increased adoption is sought;
- Change management characteristics of the target audience;
- Tools for encouraging increased adoption; and
- Drivers for adoption of GEM practices.

Through applying this understanding, environmental programs can become more efficient and effective. This may lead to higher and more consistent levels of adoption being achieved for GEM in the horticulture sector.

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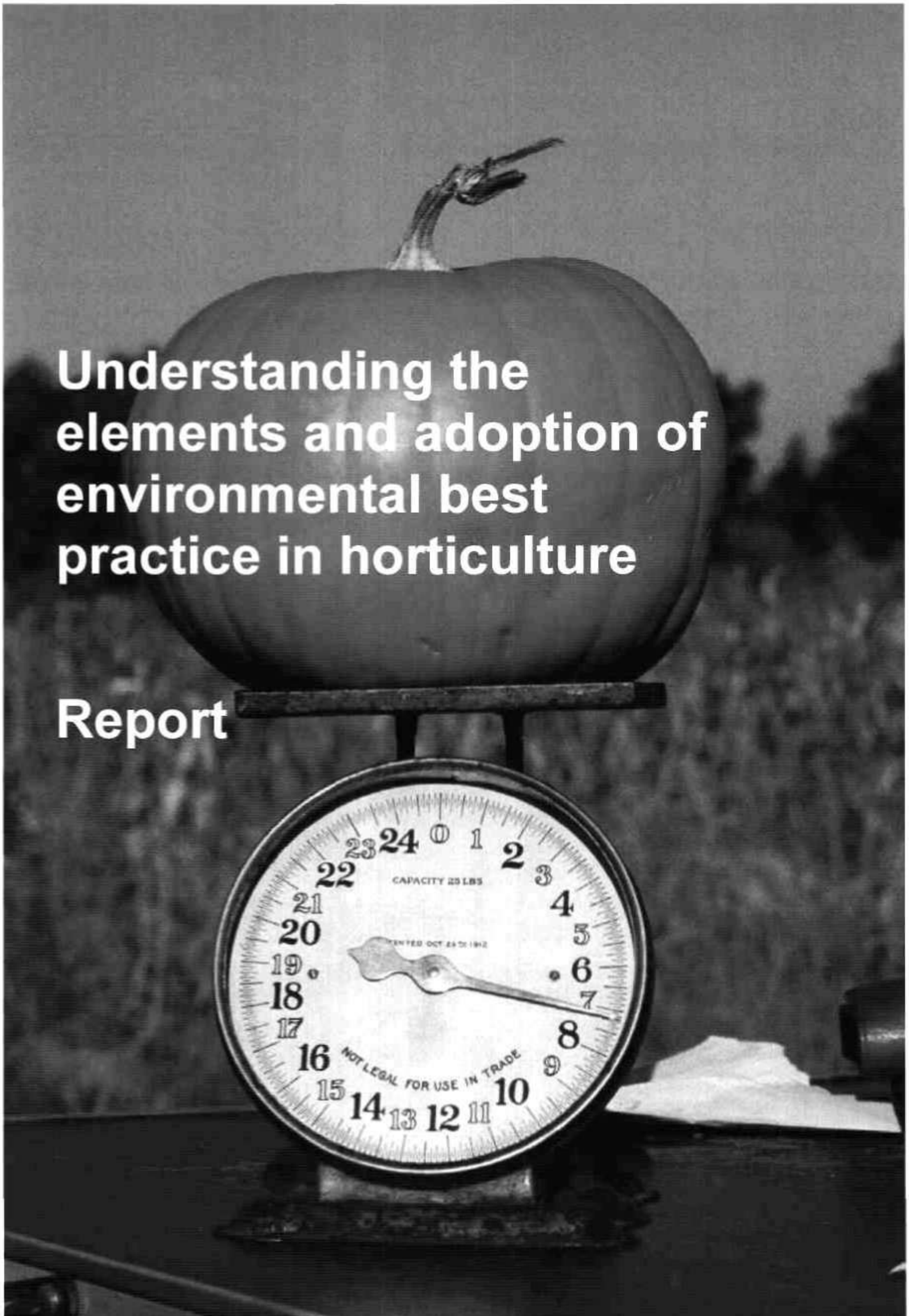
Understanding the elements and adoption of environmental best practice in horticulture

Report



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List of Abbreviations and Acronyms

AEAM	Adaptive Environmental Assessment and Management
AFFA	Agriculture, Fisheries and Forestry Australia
AFR	Australian Financial Review
ANZFA	Australian New Zealand Food Authority
COAG	Council of Australian Governments
EPA	Environmental Protection Authority
EPBC	Environmental Protection and Biodiversity Conservation
EMS	Environmental Management System
ESD	Ecologically Sustainable Development
GBCMA	Goulburn Broken Catchment Management Authority
GEM	Good Environmental Management
HACCP	Hazard Analysis Critical Control Point
HAL	Horticulture Australia Limited
IDO	Industry Development Officer
IHD	Institute for Horticultural Development
IPM	Integrated Pest Management
ISO	International Standards Organisation
LEAF	Linking Environment and Farming
NHT	Natural Heritage Trust
NRE	Natural Resources Environment
NSWEDO	NSW Environmental Defenders Office
NVFG	Northern Victoria Fruit Growers
QA	Quality Assurance
QDPI	Queensland Department of Primary Industries
QFVG	Queensland Fruit and Vegetable
R&D	Research and Development
SQF	Safe Quality Food
TCM	Total Catchment Management
WCED	World Commission on Environment and Development
WFM	Whole Foods Market
WVQMS	Woolworths Vendor Quality Management Standards
VGA	Vegetable Growers Association

1. Introduction

1.1. Overview

This report was commissioned by Horticulture Australia with the purpose of assisting the Australian horticultural sector to understand the:

- Elements of good environmental management (GEM);
- Process by which the horticulture sector adopts new practices;
- Tools to assist this change; and
- Drivers that encourage adoption.

This report is primarily intended for use by two audiences: Horticulture Australia and industry professionals developing environmental programs for the horticulture sector. As such, the authors of this report have attempted to strike a balance between a technical document and a manual about how to design, develop and implement environmental programs to achieve increased levels of adoption of GEM practices. The body of this report outlines principles, tools and strategies for the consistent implementation of codes of practice. Three case studies have been developed to demonstrate the way in which these elements of GEM may be applied. An in depth literature review, comprehensive methodology for approach taken during this study and detailed findings are included in appendices to the report for those requiring more information.

1.2. Background

Recently there has been increasing momentum from the horticulture industry and Horticulture Australia Limited (HAL) to commission projects which are relevant to large sections of the industry. "The Horticulture Environmental Audit" is an initiative of HAL and has been jointly funded by the National Land and Water Resources Audit (a Natural Heritage Trust project).

The project has been conducted in two phases. Stage 1 was conducted in 1999 with the purposes of documenting the use of natural resources by horticulture, assessing the extent of current impacts on those resources, assessing the adoption of good management practices and the need for movement to more sustainable management practices. Key findings of Stage 1 included:

- The quality of environmental and economic information across horticulture is often poor;
- Legislation affecting horticulture is increasing;
- Codes of Practice have been developed but adoption is low or unknown; and
- Off-site impacts of horticulture have not been adequately determined.

In commissioning Stage 2 of the project, HAL sought to build upon these findings by commissioning two further studies:

1. Understand the nature and breadth of GEM practices and the capacity of Australian horticulture to adopt such practices (The Best Practice Study), and
2. Develop plans to increase Australian horticulture's capacity to capture, store, assess and make available relevant information on natural resource management, including information generated externally to HAL's activities (The Information Study).

'Understanding the elements and adoption of environmental best practice in horticulture' is the findings of The Best Practice Study.

1.3. Outcomes

The expected outcomes of the best practice study were to:

- Gather information on management practices which help minimise the impact of Australian horticulture on the environment at industry and regional levels;
- Develop guidelines for the consistent implementation of codes of practice which embody the practices identified above;
- Gain an understanding of the capacity and willingness of growers to adopt sustainable practices;
- Develop an improved basis for comparing the benefits of horticulture to regional economies and to natural resource sustainability with those of other rural industries; and
- Assist the industry to be better positioned to negotiate policy about issues of national and international trade as they relate to the environment.

1.4. Approach

The project scope included all horticultural commodities in all areas nationally. To generate meaningful guidelines and recommendations, a generalist approach has been taken. The project team has sought to identify principles, practices and strategies that are relevant across all horticulture groups. At the same time, specific examples have been used to highlight the high degree of variation across the horticultural sector. An emphasis has been placed on the importance of understanding the target audience for guidelines, their specific needs and the specific environmental solutions required.

In order to develop the understanding required to meet project outcomes, the project team has utilised a number of strategies. A detailed project methodology is supplied in Appendix A. In summary, the strategies utilised were:

1. A Review of Domestic and International Literature.

The literature review included:

- Identification of the GEM practices for horticulture being applied in Australia and globally;
- Identification and exploration of documented characteristics of and approaches to change management in the rural sector; and
- Investigation of the drivers for change in horticulture.

Chapter 3 provides an overview of the findings of the literature review. It is a high level guide to the most relevant available literature. Greater detail and further references are provided in the unabridged literature review in Appendix B.

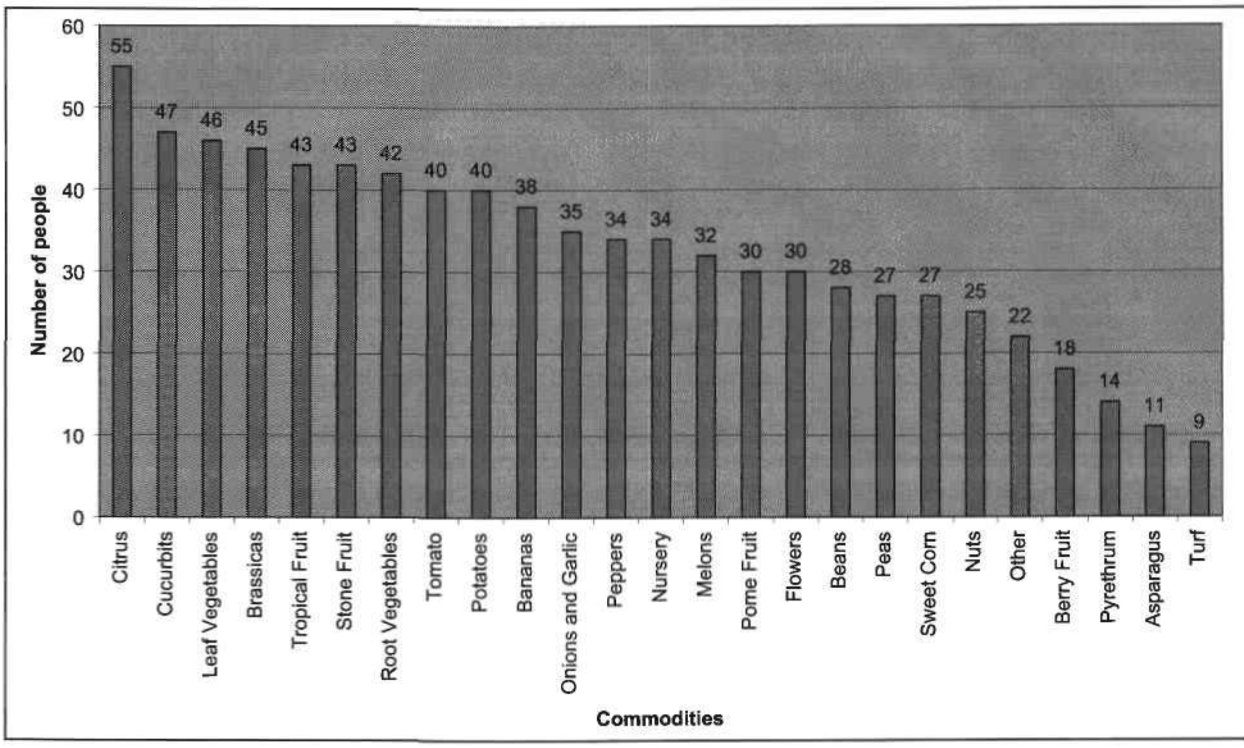
2. National Industry Consultation.

Twenty-one meetings with growers and stakeholders were held in various locations in all states of Australia. Meetings included: formal workshops and facilitated discussion forums. In total 230 individuals participated in the meetings. These included growers, agribusiness companies, processors, agricultural supply companies, researchers (private and public), industry development officers (IDOs), representatives of industry associations, extension officers, environmental professionals and academics. A survey was conducted of all meeting participants to supplement the qualitative information obtained at the meetings.

An objective of the consultation phase was to ensure as broad a range of commodity groups were consulted as possible. The range and proportion of commodity groups consulted during this phase of the study as shown in Figure 1.1.[1] As this figure illustrates, representatives from all major horticultural groups were consulted.

[1] Note that some individuals were associated with more than one commodity. As such, this data is not mutually exclusive.

Figure 1.1: Commodity groups consulted during the national industry consultation of the study



Information collected at these meetings has been collated to form the basis of the findings of this report which is outlined in Chapter 3. Detailed quantitative results are reported in Appendix C. These findings have been used to develop a model of the change processes in horticulture and how best to positively influence this process.

3. Case Study Development.

During the consultation phase, case studies were identified as examples of the way in which the principles of GEM are being effectively implemented. The identified case studies are role models in the principles, tools or drivers of environmental management. Three case studies have been profiled to highlight examples of innovative environmental management at different scales:

- The *Goulburn-Broken Floodplain Rehabilitation Scheme* (case study of a regional initiative);
- The *Enviroveg* Project (case study of an industry initiative); and
- *Abbotsleigh Citrus* (case study of an award-winning enterprise).

The findings of Stage 1 indicated that the adoption of environmental measures was low or unknown. Consistent with this finding, case studies of GEM in horticulture (particularly highly innovative examples) generally have not progressed to adoption. The *Goulburn-Broken Floodplain Rehabilitation Scheme* and the *Enviroveg* project are two such examples. However, the adoption of GEM practices at *Abbotsleigh Citrus* is further advanced and has been profiled for this reason.

2. Elements of Good Environmental Management

2.1. Overview

Central to achieving consistent environmental outcomes for the horticulture sector is to ensure codes of practice and environmental programs have consistent content. The following discussion provides a high-level overview of the generic elements of GEM, citing relevant examples where applicable. This chapter discusses the use of environmental frameworks as a means of incorporating environmental considerations into rural decision-making process and the strengths and weaknesses of various frameworks. This chapter also provides a brief outline of the specific elements that may be regarded as examples of GEM. These practices are discussed across seven key areas:

- Water;
- Soil and Land Management;
- Pest, Insect, Weed and Disease Management;
- Noise;
- Air;
- Waste; and
- Biodiversity.

Greater detail on GEM practices is provided in Appendix B where the literature review for this study is reproduced in its entirety. Appendix E lists useful sources of further information for each of these seven key areas..

Specific GEM practices will vary based on numerous factors including, scale, region, commodity and location within the catchment. The diversity and scope of horticulture in Australia means that there can be no substitute for local information and knowledge. The development of environmental guidelines needs to take into account the unique combination of local factors to produce a set of guidelines that are relevant to the region and industry in which they will be implemented. This chapter is intended as an indicative guide only.

2.2. Environmental Issues facing the horticulture sector

The dominant environmental issues facing the horticulture sector in a specific region should guide the selection of content for environmental initiatives. While this area was outside the scope of the Best Practice Study, data on environmental issues was collected during the national industry consultation.

Survey respondents were asked to rank the three most important environmental issues facing the horticulture sector in their region. As Figure 2.1 indicates, water featured strongly with four of the top five issues being water efficiency, water quality, run-off water and drainage and salinity. This was also reflected at the workshops (Table 2.1) with the three most frequently raised environmental issues being: water access, water quality and run-off and drainage. Water also dominated responses in the 'other issues' category of the survey, comprised of respondents offering alternative issues to those provided in the survey. Issues such as environmental flows, water access and groundwater management were raised. Salinity, groundwater, water use efficiency and environmental flow issues were also prominent in workshop discussions.

This result is likely to be a function of a number of factors including:

- The majority of horticulture in Australia is irrigated;
- The predominantly dry conditions being experienced in many horticultural zones during the period of consultation;
- Water usage is being increasingly regulated under changes being introduced into most states as part of the COAG Water Reform Agreement; and

- Recently, many environmental programs by state agriculture departments have been directed at on-farm water management (for example, 'Waterwise on the Farm' was mentioned in both New South Wales and Queensland meetings).

The regional workshops highlighted that water issues, chemical use, biodiversity and soil erosion (shown in red in Table 2.1) were of concern across Australia and should be regarded as high priority. However, other environmental issues raised demonstrated that these concerns are often regional or commodity based. For example urban encroachment often dominated discussion at meetings held on the outskirts of major cities (Windsor, Nambour, and Perth), GMOs were topical in Tasmania due to state government policies and waste disposal was of higher concern in rural production zones. While this trend may be related to awareness raised by existing environmental programs, it highlights the importance of local knowledge and information in the development of environmental programs.

Figure 2.1: Most important environmental issues (survey respondents)

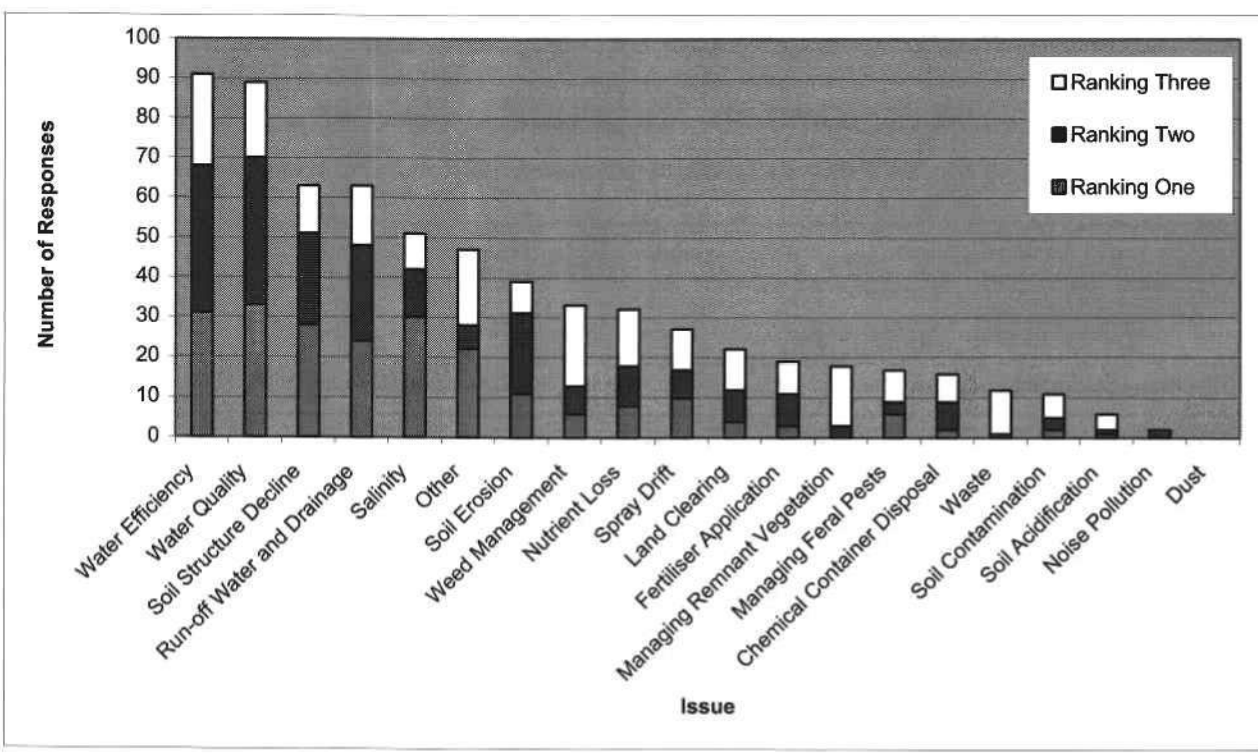
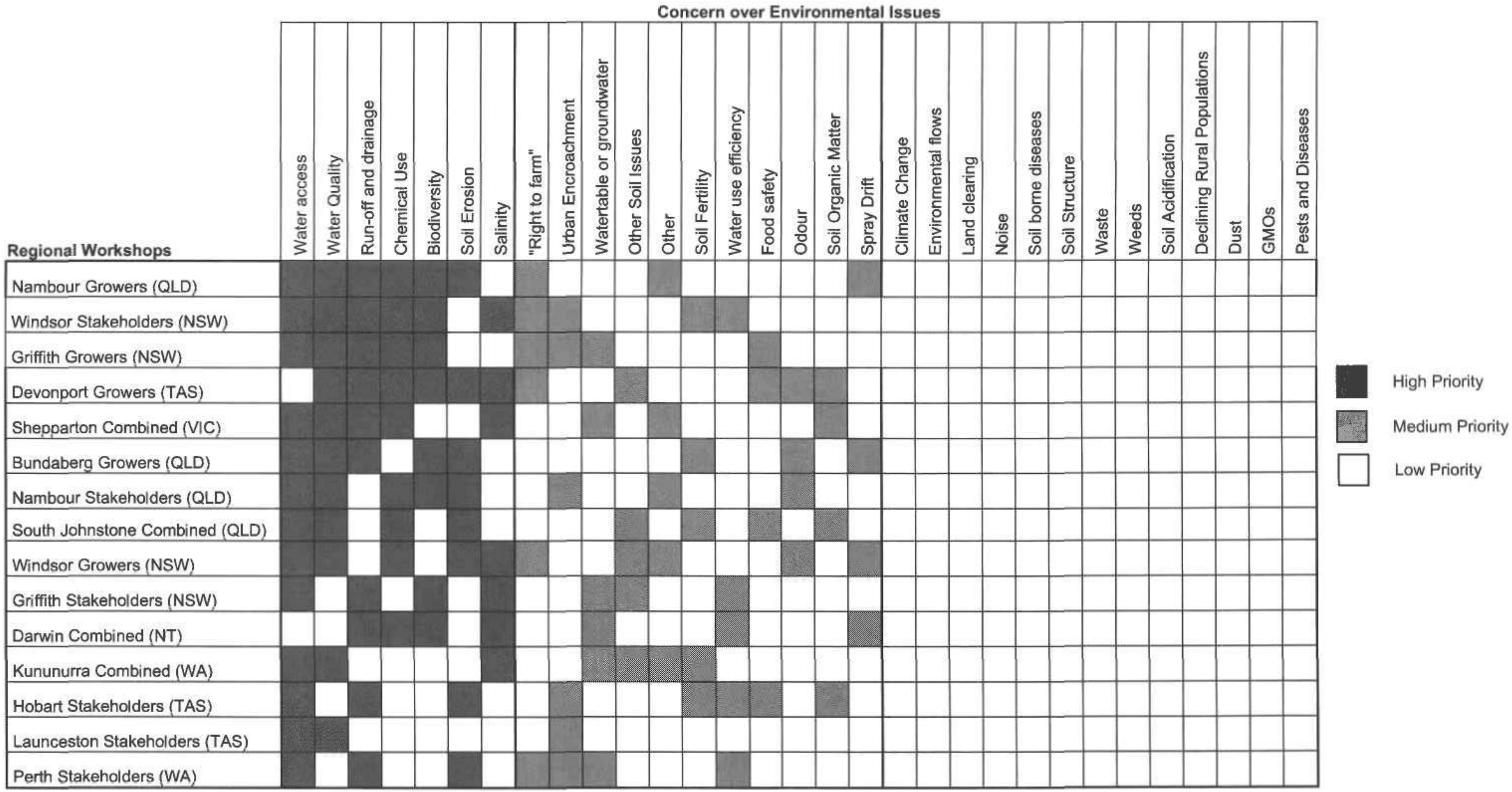


Table 2.1: Environmental issues across Australia[1]



[1] Note: Regional workshops were separated into stakeholder and grower meetings. In some circumstances meetings were comprised of combined participants.

2.3. Frameworks for Environmental Best Practice

Recently, environmental policy and legislation has been shifting in focus away from compliance towards approaches based on sustainable management of natural resources. This trend is reflected in initiatives such as the various programs under the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality. This trend is also demonstrated in the movement towards more integrated and catchment based initiatives.

Concurrent to this trend has been changing perceptions of the status of horticulture and agriculture by policy makers. Rural production is increasingly being regarded as simply another business sector. This shift is evidenced by reductions in agricultural support services such as the scaling down of agricultural extension services, the deregulation of rural management boards and the reduction of trade protection. Horticulture is increasingly being expected to compete in the marketplace similarly to other business sectors. A major component of this expectation is that horticultural producers are being held increasingly accountable for the environmental impacts of their production activities. This is an expectation held not only by government, but by consumers, stakeholders and community groups.

The adoption of decision-making frameworks offers growers a structured approach to business planning in this changing production environment. A decision-making framework is a formalised process for assessing, managing and monitoring the financial, personal, social and environmental variables in the production process. An effective decision-making framework facilitates proper medium to long term financial planning. This relative financial stability enables quality environmental outcomes to be achieved. Workshop discussion, during the consultation phase of this study, revealed that this is recognised by both growers and stakeholders in the horticulture sector.

The selection of the most appropriate decision-making framework hinges on a number of factors, however, scale tends to figure most predominantly. Some frameworks may be successfully implemented at a variety of scales (for example, environmental management systems). Others, such as codes of practice and quality assurance, are most applicable to a region or industry. Regardless of the specific decision-making framework selected, a holistic perspective should be maintained. This allows the broader ramifications of any decision or action to be assessed, be these on-farm, off-farm or regional impacts.

An increasingly recognised approach is to base decision-making frameworks on a 'systems' view of production. This approach looks at the production in terms of the inputs and outputs and involves assessing, managing and monitoring the:

- Type, quality and quantity of inputs;
- Complex transformation processes occurring in production; and
- Type, quality and quantity of outputs.

Figure 2.2, is a schematic representation of a horticultural system. If this approach was applied to a decision regarding nutrient application, for example, then a grower may:

- Examine the level and type of inputs. This may involve looking a present and past application rates in terms of soil type and plant requirements;
- Evaluate the present application techniques and interactions between this and other processes (such as irrigation); and
- Monitor 'sinks' for excess nutrients. For example, run-off into local waterways, seepage into groundwater and accumulation in the soil profile.

Through this approach the most appropriate type and quantity of nutrients may be selected and applied to avoid wastage. With this approach, environmental 'sinks' for excessive nutrients benefit through reduced impact and growers benefit through reduced nutrient costs.

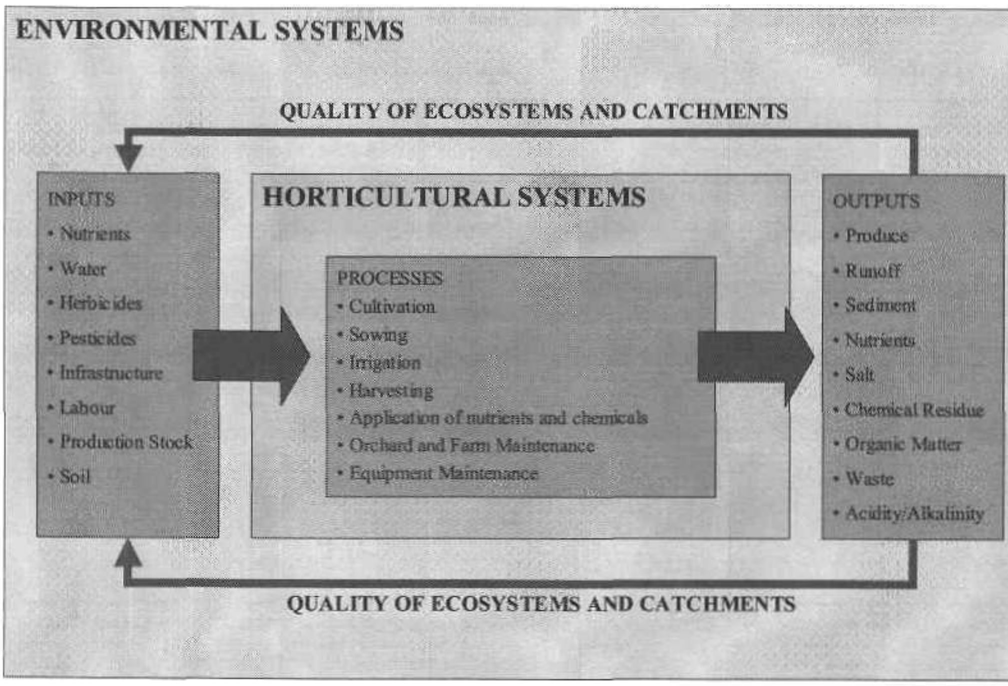
Structuring a decision-making framework around a systems approach has a number of strengths. These include:

- Goals and objectives are stated;
- Performance criteria can be measured and monitored;
- Variable inputs and outputs can be measured;
- Systems can be analysed at varying degrees of complexity;
- Changes to systems can be predicted and monitored;
- Systems can be benchmarked and adapted both tactically and strategically;
- The interrelationship between inputs and outputs are better understood.

A systems approach promotes a clearer understanding of the most important variables acting upon and within the horticulture sector, as well as their external impacts. This understanding, in turn, may encourage more effective farm management across the industry, catchments or production units within that industry.

There are a number of forms of environmental decision-making frameworks operating within the Australian horticulture sector. The most high profile of these is the Environmental Management System (EMS). However, environmental decision-making frameworks may also be in the form of codes of practice, quality assurance systems, Adaptive Environmental Assessment and Management, total catchment management or whole farm planning. These frameworks and other examples are discussed in the following sections of this chapter. The strengths and weaknesses of these frameworks are summarised and suitable scales for application of these frameworks are discussed.

Figure 2.2: Schematic representation of a horticultural system



Environmental Management Systems

An EMS is a methodological approach, which formalises environmental planning, implementation and review. This approach may be applied at a number of levels ranging from international accreditation, to third party verification or self-audit. The development of an EMS is guided by policies and practices relating to:

- Actual or potential environmental impacts;
- Actions to prevent environmental harm; and
- Actions to use environmental resources efficiently (Piccone 1999: 14).

The use of EMS as an agricultural decision-making framework is rapidly growing in Australia. Initiatives such as the development of a 'National Framework for the Development of Environmental Management Systems in Agriculture' by a Commonwealth-State government EMS working group has led to a heightened awareness of EMS among rural producers. AFFA is currently developing a database of all EMS projects in Australia in their field. The 'EMS Navigator' is accessible through their web-site (www.affa.gov.au) and lists further examples of EMSs and projects relating to EMS research and development in Australia.

Examples of EMS in horticulture include the Sunraysia region of Victoria is a pilot site for an EMS in the horticulture industry. The Yarra Valley and the Pome Fruit Industry have also developed EMS (Carrathurs 1999: A3). One example of the successful adoption of EMS at farm-level is that of *Abbotsleigh Citrus* (profiled in Chapter 6) who have developed a sophisticated EMS that is fully integrated into the business model of the operation.

Principles of an effective EMS (as outlined in the outcomes of a National Workshop on EMS in Agriculture (AFFA 2001:6) require a clearly defined purpose and set of objectives that are criterion based, measurable, give feedback on progress and focus on continuous improvement. The first priority for any management system is to create a structure that ensures that the system is simple, clear and achievable, as well as dynamic and evolving (IHD 2000: A3). EMS are often most successful when they integrate with existing farming systems and processes as change can be managed in incremental amounts. Effective consultation with the end-users of the EMS is also critical as they have the most thorough understanding of the existing process and logistics of implementation.

The main strength of an EMS as a decision-making framework is that it formalises the process of measuring change. It can be monitored over time and adapted to continually improve performance or respond to external changes (such as policy or market shifts). Furthermore, credible and transparent EMS may create market benefits (AFFA 2001: 3) such as in the case of *Abbotsleigh Citrus* (detailed in Chapter 6).

The International Standards Organisation (ISO) series 14001 is the international standard for EMS. ISO registration may be sought to ensure the EMS meets internationally recognised standards of transparency and accountability. This formal accreditation system allows EMS to be adopted for a range of purposes, from on-farm business management, the co-ordination of industry and regional environment initiatives or to demonstrate environmental performance to stakeholders and the marketplace.

The strengths and weaknesses of EMS as a decision-making framework are summarised below in Table 2.2.

Table 2.2: Strengths and weaknesses of EMS

Strengths	Weaknesses
• Applicable at a variety of scales including regional, catchment and on-farm. • Applicable at a number of levels including international accreditation, third party verification and self-audit. • Has institutional support (ISO 14001 and AFFA). • Australian examples readily available. • Existing processes can be incorporated. • Focus on monitoring and continuous improvement. • Recognised by market, government and stakeholders as an indicator of good environmental performance.	• A poor EMS may mask poor environmental performance. • Quality of EMS varies greatly. • Tend to be focussed on human activities rather than environmental impacts. • May be based on a systems approach.

Adaptive Environmental Assessment and Management

Adaptive Environmental Assessment and Management (AEAM) is a computer based methodological framework designed to deal with uncertainties inherent in environmental change. AEAM provides a useful alternative to EMS as its approach focuses on the way natural systems operate as opposed to EMS, which is more anthropogenic. The AEAM model predicts the response of the system to the development of a set of preferred management actions (Grayson and Doolan 1995: 3).

AEAM is not currently widely adopted in the Australian rural sector and due to the technical nature of this framework it is unlikely to be readily adopted at farm-level. However, AEAM may prove to be of particular merit when integrated as a tool into other management programs such as Total Catchment Management (TCM) and Landcare. For example, the Ovens Basin Water Quality strategy was developed using the framework of AEAM as a document that addresses the key issues affecting water quality within the catchment (Ovens Basin Water Quality Working Group 2000).

The strengths and weaknesses of AEAM as a decision-making framework are summarised below in Table 2.3.

Table 2.3: Strengths and weaknesses of AEAM

Strengths	Weaknesses
• Focussed on natural systems. • Strong systems-based approach. • Useful decision-making tool at a catchment or regional level. • Focus on monitoring and continuous improvement.	• Few Australian examples available. • Technologically complex. • Does not scale well to farm level.

Quality Assurance

Global market forces are requiring the food industry to become increasingly accountable for the integrity of its products and production methods. As consumer preference shifts towards produce grown using environmentally sound practices, it is likely that environmental elements will be required for Quality Assurance (QA) systems nationally and internationally. Therefore, the need for transparent and accountable systems of management for environmental assurance is increasing.

QA systems in Australia have usually adopted a 'top quality' objective aimed at high value markets. Product defects are identified and an 'inspect and reject' system is implemented (Piccone 1999: 10). These systems often involve grading of products and specifications to prevent spoilage, and tend to incorporate post-harvest measures.

The ISO 9000 series outlines international quality management standards while the Hazard Analysis Critical Control Point (HACCP) technique is used to identify and control food safety hazards. Other codes have been developed such as the SQF2000 (Safe Quality Food Certification) and the Woolworths' Vendor Quality Management Standard (WVQMS) that are based on the ISO 9000 series with additional components such as HACCP (Piccone 1999: 14). SQF2000 is a HACCP points-based food safety and quality risk management system provided to all the stakeholders of the food chain.

A good quality assurance system will improve farm business performance by using systems to pinpoint internal management strengths and weaknesses, increase efficiencies, quantify and reduce costs, and further strengthen relationships within the market.

During the consultation phase of this study, growers and industry professionals expressed that it would be beneficial if GEM practices could be built into existing QA systems rather than the development of entirely new systems. This need for alignment of frameworks is being increasingly recognised. For example, the ISO 9000: 2000 quality standard is closely aligned to the ISO 14001 environmental management systems standard.

Although meeting participants were critical of the way in which some QA systems had been implemented in the past, the importance of QA programs being industry driven was a key finding of the consultation meetings.

One QA system that generally received positive feedback from growers and stakeholders was '*Freshcare*' (Freshcare Ltd 2000). *Freshcare* is a code of practice based on HACCP principles for implementation by the horticultural sector. Growers and stakeholders reported that the main strength of *Freshcare* was that it was industry led rather than imposed by the supply chain.

Table 2.4: Strengths and weaknesses of QA

Strengths	**Weaknesses**
• Market driven. • Formal infrastructure for implementation. • On-farm emphasis. • May generate grower support when industry led. • May lead to increased production efficiency. • Strong focus on environmental performance and monitoring. • Strong adoption of food safety has already occurred therefore potential for environmental QA elements to be incorporated into existing systems.	• QA was controversial when initially implemented and there is strong grower resistance. • Compliance focussed rather than focus on continuous improvement. • May involve costs to growers through external auditing of systems. • Focuses on product attributes which do not reflect the ecological integrity of the farming practice.

Self-Auditing Schemes

Self-auditing schemes are decision-making frameworks based on grower self-assessment. They allow growers to monitor their environmental performance against their own previous progress or standards that have been externally set. Self-auditing schemes are widely used, both domestically and internationally to promote environmental management principles among farmers and horticulturalists. These schemes are often industry driven as a response to external pressure to demonstrate environmentally responsible practice. Several examples of self-auditing schemes exist among the horticulture and agriculture industries. These include:

- *Enviroveg* is a program designed to assist Victorian vegetable growers to adopt sustainable farming practices. The program includes a self-audit scheme that rewards progress with logos and branding that may be applied to the product. This project is in its initial stages and is using grower input to develop the guidelines and manual for the scheme. *Enviroveg* is profiled as a case study in Chapter 6.
- The Australian Professional Nursery Operators has developed a self-auditing tool designed to assess and improve environmental performance (Nursery Industry Association of Australia 1998). This tool is a quick self-help tool to determine how well "best practice" standards are being met.
- CSIRO (2001) has developed a Self-Help Evaluation Framework (SHEF) for Integrated Catchment Management (ICM). This publication aims to help stakeholders understand ICM and to gradually work towards a sustainable catchment by tracking progress, sharing viewpoints, evaluating goals and promoting communication about ICM.
- Farm *A*Syst is a United States self-audit scheme designed to "educate farmers on how their activities, storage structures and well design may affect the quality of their drinking water". It is a voluntary program and the assessment system is confidential.

Self-auditing schemes are applicable at a variety of levels but are most commonly applied at an on-farm level. They may be applied as a decision-making framework in their own right (such as with *Enviroveg* and SHEF) or as a tool within another framework. For example, *Freshcare* contains a self-auditing component as part of its code of practice (Freshcare Ltd 2000).

As shown in Table 2.5, one of the principal advantages of self-auditing schemes is that they are a voluntary initiative. The consultation phase of this study has shown that, in general, growers are not comfortable with external auditing of their operations. Self-auditing schemes provide the option of external audit if necessary, however, growers may chose to avoid or delay this step until required (whether by the market supply chain or legislation). As such, self-auditing may succeed in increasing adoption where frameworks requiring external audit do not.

Table 2.5: Strengths and weaknesses of self-auditing schemes

Strengths	Weaknesses
• Voluntary. • Results may be kept confidential. • Often market driven. • Reduces costs associated with external auditing (such as associated with QA). • May generate grower support when industry led. • Strong focus on environmental performance and monitoring. • May be aligned with a systems approach.	• Lack of external verification of environmental performance. • Does not apply well at catchment or regional scale. • Anthropogenically focussed.

Codes of Practice

Codes of Practices have been widely used for some time across industry as a way of encouraging the adoption of GEM practices. Codes of practice are emerging as a means of promoting consistent goals and measurable objectives across a range of growers.

The most prominent example of an environmental code of practice within the Australian horticulture sector is the QFVG's Farmcare (1998). *Farmcare* identifies different areas of environmental management and provides guidelines for good farm management within those classifications. The code of practice outlines a system whereby farmers should adopt all "reasonable and practicable measures within the constraints of a sustainable agricultural system to conserve environmental values".

The Code of Practice places the emphasis on the farmer to:

- *"Consider the potential harm of a management practice;*
- *Consider the sensitivity of the receiving area;*
- *Consider the current state of technical knowledge for the activity;*
- *Consider the likelihood of successful environmental outcomes from measures that might be used; and*
- *Consider the financial implications of implementing those measures".*

(QVFG 1998 p2)

Within Australia, some codes of practices for the horticulture sector are recognised under relevant legislation. For example, Farmcare has been endorsed as an approved code of practice under the Queensland Environmental Protection Act 1994 (QFVG 1998 pii). However, confusion over the legal status of codes of practice is common in the horticultural sector. This is likely to provide a barrier to the adoption of this framework unless this is clarified with relevant stakeholders.

Table 2.6: Strengths and weaknesses of codes of practice

Strengths	Weaknesses
• May be registered under relevant legislation. • Applicable at various scales. • Standards may be aligned with a systems approach. • Provides a basis for benchmarking. • May adopt a self-auditing approach. • May be based upon a systems approach.	• Confusion within the sector over the legal status of codes of practice. • Lack flexibility for adaptation to local conditions and individual situations.

Total Catchment Management

By examining environmental issues from a catchment perspective, total catchment management (TCM) is a high-level, holistic systems approach. Catchments are important from a horticulture perspective because most environmental impacts can be contained within the catchment or system.

TCM has been widely adopted by State governments in Australia. The Department of Land & Water Resources Conservation in NSW administers a region-by-region TCM program. TCM often involves a large number of stakeholders, for example, the four States spanned by the Murray-Darling Basin. As such, these systems are designed to manage high-level resource management issues from a stakeholder perspective.

One weakness of the TCM approach is that catchment boundaries are geographically, rather than politically defined. This can create bureaucratic difficulties in the administration of the framework. In the case of the Murray-Darling Basin, the co-operation of four State governments and numerous local councils is required to effectively manage the catchment.

Table 2.7: Strengths and weaknesses of total catchment management

Strengths	Weaknesses
• Strongly system based approach. • Widely adopted in Australia. • Strong government support for this framework. • Focussed on natural systems and environmental flows. • Local focus.	• Can lack a business management focus. • Not market driven. • Does not usually contain provisions for auditing (either external or self audit). • Based on geographic rather than political boundaries.

Whole Farm Planning

Also known as Farm Business Planning or Integrated Farm Management, Whole Farm Planning considers the present and future physical, financial and human farm resources. This type of planning framework can greatly influence the ability of a farm to achieve best environmental practice and best long-term economic outcomes. It is also important in integrating the economic and environmental objectives important for sustainability. Whole Farm Planning may employ a systems approach to manage farming operations from a holistic perspective. The strength of whole farm planning is that it applies conventional business planning techniques to the rural sector. Whole farm planning is a useful framework to assist growers in adjusting to the increasingly competitive horticultural marketplace.

In Europe and North America, quality assurance standards have extended to encompass the entire farming process. These farmers are under pressure to demonstrate sound environmental practices which minimise off site impacts such as soil loss, contamination of ground and run-off water, loss of biodiversity and water use efficiency (Department of Natural Resources and Environment (DNRE) (Vic) 2001). As such, Whole Farm Planning has been widely adopted as an integral part of farming operations in Europe and North America.

An example of the whole farm planning approach being adopted internationally is the Linking Environment and Farming (LEAF) project in the UK. LEAF is a whole farm approach to integrated crop management. The LEAF program is closely aligned with ISO 14001 in its adoption of formal procedures such as audits, waste management plans, conservation maps, records, and setting targets. LEAF is focussed on environmental best practice utilising both modern technology and traditional practices (IHD 2000: 3). LEAF uses demonstration farms and farmers to educate others about standards and reporting. Role-model farmers are generally highly motivated, skilled and located in strategic areas. LEAF also recognises that integrated crop management is site specific and decision-based.

The consultation stage showed that Whole Farm Planning was a strategy that growers would be willing to try. An example of an Australian initiative to encourage Whole Farm Planning, is the NHT funded "FarmBis Australia". Through farmer education and training in whole farm planning principles, FarmBis aims to improve the sustainability, profitability and competitiveness of the rural sector. FarmBis has key objectives including helping farmers profit from change, providing a welfare safety net, providing incentives for adjustment, and encouraging social and economic development. Funding for projects is allocated after evaluation of proposals initiated and partly funded in the community or corporate sectors. Preferred projects provide broad education and training for industries compared to the State Government FarmBis projects that assist individual farmers (FarmBis Australia 2001).

Table 2.8: Strengths and weaknesses of Whole Farm Planning

Strengths	Weaknesses
• Business planning approach. • Widely adopted in Australia. • On-farm focus. • Strong grower and stakeholder support for this approach. • Medium to long term focus. • Goal orientated.	• Anthropogenically focussed. • Not applicable at a catchment or regional scale. • No direct correlation with broader decision-making frameworks such as codes of practice or quality assurance (though elements of these may be incorporated).

2.4. Elements of Good Environmental Management

When developing environmental guidelines it is necessary to determine which relevant elements of GEM should be included. These elements will vary according to the critical issues in the region, industries involved as well as financial, social, cultural and institutional factors.

The following section outlines a number of practices, which may be regarded as the generic elements of GEM. These practices have been identified via a thorough review of relevant literature and consultation with growers, stakeholders and industry professionals. This list is not exhaustive due to the degree of variation in the horticulture sector. These practices are intended only to provide a useful starting point for the development of guidelines. Local and industry research is strongly recommended to develop the most appropriate guidelines for an area. Sources of useful information on each of the practices are provided as a supplement to the reference list at the end of this document.

Water

The Australian State of the Environment Report 1996 found that Australia has the most variable rainfall and stream-flow in the world (Wasson *et al* 1996 p 7-4). The report also found that in many irrigated catchments (and particularly the Murray-Darling Basin) irrigation is:

> *"nearly at the limit of the water resource and the further expansion of irrigated agriculture will be largely through productivity increases and industry restructuring".*
>
> (Wasson *et al* 1996 p 7-11)

Under the Council of Australian Governments Water Reform Framework (1999), water is becoming a tradeable commodity, segregated from land title (MacArthur Agribusiness and Sinclair Knight Merz 2001: 77). Water management issues are of increasing concern to growers as the regulations governing access to water are changing. In this context it is not surprising that at each of the consultation meetings, water and water management were cited as the biggest environmental issues facing horticulture. Two issues dominated discussion; access to water resources and water quality. The Information Study also found water management as the issue growers were most likely to seek information on over the next five years (GrowSearch 2002).

Inefficient management of water is a significant contributing factor to a number of environmental problems facing producers. Salinity, declining water quality, nutrient run-off, aquifer shrinkage and waterlogging are caused and/or exacerbated by poor water management. The impact and extent of these issues varies based on a number of crucial factors. These include: region, location within the catchment, type and scale of the enterprise, previous horticulture practices and current levels of environmental awareness and protection. Excessive water inputs and/or poor management of water outputs cause these problems and will impact on the profitability of horticulture enterprises in either the short or long term. Under the new Water Reform Framework, the efficient use of water may have economic benefits for horticulturists in this market environment.

Good water management for horticulture growers relies on the use of systems and practices that increase water-use efficiency. This should insulate growers against the impact of changes to the allocation system, whilst ensuring water availability for catchment health (often described as 'environmental flow'). Horticulturalists should accept and participate in the establishment of environmental flows to maintain river health, conserve aquatic ecosystems and dilute salt concentration peaks (Bell et al 2000: 154). Growers in areas of low rainfall, located downstream in catchments and with relatively high water requirements particularly need to optimise their water usage.

Table 2.9 contains a list of good water management practices, which are consistent with environmental best practice. These practices may be used as a guide for the type of practices that should be included in environmental guidelines.

Table 2.9: Good water management practices

Practice	Description
Targeted irrigation systems	The use of efficient water application systems such as drip, trickle, micro-spray and spitter irrigation systems.
Soil moisture monitoring	The use of technologies such as Tensiometers, Gopher, EnviroSCAN and Neutron probes to assess the level of water held in the soil profile to assist in determining the quantity and duration of irrigation required.
Regulated deficit irrigation	An irrigation strategy (predominantly used in stone fruit) that involves less irrigation early in the season to reduce excessive vegetative growth.
Scheduling	A plan of when and how much water is required to generate maximum yields without water wastage.
Opportunistic or continuous cropping	Planting when soil moisture is available due to rainfall events.
Benchmarking water use	Process by which performance is measured and used as a basis for comparison.
Run-off and drainage management	A range of measures that collect drainage and allow it to be reused.
Maintenance of vegetation cover	Establishment of a permanent vegetation cover and managing remnant vegetation.

Soil and Land Management

Soil erosion and health were cited as significant environmental issues in many of the consultation meetings. At Tasmanian meetings, in particular, soil erosion was raised as a serious problem for horticulture. In other parts of Australia, soil fertility, salinity and soil structure decline were raised as issues. The specific soil and land management issues of concern varied according to the dominant commodities, soil type and topography of the region.

The effective management of soil and land has demonstrated benefits in terms of lower input costs and, in some cases, improved yields. These benefits may be realised in both the short and long-term but will ultimately result in greater sustainability of environmental and horticulture systems. The management of soil and land resources under production can significantly decrease the quantity of fertiliser and labour inputs required. Outputs of salt, nutrients and sediments can be reduced through appropriate management and the quality of water outputs improved. Through effective management of cultivation, orchard and farm maintenance and nutrient application, run-off, sediment, nutrient, acidity/alkalinity and salt outputs can be reduced. Organic matter content of the soil can also be improved.

Good soil and land management practices (outlined in Table 2.9, following) involve a range of measures to address issues such as:

- Soil acidity;
- Soil structure decline;
- Erosion;
- Low organic matter;
- Nutrient levels; and
- Biodiversity loss.

Table 2.10: Good soil and land management practices

Practice	Description
Low impact tillage systems	Ploughing regimes which minimise or reduce tillage.
Erosion control measures	Measures designed to reduce the loss of sediment in run-off or as dust.
Fertiliser management	Appropriate scheduling, type and application rates and application methods and other aspects of good fertiliser management.
Mulching	Application of vegetative matter to the topsoil.
Maintenance of vegetation cover	Practices including agroforestry, alley cropping and crop rotations.
Conservation and maintenance of native vegetation	Conservation of native vegetation including riparian vegetation, wetlands, forest, scrub and/or native grasses.

Pest, Insect, Weed and Disease Management

Within horticulture systems, management of agricultural chemicals is important from environmental, social and economic perspectives. Agricultural chemicals are a costly input into production and minimising their use will reduce outlays by growers through savings on fuel, labour and machinery costs. In additional to environmental concerns, the appropriate management of chemicals is also a fundamental component of on-farm occupational, health and safety management.

If chemical residues are an output from farms (in run-off, produce or as drift) they may have implications for human health, quality assurance of produce, and the produce of neighbouring stock or organic enterprises, as well as impacting upon ecosystems and water quality.

Legislation is in place at both Commonwealth and state level to ensure agricultural chemicals are applied in a manner, which causes no harm to consumers, the public, livestock and some natural systems (James et al 1997: 22). All agricultural and veterinary chemicals must be registered by the National Regulatory Authority prior to legal sale in Australia (Environment Australia 1998 p 19). The government infrastructure surrounding the management of chemicals is complex and application of chemicals to crops should be thoroughly researched to ensure compliance with regulations and appropriateness to both the local area and crop.

Stockpiling of chemicals poses an unnecessary risk, and should be avoided. Monitoring usage provides information for better demand management so that chemicals can be ordered as required. Each time chemicals are purchased the choice should be reviewed to ensure an appropriate selection. Directions on the labels should always be read to avoid excessive or inappropriate (off-label) application.

Integrated Pest Management (IPM) was consistently cited during the consultation phase as an example of a GEM practice with which growers were experiencing successful outcomes. In most areas, IPM had been attempted and where it had not, growers were keen to trial the practice. Implementation of IPM by growers is often driven by alternatives to chemical control where resistance by pests or diseases has occurred. As is discussed in detail in Chapter 4, the strong support available in the private sector for IPM has been a significant factor in the high rate of adoption.

Other aspects of the good management of pests, insects, weeds and diseases are outlined in Table 2.11.

Table 2.11: Good pest, insect, weed and disease management practices

Practice	Description
Chemical handling procedures	Practices for the storage, transport and disposal of chemicals.
Integrated pest management	Control strategies in which combinations of biological, chemical, mechanical and cultural tools are used.
Application management	The minimisation of chemical application through appropriate practices and equipment.
Containment	Prevention of the movement of chemicals offsite.
Farm hygiene	The prevention of the introduction of pest, weeds and diseases.
Conservation and maintenance of native vegetation	Including riparian vegetation, wetlands, forest, scrub and /or native grasses.

Noise

Horticulture is coming into closer proximity with residential areas as urban encroachment moves into areas which were previously solely under horticultural production. It is particularly in these areas noise is an issue. Excessive noise should be avoided in areas adjacent to dwellings during times when people may be asleep (11pm to 7am is a useful guide but this will vary between states and local council areas). Where farms are adjacent to dwellings and evening activity is necessary, commencing activity near the dwelling and moving away as it gets later may be a helpful compromise (and the converse for early morning activities).

Effective communication with neighbours may be the best management strategy. If neighbours are aware that harvest is occurring for the next two weeks (for example) and there will be noise between certain times, then neighbours may be more accepting.

Growers should be aware of the local council and state authority regulations for noise in their area. Useful sources of information include:

- The Environmental Protection Authority (EPA) or equivalent body in each State;
- Local councils; and
- Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future. Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.

Air

GEM regarding air quality for horticulture has five aspects of management:

- Spray drift;
- Dust;
- Smoke;
- Odour; and
- Greenhouse gas emissions.

As with GEM practices for noise management, effective communication with neighbours may be the best management strategy. Informing neighbours of times, dates and duration of spraying and burning may help reduce the possibility of a complaint being made. Other GEM practices for air are outlined in Table 2.12.

Growers should be aware of, and comply with, all regulations governing air quality and management. Growers should contact the relevant environment authority in their State or Territory and their local council.

Table 2.12: Good air management practices

Practice	Description
Managing spray drift	Minimisation of drift through buffer zones, timing of spraying and appropriate equipment.
Managing dust	Use of conservation tillage practices and other techniques to reduce farm traffic.
Managing burning	If burning is necessary, a high intensity burning is most likely to reduce impact.
Managing odour	Practices which reduce the movement of chemicals offsite or odours from manure.
Managing greenhouse gas emissions	Reducing land clearance, burning activities and the use of fossil fuels.

Waste

Stage 1 of this study, 'Horticulture – productivity and sustainability' (Sinclair Knight Merz 2001) found that the disposal of chemical containers was the highest priority environmental indicator among state agencies and horticultural producers. The present study has found that primary areas of concern for waste disposal on farms are chemicals, chemical containers and plastics (e.g. drip tape, banana bags and greenhouse waste). The disposal of organic matter (such as trees which have been removed) may also be a problem.

The environmental literature indicates that good waste management should follow the 'waste hierarchy' of 'reduce, reuse and recycle' wherever possible. Practices that prevent the generation of waste should also be favoured over waste disposal options. For example, it is preferable to only dilute the amount of a chemical required for application to avoid the problem of disposing of excess chemicals. Also, green waste should be mulched or composted where possible to keep down weeds and retain soil moisture thus reducing herbicide requirements and amount of irrigation required. Chemical containers should be disposed of through an appropriate program wherever possible, such as *Drum Muster* and *ChemCollect*. Plastic should be removed to landfill where possible or burnt under high intensity conditions.

Table 2.13 provides information sources for the GEM of waste.

Table 2.13: Good waste management practices

Practice	Description
Disposing of chemicals	Mixing only appropriate amounts of chemicals or disposal of dilute chemicals onto land.
Disposing of chemical containers	Use of an appropriate collection program such as *Drum Muster* and *ChemCollect*.
Disposing of plastics	Reuse of plastics or disposal to avoid burning where possible.
Disposing of organic matter	Use of mulching and composting.

Biodiversity

With increasing federal and state government biodiversity conservation legislation, landholders are under increasing expectation to actively manage endangered and threatened species, remnant vegetation, riparian vegetation, native animals and feral pests within the boundaries of their properties. Land clearing is an increasingly restricted activity due to its impact on biodiversity and a suite of other environmental problems. Due to the high level of regulation in these areas, significant departmental support is available for various government agencies in each state. Due to the highly endemic nature of Australian ecosystems, GEM practices for biodiversity are highly variable. GEM practices in Table 2.14 (over page) are high-level only and local information is essential for the management of biodiversity.

Table 2.14: Good biodiversity management practices

Practice	Description
Conservation and maintenance of native vegetation	Including riparian vegetation, wetlands, forest, scrub and /or native grasses.
Managing native animals	The conservation and management of native animals present on a property.
Managing endangered and threatened species	Species that are listed in Federal or State Acts.
Managing feral pests	Controlling the populations of, or removing feral pests from a property.

2.5. Summary

Successful environmental management hinges on effective planning. Without sound financial and personal planning, good environmental outcomes are difficult to obtain. An environmental decision-making framework formalises this planning process and integrates environmental objectives into the farm decision-making process. A number of models for environmental management are available. These models include:

- Environmental management systems;
- Adaptive environmental assessment and management;
- Quality assurance;
- Self-auditing schemes;
- Codes of practice;
- Total catchment management; and
- Whole Farm Planning.

Environmental guidelines should include a number of elements of GEM. These elements will vary based on the critical issues in the region, the industry or industries involved as well as financial, social, cultural and institutional factors. When developing environmental guidelines, it is critical to tailor the guidelines to the industry and region involved. Environmental management has very few generic, prescriptive solutions. Local solutions have the greatest chance of increasing on-farm adoption of GEM practices. As such, local and industry research and consultation is strongly recommended to develop the most appropriate guidelines for an area.

3. Implementing Good Environmental Management Practices

3.1. Overview

The way in which environmental programs are designed and delivered is crucial to their success as an environmental initiative. Horticultural producers have unique change management characteristics that need to be integrated into any implementation strategy. At all stages of the strategy it is critical to build grower ownership and utilise elements that most readily drive changes in grower behaviour.

This chapter examines the change management characteristics of the horticultural sector, specifically as they apply to the adoption of GEM practices. This study has defined and modelled the process by which new practices and technologies are adopted in the horticultural sector. This 'Adoption Process Model' has been developed through a series of qualitative meeting facilitation techniques applied during the consultation phase of this study. The change management characteristics of an industry group are a complex and abstract set of sociological and psychological factors. These factors are difficult to quantify and emerge through qualified, value statements during group discussion. Details of meeting facilitation techniques and methodology are provided in Appendix A and detailed meeting results are provided in Appendix C.

The Adoption Process Model identifies two areas of understanding, which are fundamental to the successful implementation of environmental programs:

1. The application of appropriate change management tools; and
2. The utilisation of factors that are known to drive change in the horticultural sector (such as market access and legislation).

These two aspects of the Adoption Process Model are discussed below. This discussion is based on the findings of the facilitation meetings. Qualitative meeting discussion has been heavily referenced to provide insights into the mindset of growers and stakeholders on these issues. Due to the high level of regional and commodity variation in change management characteristics these have been employed as illustrative examples to highlight this variation. Where applicable, quantitative survey data has been discussed.

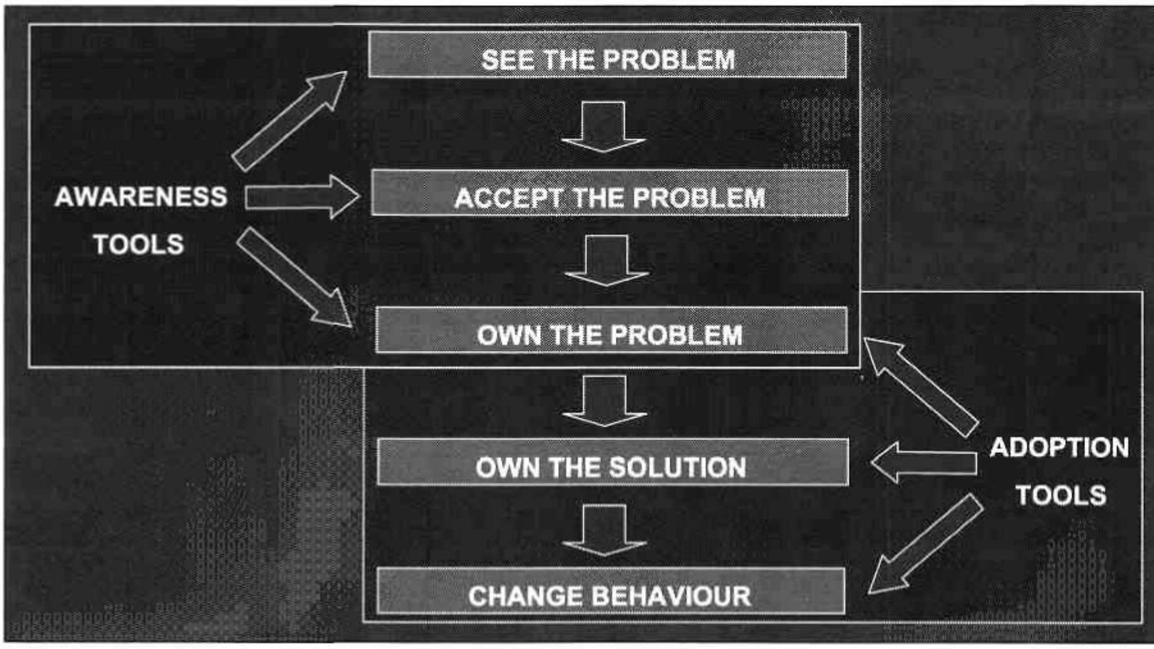
3.2. Adoption Processes in the Horticultural Sector

Horticultural producers in Australia have unique and specific change management needs. These needs are based on number of sociological and psychological factors including level of training, literacy, commodity, age, gender, industry, ethnicity, values, beliefs and location. However at a high-level, the process by which behavioural change occurs among horticultural producers has many common elements. These elements are shown in the Adoption Process model in Figure 4.1.

This model describes the phases of acceptance which growers must pass through to change their behaviour, the appropriate tools to assist the growers at different phases and the motivating factors that drive growers to move from one phase in the process to the next. In Figure 3.1, orange boxes represent the phases in grower acceptance that lead to increased adoption. The appropriate tools are described by two broad categories: adoption tools and awareness tools which are outlined in detail in section 4.3. The green arrows between the phases annotate the motivations driving grower change such as legislation, market drivers and economic drivers. Drivers for change in the horticulture sector are discussed in detail in section 4.4.

As Figure 3.1 indicates, the Adoption Process for horticulture is punctuated by distinct phases of grower acceptance of the need for change (discussed following). The speed at which growers progress through these stages varies greatly based on the grower's receptiveness to change, the way the change process is managed by industry professionals (from either the public or private sectors) and change is voluntary or forced by legislation. Environmental leaders are expected to move rapidly through the Phases 1 to 3 in a very short time frame (weeks), while Phase 4 may be lengthier as these growers seek to develop their own, innovative solutions. Alternatively, change resistant individuals may never move into Phase 2 and 3 in which the problem is acknowledged and responsibility for action accepted. Understanding and actively managing grower progression through the Adoption Process phases is essential to ensuring maximum adoption of GEM practices.

Figure 3.1: Adoption Process model



Phase 1: "See the Problem"

At this stage grower recognises a problem is present and is most effectively triggered through tangible evidence of the problem. For example, this may occur through:

- Observation of physical signs (such as erosion on the grower's property); or
- The problem being brought to the growers' attention (for example through an industry newsletter or media attention).

If the latter is the case, secondary reinforcement may be necessary to encourage the grower to move into the next phase of the Adoption Process. Growers may need to observe this problem on their own properties.

Phase 2: "Accept the Problem"

At this stage, the grower accepts that the issue is, indeed, a problem and some form of action needs to be taken to address it. An example of this phase may be that a grower is aware that the local waterway has elevated nutrients, *and that this is a result of run-off from horticultural properties.* Recognition of the impact of an environmental issue or productive activity is often a crucial part of 'accepting the problem'. Inherent in this phase is a heightened understanding of the problem. This increased understanding is a fundamental component of building grower acceptance of a problem.

This stage is often reached through the provision of specific local cause and effect evidence to the grower. During this phase, growers look to others to solve the problem.

For example, it may be seen as a government responsibility to provide collection services for the appropriate disposal of chemical containers.

Phase 3: "Own the problem"

When the grower enters this phase, they have accepted that the problem is their responsibility to address. The grower will be responsive to information on potential solutions and may be proactive in seeking these out.

Phase 4: "Own the Solution"

For environmental measures to be readily adopted in the horticulture sector, it is important that growers have ownership in those measures. If growers are included in research and development processes, adoption is more likely to occur. Where technologies or practices are being transferred, local trials or demonstration sites are important. Solutions aligned with key drivers for behavioural change (as discussed in section 4.4 following) are also more likely to be successful. Where these conditions are met, growers will feel more comfortable with making a financial commitment to the implementation of environmental measures.

Phase 5: "Change Behaviour"

Guiding growers to change their behaviour and ultimately adopt GEM practices is the objective of any implementation strategy. It is important to understand that each of the phases of the above process are required for change to occur. However, the lengths of time in each phase and the total time required to move through the adoption process will vary for each individual and enterprise. Environmental innovators are those which move more rapidly through the entire process particularly, phases 1 to 3 may be particularly rapid whereas change resistant individuals will require significantly more time in each of the five phases.

It is important to note that at any stage during the Adoption Process, growers may choose to 'actively reject' behavioural changes (Linehan and Johnson 2001: 21). This occurs where despite understanding all relevant information, growers choose not to change their behaviour. Active rejection occurs based on the values and beliefs of individuals and will occur wherever voluntary adoption is sought.

As such, 100% adoption of voluntary measures is not a feasible outcome of extension programs (Linehan and Johnson 2001: 24). This is particularly the case of environmental measures where many of the benefits are public goods and direct, short-term benefits to growers may be minimal. Emerging research suggests that the most appropriate measure of the success of a program is to identify the proportion of the group who are receptive to change. Program success should then be measured against that proportion. The following discussion of tools and drivers are techniques for increasing the adoption among this group.

3.3. Tools for the Implementation of Good Environmental Management Practices

At different phases in the Adoption Process, different communication and information tools are required. One common mistake made by information and extension officers is assuming awareness naturally leads to adoption. Although awareness raising is a critical component of the adoption process, a heightened knowledge and understanding of the issue will not necessarily lead to changes in grower behaviour. Successful programs lead the target audience through all phases in the process with the appropriate combination of tools for the audience and the adoption phase.

As indicated in Figure 3.1, the Adoption Process tools may be divided into two categories: Awareness Tools and Adoption Tools. The role of these tools in the adoption process is discussed, in detail, below.

3.3.1. Awareness Tools

Awareness Tools are those strategies most commonly used for communication and information distribution. These tools are passive, as the growers are not proactively involved. Examples of awareness tools include:

- Newsletters (distributed via post, e-mail or fax);
- Fact sheets;
- Media;
- Videos;
- Decision support soft-ware;
- Web-sites; and
- Meetings with speakers.

Awareness Tools are primarily used to generate recognition and acceptance of issues, problems and potential solutions. These are most effective in Phases 1 and 2 of the Adoption Process (Figure 3.1) and are also useful in Phase 3 to provide information on solutions.

The appropriate mix of awareness tools for a particular audience varies greatly based on the commodity group (or combination of commodities), spatial distribution of growers and the general level of sophistication of the growers. As such, identifying the characteristics of the target audience is critical to the successful use of awareness tools.

Many examples of differing communication needs were identified during the consultation phase of this study. The following examples serve to illustrate the importance of understanding the communication needs of the target audience (note these are general findings only).

1. E-mail is the most useful means of communicating with most potato producers. The industry has become increasingly scattered as farms increase in size and growers spread out to reduce their disease risk. Holding meetings is not feasible and the growers respond well to e-mail communication (Consultation Meeting, Virginia, 31/08/01).
2. E-mail is also the most useful means of communicating with vegetable growers in Western Australia (Consultation Meeting, Kununurra 5/9/01, Perth 3/9/01). This is due to the distinct (and isolated) production areas in the State ranging between the Ord River and the outskirts of Perth. Faxes are also an effective awareness tool (Consultation Meetings, Kununurra 5/9/01, Perth 3/9/01).
3. Internet based tools are not useful in Central and Northern Queensland due to technical difficulties in downloading large amounts of information (Consultation Meetings, South Johnstone 20/8/01, Bundaberg 16/08/01).
4. Videos with accompanying audio-cassettes in multiple languages are useful in areas where growers are from non-English speaking backgrounds or where literacy levels are low (Consultation Meeting, Virginia, 31/08/01).
5. Newsletters are more useful when faxed than when posted due to the high volume of mail received by citrus growers in the Murrumbidgee Irrigation Area (Consultation Meeting, Griffith 29/08/01).

The Information Study found industry newsletters to be the most highly rated awareness tool within the industry (GrowSearch 2002). Industry journals, government information sheets and books were also highly rated. Industry newsletters were also found to be the second most useful information source, followed by the Internet and industry journals.

3.3.2. Adoption Tools

As individuals enter Phases 3-5 of the Adoption Process, they become proactively involved. Adoption Tools are those which actively engage the growers. These tools provide practical and technical assistance to enable the implementation of environmental measures. The role of Adoption Tools was aptly surmised by a South Australian industry professional:

> *"Growers need to be more than just told they need a sediment trap. They need to be shown how to dig one".*
>
> (Consultation Meeting, Virginia 31/08/01)

Examples of effective Adoption Tools include:

- Field days;
- Videos;
- Conferences;
- Demonstration sites;
- Open trials;
- Tours to regions of successful implementation;
- Individual consultation; and
- Training courses.

In the past, government extension services (through State agriculture or primary industry departments) have been the major provider of adoption tools to growers. These extension services provided one-on-one advice and assistance to growers, often on their own properties. In line with the increasing expectation of horticultural producers to compete in the marketplace, as do other business sectors, changes to government policy in the mid-1980s has meant these services have been largely withdrawn in most states (AgWA pers comm 24/9/01). The perception within the industry (founded or otherwise) is that:

> *"The extension service has been gutted and no support has been put in its place. The service has disappeared overnight"*
>
> (Consultation Meeting, Perth, 3/09/01)

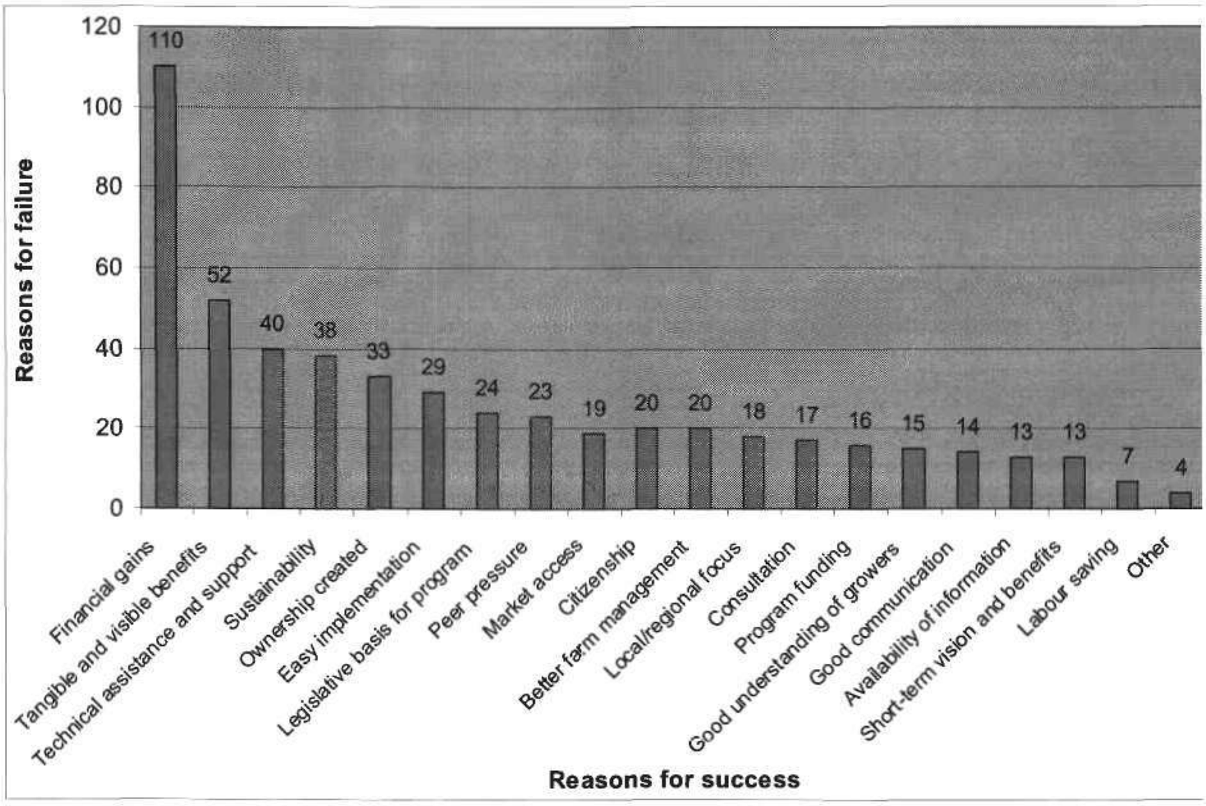
The consultation phase of the present study found that horticultural growers, particularly in Tasmania, Queensland, New South Wales and Western Australia, were still expecting to receive this service. An AgWA customer survey conducted recently indicated that older growers especially, continued to seek this service.

Since the withdrawal of extension services, government programs have placed a greater emphasis on awareness tools than on adoption tools. Indeed, technical and practical information is now more commonly supplied by private consultants. The consultation phase of this study found that the primary reason that IPM has been readily accepted by the horticultural sector nationally is that on-farm technical assistance is readily available through private consultants. In preparing programs to implement environmental guidelines, it is important to include adoption tools to provide technical assistance and drive changes in grower behaviour.

Unlike Awareness Tools, the effectiveness of various Adoption Tools does not vary greatly based on the specific target audience. However it should be noted that while the *tools* may be equally effective, the *content* should be tailored to the specific skills and educational needs (i.e. language barriers or literacy levels) of the target audience.

During the consultation phase growers and stakeholders were surveyed on reasons why some projects succeed in increasing adoption. A wide variety of responses were received and the most common responses are shown in Figure 3.2.

Figure 3.2: Reasons why projects succeed in increasing on-farm adoption of GEM practices



As Figure 3.2 shows three of the top four responses were:

- Technical assistance and support;
- Easy implementation; and
- Tangible and visible benefits.

These responses emphasise the importance of the role of Adoption Tools as practical explanations and demonstrations of GEM practices. Qualitative discussion revealed that across all commodity groups and all regions, field days were the single most effective Adoption Tool. Field days meet all of these criteria by demonstrating and explaining practices and technologies in an interactive way. At one Tasmanian meeting, the reason for the success of field days was explained as follows:

> *"Growers are practical people, they need to see the benefits, i.e.: this is what I did, this is how it worked, this is the result."*
>
> (Consultation Meeting, Launceston, 10/08/01)

The findings of the Information Study support the importance of adoption tools. Conferences were found to be the most useful information source to the horticulture sector (GrowSearch 2002). This is likely to result from to both the information provided at conferences and the role of conferences in providing a forum for growers and stakeholders to meet as discuss issues of importance.

During the consultation phase, it was suggested that incorporating a number of Adoption Tools into research and development projects was an important step in building ownership in those solutions. It was suggested that involving growers at a number of stages in the research and development of environmental technologies and solutions would increase grower ownership of these solutions. As such, an effective communication strategy for Phase 4 in the Adoption Process may involve:

- A project 'launch' in which growers are invited to hear details of the R&D program and provide early input;

- A demonstration site that is periodically "opened" for growers to view the progress of any field trials. Field trials conducted on a grower's property may be particularly effective;
- A field day to communicate and demonstrate the outcomes of the research; and
- A newsletter to raise awareness of the findings of the project among industry professionals and researchers in other regions and working with other commodities.

Structuring R&D funding to ensure these Adoption Tools are included may be a useful way to move growers into Phase 5 of the process where behavioural change occurs.

The *Enviroveg* Project of the Victorian Vegetable Growers Association (profiled in Chapter 5) has implemented an innovative tool whereby leading horticultural soil scientists and academics are brought to growers' farms to conduct soil tests. Initial findings are presented to growers at an evening workshop and full results are made available once complete. The findings are used as the basis for further soil conservation projects.

Another factor, which emerged as encouraging changes in grower behaviour, was the personality of the individual delivering the program or guidelines. In most instances where an environmental program was generating high levels of adoption, growers named the individual rather than the program as the means of identifying the program. For example, growers would state "Joe Bloggs' soil stuff" not the official title of the program. Selecting an individual whom the growers trust, or can win the trust of growers, is important for encouraging grower ownership in a program. Some attributes, which emerged during the consultation phase, were that the individual should be:

- Either from the industry or the local area;
- Perceived as being loyal to the growers and passionate about the project;
- Open and approachable; and
- Accessible to provide practical and technical assistance.

The movement from Phase 4 to Phase 5 is perhaps the most difficult transition in the model and growers want to be guided by a trusted individual. The importance of trusted individuals also emerged in the Information Study (GrowSearch 2002) with the highest response rates being attained where surveys were endorsed by a trusted individual.

To facilitate adoption, it is also necessary to use a number of factors that motivate change in horticultural producers. Understanding the role of market, economic and legislative drivers (among others) in the target audience is the next important step in the development of a plan to encourage the adoption of GEM practices.

3.4. Understanding the Drivers for Change

The tools for increasing adoption of environmental measures are most effective when they are designed to tap into the factors that drive change among the target audience. These factors drive the Adoption Process, by encouraging movement from one phase of the to the next (as indicated by the green arrows in Figure 3.1).

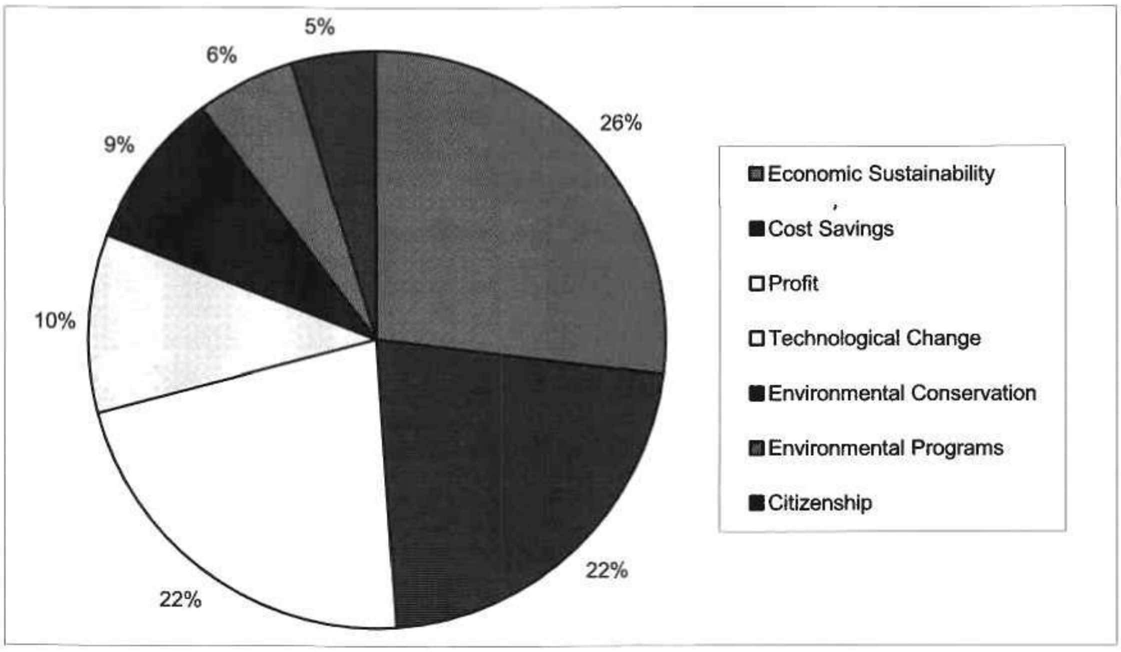
When designing an implementation strategy, an intimate understanding of the factors that drive change in the target audience is fundamental to increasing adoption. The unique suite of drivers in region or industry groups should, indeed, form the focus the implementation strategy. While the relative significance of drivers will vary between target horticultural groups, a survey of meeting participants in the consultation phase of this study has found that several drivers are dominant within the Australian horticultural sector. These drivers (shown in Figure 3.3 following) refer to the factors that the industry personally felt encouraged them to change their behaviour.

Economic sustainability was the major driver for the implementation of environmental measures. During the consultation phase, the concept of sustainability was shown to primarily focus on the ability of growers to be financially viable in the long term with profitability being the dominant concern. As such, the top three drivers, with a combined response of 70%, for the implementation of environmental measures were financial (sustainability, cost savings and profit).

Environmental programs were not shown to have the same level of influence as these factors. This demonstrates the importance of understanding the drivers for change as a means of increasing the adoption resulting from environmental programs. For example, the inclusion of a cost-benefit analysis to demonstrate how an environmental practice or technology could save costs is likely to increase the effectiveness of an environmental program.

The consultation phase of this study examined some of the broad change drivers in the Australian horticultural sector. These findings of the consultation, and techniques for utilising these to drive the implementation of GEM practices, are discussed below.

Figure 3.3: Drivers for the implementation of environmental measures



3.4.1. Market Drivers

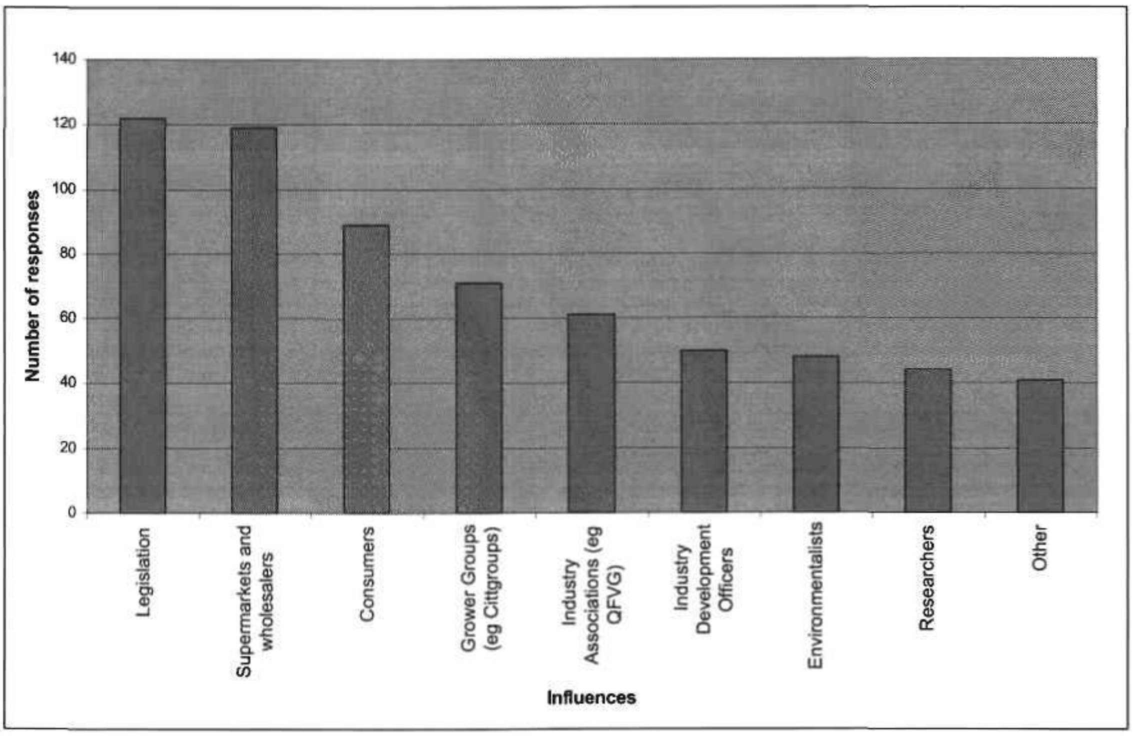
Financial concerns were found to be the most significant factor motivating growers to adopt environmental measures. Figure 3.4 illustrates the factors with exert the greatest influence upon the decisions of growers to adopt environmental measures. These refer to the organisations or entities whose opinions or actions were most likely to result in a behaviour change by growers. In light of the strength of financial considerations as motivations, it is not surprising that, after legislation, supermarkets, wholesalers and consumers exert the strongest influences on change.

The current market for horticultural produce is highly competitive, complex and dynamic. This highly competitive environment means that producers are sensitive to factors that may influence their margins. Market forces are highly effective in driving change in the horticultural sector. These market forces generally fall into three categories:

1. Market access;
2. Price premiums for 'green foods'; and
3. Marketing opportunities.

The characteristics and strengths of each of these elements of market forces in driving change are discussed below.

Figure 3.4: Influences on change in the horticultural sector[2]



Market Access

Market access refers to the ease with which producers can sell produce into new and existing markets. Market access is primarily influenced by quarantine (export) or QA (export and domestic) requirements. Market access was consistently cited, during the consultation phase, as being a major reason for changing behaviour. This motivation takes two forms. Access to new markets may be the 'carrot' that encourages growers to change. Seemingly more effective is the threat of losing markets if a grower does not comply with requirements of that market (be it quarantine or QA).

The introduction of QA systems is an example of the effectiveness of threats to market access in driving change. Since the early to mid 1990s, most supermarkets and wholesalers have introduced various forms of QA. Under this system, produce is required to meet certain quality standards to be accepted into these markets. These standards include, for example, requirements of chemical certification by the producer, colour, size and/or levels of damaged produce. Producers have met the introduction of QA systems with varying degrees of acceptance. While many producers have negative attitudes towards QA, the 'stick' of reduced market access has led to relatively high levels of adoption. An industry professional explained:

> *"Growers are not happy with QA but their businesses are running better and they recognise this".*

(Consultation meetings, Perth, 03/09/01)

QA has been most widely accepted where it has been addressed by growers prior to the imposition of market requirements. For example, the Queensland Fruit and Vegetable Growers' developed *Freshcare* (Code of Practice On-Farm Food Safety Program for Fresh Produce) in response to the perception that QA would be imposed by either the supply chain requirements or government regulation. In this case, the perception of reduced market access alone was enough to drive change. High levels of adoption were achieved due to industry ownership of the solution. This is one

[2] This question was not mutually exclusive. Respondents were asked to nominate the three factors most likely to influence their decisions. The results in Figure 3 are cumulative.

example of how the motivations for change can be harnessed to drive the Adoption Process in horticulture.

While presently no specific environmental requirements have been introduced into QA systems, this is on the horizon. Southcorp (one of Australia's largest wine producers) has recently announced a 'partnership' with the Australian Conservation Foundation. By 2005, Southcorp will not accept grapes from growers who have not implemented best practice salinity control measures on their farms (Environmental Manager 20/11/01). It is expected that this type of QA will be increasingly common for horticulture in the future. Some wholesalers are restructuring their QA systems to allow environmental issues to be incorporated should this be desired. Should environmental QA be more broadly adopted, growers will be required to adopt environmental measures to maintain market share. Projects such as the *Enviroveg* project of the Victorian Vegetable Growers' Association (profiled in Chapter 6) are using this concern as a means of encouraging the early adoption of environmental measures. This will allow growers to offset cost over time and maintain market access.

The use of Genetically Modified (GM) organisms in horticultural production is another example of how market access may be restricted. There is a global trend towards the restriction of the sale of GM produce. For example, Brazil and Russia have officially banned the growth of GM crops and the importation of produce with GM material (Global Ecovillage Network 04/12/01). The European Union has put in place legislation that requires all GM foods and foods produced using GM feed to be labelled (Reuters New Service 29/08/01). In the UK, there is a trend towards some supermarkets restricting sales of GM foodstuffs (Reuters New Service 01/06/01). Consumer, scientific and government concerns over the safety of GM food for human consumption and the environmental implications of GM 'escapes' into natural systems has led to this high degree of market regulation.

In Australia, compulsory labelling standards apply to GM food products. Under Standard A18 of the *Australian Foods Standards Code* (Food produced using gene technology) food producers are required to know, document and in some cases label the genetic modification status of their products. The Standard requires:

- All GM food be assessed and approved for sale and use; and
- All GM food and ingredients to be labelled where they contain:
  - Novel DNA and/or novel proteins in the final food; or
  - Have altered characteristics.

To do this, food businesses must take all reasonable steps to:

- Find out if their food is GM or has a GM ingredient – this includes additives and processing aids;
- Find out if the GM food or ingredient is approved; and
- Determine the labelling requirements for the food.

It is unlikely that this significant degree of market restriction applied to GM foods will be applied to produce based on environmental concerns. However, it serves to highlight the general trend towards food produced cleanly and in an environmentally sensitive manner. International quality requirements are becoming more stringent, particularly in Europe, Japan and North America and this trend is likely to be reflected in environmental requirements. During the consultation phase, it was suggested that Australia has an image of 'clean and green' production. Growers who are early adopters of environmental measures are likely to be able utilise this image to gain access to these markets, thus providing an incentive to adopt.

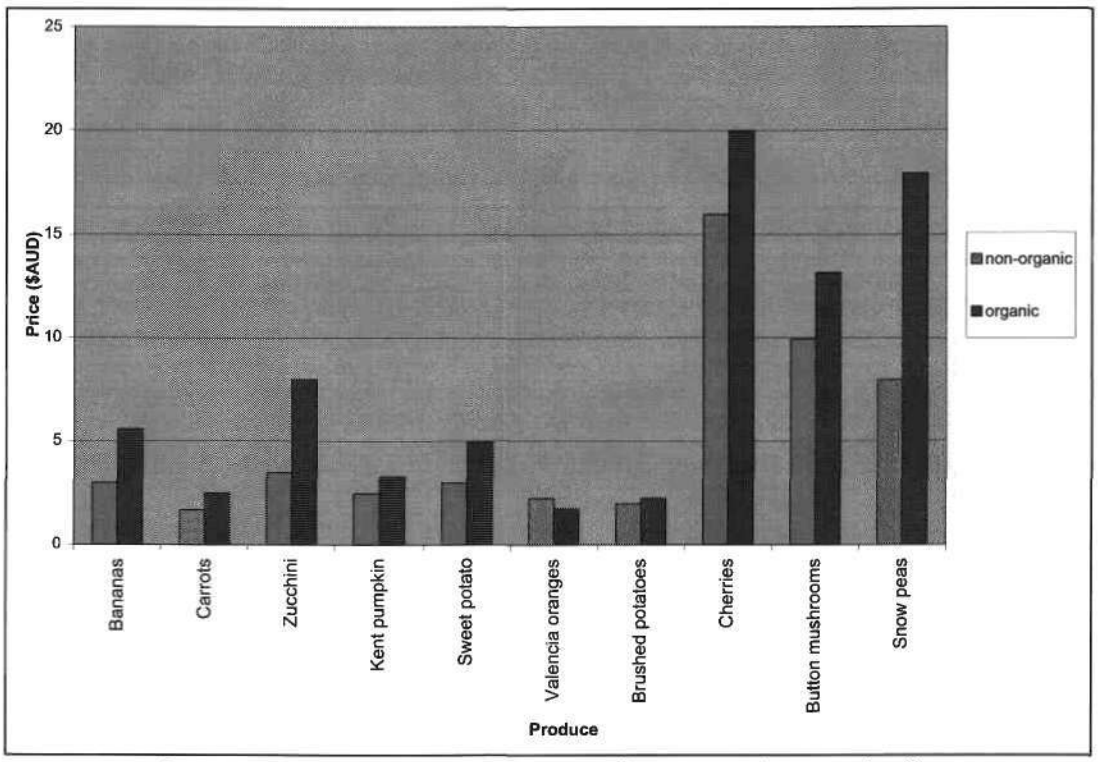
Premiums for 'Green' Foods

Another way markets drive change is through offering financial incentives. This may take the form of price premiums paid for produce that meets certain criteria. For example, price premiums are currently paid for organic produce.

Certified organic produce is defined by the National Association for Sustainable Agriculture Australia Ltd as foods grown using appropriate land management practices without the use of artificial fertilisers, herbicides, pesticides, growth regulators, antibiotics, genetically altered elements, or hormone stimulants, or intensive livestock systems. Produce may be certified after the farm has been operated organically for 3 years. In Australia, organic produce comprises 1-2% of the fresh food market and growing strongly (Global Ecovillage Network 4/12/01). Globally, share is growing by 25% per annum with the value of the world organic market projected to reach US$100 billion by 2006. In Europe, market share is expected to reach 30% by 2010.

It has been demonstrated in the market place that consumers are willing to pay a higher price for organic produce. Figure 3.5 illustrates the comparative retail price differential between organic and non-organic produce at selected retail outlets on a given day. The motivations for consumer preference for organic foods largely stems from increased awareness of health and safety issues. Organic foods are also viewed as an environmentally responsible purchase.

Figure 3.5: Comparative retail prices of organic and non-organic produce



Source: www.greengrocer.com.au, www.colesonline.com.au and www.woolworths.com.au on December 4, 2001.

While price premiums for 'green' foods are not a common practice in Australia, these foods have begun to attract price premiums in the USA and Europe. Bananas that carry the 'Eco-OK' label in the USA have been attracting price premiums of up to 60 cents per pound (Masibay 19/07/2000). The Eco-OK label is an initiative of the 'Better Banana' project, which awards certification to companies that meet certain socio-environmental criteria. Examples of practices being adopted include on-farm reforestation projects and higher wage levels on banana plantations in Costa Rica and Panama. To maintain certification, farms must show continual improvement during annual audits and surprise visits. To date, several large banana producing companies, including Chiquita have become involved in the 'Better Banana' Project (Masibay 19/07/2000).

If the Australian market follows this global trend then price premiums for 'green' produce are likely to become more common. This may encourage growers to begin to implement environmental best practice technology in order to position themselves to take advantage of these opportunities as they arise.

Marketing Opportunities

International trends indicate that consumer demand for environmentally friendly produce is increasing. Producers who can market their produce as environmentally sound may be able to increase market share, leverage price premiums or both. One example of the trend towards the marketing of produce as environmentally sound, is that of the "Whole Foods Market" (WFM) chain of stores in the USA. WFM are the world's biggest retailer of natural and organic foods with 126 stores in North America. The company has a motto of "Whole foods, Whole people, Whole planet" and has a policy of sourcing organic, biodynamic and environmentally sound products whereever possible. By marketing the stores, WFM has been able to harness consumer preference for 'green foods' and had over the counter sales of US$1,800 million in 2000.

In Australia, there is the potential for growers to market their produce in a similar way by implementing GEM practices. *Abbotsleigh Citrus* in the Central Burnett region of Queensland (profiled in Chapter 7) has implemented an EMS that aims at ensuring the company operates at environmental best practice standards. The company's stated aim is:

> *"To fully embrace the concept of sustainable agriculture, which includes the protection and enhancement of the environment".*

(*Abbotsleigh Citrus* Company Profile 2001: 4).

Abbotsleigh Citrus actively markets itself as 'clean and green' and now exports to Singapore, Malaysia, Indonesia, Philippines and Hong Kong (Landline 22/09/01). Supply contracts from major Australian wholesalers have also been secured (Foodweek 05/03/01). As mentioned above, the 'clean and green' image of Australian produce also provides marketing opportunities for those growers demonstrating GEM practices. Marketing which leverages off these factors may increase the market access gained or price premiums attained. There remains however some scepticism as to whether in the long term, consumers and large retailers for example will be willing to pay price premiums for environmentally best practice accredited products. Nevertheless producers such as *Abbotsleigh Citrus* are likely to be realising some 'first mover' advantage in this area and could be expected to hold this position as other producers are forced to edge toward these standards on the back of tightening regulatory standards.

3.4.2. Economic Drivers

Economic drivers refer to a broad suite of motivations for implementation that are based on financial gain. Economic drivers for the implementation of GEM practices are often based on cost savings rather than increased profit. Figure 3.3 indicates that cost savings are an equally strong incentive as increased profit. Two types of economic driver will be discussed here:

1. Cost savings; and
2. Long-term financial viability of production.

In both sections, cost-benefit analysis will also be discussed as the primary tool for demonstrating the economic benefits of an environmental program to growers.

Cost savings

Many elements of GEM involve the effective management of horticultural systems such as water, fertiliser and chemicals. As these inputs all have an associated cost, the reduction of these inputs will result in reduced production costs to the producer. Cost-benefit analysis can clearly demonstrate the financial advantage of reducing inputs to production. For example, the cost of soil testing to improve the application of nutrients should be assessed against reductions in nutrients applied over a fixed period. Cost-benefit analysis can also be clearly demonstrated where there is a financial cost associated with legislative non-compliance.

For *Abbotsleigh Citrus*, financial benefits have been realised through the introduction of an IPM system. The costs of pest and disease control have been minimised by using biological controls wherever possible. To assess the economic benefits, the company has developed a model to track the current IPM costs against the cost of traditional control measures. The model also allows *Abbotsleigh Citrus* to determine the point at which natural control measures become more expensive than chemical control. This cost-benefit analysis is discussed in detail in Chapter 7.

Cost-benefit analysis of the savings of specific environmental measures at a property level is relatively straightforward and can be used as a powerful motivation for the adoption of environmental measures. However, conducting a comprehensive analysis of a number of measures over an entire farming operation or catchment can be problematic due the interactions between initiatives. General benchmarking information such as average industry gross margins is often not readily attainable. Therefore, the use of cost-benefit analysis as a tool for demonstrating financial benefits is more suitable for individual environmental practices or projects rather than larger, more holistic programs.

Long-term Financial Viability of Production

In horticulture, where many producers are operating on tight margins, the balance between short-term financial survival and the long-term financial viability of production is often a difficult proposition. One industry professional suggested that the best way of improving environmental management is improving the profits of growers (Consultation Meetings, Griffith, 29/08/01). Once the focus of growers can be shifted from the short-term to long-term planning then environmental considerations may be more likely to be factored into the decision making process.

The critical link that is often not made is that incurring environmental damage is reducing the productive capacity of the farm. Water, soil and land are the resources of a grower. If these are degraded then in the medium to long-term, production will suffer. Demonstrating this in financial terms can often be quite difficult as water, soil and land qualities do not have easy quantified dollar values. This is particularly the case where the long-term financial viability is being compromised by upstream or downstream off-farm impacts such as degradation of rivers systems. One of the factors working against the adoption of GEM practices is that contemporary accounting standards do not adequately address the diminution of land value due to inadequate environmental management. If land management practices lead to a slow and subtle degradation of the land due to salinity, soil erosion or diminished production value, the asset value is not often adjusted to reflect this. This would result in reduced productivity and hence profitability of the enterprise.

In some cases it is possible to generate an economic case based on cost-benefit analysis of the financial factors alone. On the floodplain of the Lower Goulburn-Broken River in Central Northern Victoria, such a case has been built as a means of securing support for an innovative environmental project.

The Lower Goulburn-Broken Floodplain Rehabilitation Scheme (profiled in Chapter 5) proposes to return 10,000 hectares of farming land to natural floodplain conditions. Consistent flood events have resulted in significant amounts of flood damage leading to high infrastructure maintenance costs, loss of production and declining water quality in the Murray-Darling Basin. In light of these considerations, the current management approach was proving to be clearly financially unsustainable in the medium to long-term. This was supported by a formal cost-benefit analysis of returning the floodplain to near-natural conditions. The analysis indicated that significant economic benefits would flow from the project. Some of these include:

- Reduced infrastructure maintenance costs;
- Reduced flood damage to private properties;
- Fewer production losses due to flooding; and
- Significant water quality benefits for the Sunraysia and Riverland horticultural areas, downstream of the junction of the Goulburn and the Murray Rivers.

This scheme provides clear evidence of the economic benefits that effective environmental management can provide. These economic benefits have been used to generate support from local stakeholders and funding support from the State Government. More detail on the economic analysis and tools used to generate support and ownership are provided in Chapter 5.

3.4.3. Legislative Drivers

Adoption induced through environmental removes the notion that adoption is voluntary. This has the effect of pushing growers through phases one to three of the adoption process model and into phase 4 where solutions to the issue are sought.

However, regulatory compliance was not cited as a major motivation for change (Figure 3.3), and yet survey respondents cited legislation as the greatest influence on change (Figure 3.4). During discussion at the consultation meetings, legislation was named at all meetings as the most direct and effective means of forcing change within the horticultural sector. It would appear, therefore, that horticultural producers are not motivated by the perceived threat of legislation as strongly as by the actual imposition of legislation. The presence of legislative enforcement was also nominated as one of the major reasons projects succeed in increasing on-farm adoption of environmental measures. An industry professional explained the role of legislation in encouraging growers to change this way:

> *"All that works, it seems, is legislation and market forces"*
>
> (Consultation meetings, Perth, 03/09/01)

While this is an oversimplification of the issue, this viewpoint demonstrates the strength of legislative drivers in environmental projects. As such, environmental programs may be more successful in increasing adoption of GEM practices when Awareness and Adoption Tools build on the regulatory obligations of growers.

This obligation has been growing over the last two decades with a trend in Australia towards increased environmental regulation. This trend has involved:

- Increasing restrictions on private property use (through restrictions on land clearing, water use and chemical use);
- The pricing of public goods (such as water and waste);
- The use of market mechanisms to regulate the quality of environmental systems (e.g. salinity trading in the Hunter Valley of New South Wales, water trading in most Australian states and carbon trading); and
- The use of the precautionary principle to identify and address potential environmental hazards before they happen (e.g. food safety programs, chemical application and genetically modified organisms).

These trends have been tempered by a movement towards the use of voluntary instruments such as conservation covenants. There has also been increasing provisions made for community consultation in legislation and a wide-range of decision-making processes. These trends are indicative of the broader movement in policy and legislation towards a sustainable management approach to natural resource management.

An example of the effectiveness of combining legislative drivers with adoption and awareness tools is a Tasmanian program to address the weed Pampas Grass. The Pampas Grass Program under the Noxious Weeds Act (TAS) 1964[3] employed a range of adoption and awareness tools to encourage weed management. These included:

- Advertising on billboards;
- Pamphlets distributed to school children in rural areas;
- Collaborating with Landcare to offer assistance and develop a co-operative approach; and
- Involvement of key individuals e.g. leading growers, farmers and local councils.

This approach generated a high level of ownership for both the problem and the solution in the community.

Within Australia, all levels of government are committed to the principles of Ecologically Sustainable Development (ESD) by the Intergovernmental Agreement on the Environment (Boer 1995:274). The most commonly cited definition of ESD is "Development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED 1987:87). This focus on ESD has brought the environment performance of agriculture and horticulture under scrutiny. Environmental regulation, legislation and programs are increasing for rural production. Areas that have been the focus of legislation in recent years include:

- Water;
- Soil and land;
- Salinity
- Biodiversity;
- Chemicals;
- Air; and
- Planning.

Programs for increasing adoption of environmental measures should refer to, where possible, relevant legislation to drive change. The following discussion provides a high level overview of the Australian legislative trends in each of areas listed above. This discussion is indicative and is intended only to provide a guide as to legislative drivers that may be useful.

Water

The changes to water access regulations nationally are potentially the most significant legislative change to affect the horticulture sector in recent times. Under the Council of Australian Governments (COAG) Water Reform Framework (1999), governments have committed to significantly changing arrangements for:

- Water pricing;
- Water allocation (including environmental flows);
- Tradeable water rights; and
- Institutional reforms (Banyard 2000:316).

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[3] The Noxious Weed Act (TAS) 1964 was repealed by the Weed Management Act (Tas) 1999. Pampas Grass is a declared weed subject regulation under the new act. This act sets out a range management strategies including the establishment of Weed Management Plans for declared weeds and on-the-spot fines for non-compliance. The Weed Management Plan for Pampas grass is currently under development (Pers comm. DPIWE 4/12/01).

Each of the states has taken a different legislative approach to the implementation of the COAG Water Reform Framework. NSW (Water Management Act 2000), Victoria (Water Act 1989 and Bulk Entitlement Program 1997) and South Australia (Water Resources Act 1997) are considered to be the leaders in water reform. These states have some of the most heavily allocated catchments where tradeable water rights are more likely to be effective in driving change (Banyard 2000: 312). Under the Water Management Act [NSW] 2000, provisions have been made for the development of water management plans. These Water Management Plans are the vehicle for community and industry consultation in implementing the Act. These plans should also be consistent with Regional Environment Plans (Environmental Planning and Assessment Act [NSW] 1979) and Vegetation Management Plans (Native Vegetation Conservation Act [NSW] 1997).

Soil

Little legislation directly applies to the management of soil. The law predominantly relies on irrigation, chemical and land clearing legislation to address the root-cause of soil problems. However the Commonwealth Government provides tax incentives for land care (Income Tax Assessment Act (Commonwealth) 1997 Division 387). NSW (Soil Conservation Act (NSW) 1938) and Western Australia (Soil and Land Conservation Act (WA) 1945) have provisions to issue soil conservation notices to place a moratorium on actions that cause soil or land degradation and conversely order rehabilitation works to be undertaken.

Salinity

Salinity legislation has been introduced in some states over the past 10 years as part of broader catchment-wide initiatives. The trend towards market mechanisms to address environmental problems has been reflected with the NSW Salinity Strategy 2000 and the Murray-Darling Basin Commission introducing tradeable salinity rights. Salinity targets are the main tool for management and include end-of-valley targets and within valley targets. The trend towards sustainable management approaches is also reflected in salinity management policy with the major Commonwealth Government initiative in this area being the National Action Plan for Salinity and Water Quality.

Biodiversity

Perhaps the most significant piece of biodiversity legislation to be introduced in Australia is the Environment Protection and Biodiversity Conservation Act (Cth) 1999 (EPBC Act). The EPBC Act provides for the:

- Identification and listing of 'Threatened Species' and 'Threatened Ecological Communities';
- Development of 'Recovery Plans' for listed species and ecological communities;
- Recognition of 'Key Threatening Processes'; and
- Reduction of these processes through 'Threat Abatement Plans'.

Under the act, land clearance is identified as a Key Threatening Process and Environment Australia had the stated target that all Australian jurisdictions should have clearing controls in place "that will have the effect of reducing the national net rate of land clearance to zero" (Commonwealth of Australia 2001: 7). Indeed, much biodiversity legislation focuses on restricting land clearance as the means of conserving biodiversity (Curran 2000:34). Examples include the Vegetation Management Act (Qld) 1999and the Native Vegetation Conservation Act (NSW) 1997.

A trend in the biodiversity legislation is for the use of voluntary initiatives. Several economic incentive/compensation programs have been introduced, which may act as drivers for growers. These include:

- Compensation for vegetation conservation in South Australia at $7.30/ha (Bredhauer 2000:395);
- Attempts by the Queensland govemment to secure compensation at $23.40/ha (Bredhauer 2000: 395);
- Proposal by the Commonwealth Government to introduce tax deductibility for falls in property value due to the landholder entering into a conservation covenants (NSWEDO Bulletin 2001); and
- Tenure agreements in South Australia which depend upon the leaseholder demonstrating ecologically responsible management of the property (Curran 2000: 51).

This trend reflects the international move toward use of economic instruments. An example is conservation easements. Widely used in the USA, UK and Germany, these provide payment in return for conservation of land (Curran 2000: 72).

Chemical Use

There is a global trend towards the reduction of chemical use in food production. Worldwide, markets are more resistant, and communities increasingly sensitive, to the presence of chemical residues in foods. All states and territories have been guided in recent reforms by the new Food Standards Code released by the Australia New Zealand Food Authority in 1999. This standard is a co-operative arrangement between all states and territories. Under this standard, the management of chemicals in Australia is very much focussed upon the end-user, such as horticulture (Environment Australia 2001).

Each state has food safety acts that require food businesses and producers to identify potential hazards, take steps to control this and meet regulated contents of pesticide residue and heavy metals. However, explicit environmental legislation aimed at controlling chemical use and application is relatively recent.

Soil chemical residues have been one such issue, where levels can impact upon the saleability of land or result in a clean-up order being issued. The national *"ChemCollect"* program is a free service that collects and disposes of unwanted and deregistered farm chemicals. These types of programs (others include Drum Muster) aim to reduce chemicals in the environment through the creation of safe disposal routes.

Similar to chemical residues, markets have not received genetic modified (GM) foods well. ANZFA has introduced labelling requirements for GM foods which have been described as "one of the strictest labelling regimes in the world" (AFR 2000: 3). The Commonwealth regulates GM organisms and research through the Gene Technology Act (Cth) 2000. The Tasmanian policy on gene technology is particularly cautious with moratoriums placed on the release of new transgenic crops or their trial in the open environment.

Air

Within each state, the air regulations pertaining to horticulture tend to be from a local council level. Although this varies from state to state, activities such as burning and timing of spray applications tend to be regulated.

There is a trend towards the regulation of activities relating to greenhouse gas emissions. The most likely impact on growers will be regulation relating to land clearing. Impacts on other activities are not clear at this point.

Planning

The encroachment of urban development into horticultural and agricultural areas is an increasingly significant problem. This problem arises from local council zoning policies. Local council decisions to allow urban encroachment around horticultural land are a result of a combination of policy issues, decision-making and a lack of legislative restriction. To address this lack of legislative controls, there is a trend in the USA and Europe to introduce 'right to farm' legislation (Industry Commission 1999). The aim of this legislation is to ensure that rural activities bordering on a new urban subdivision can continue. There is increasing pressure in the horticultural sector for this type of legislation to be introduced in Australia.

3.4.4. Other Drivers

While business and compliance issues are the dominant motivators for changes in grower behaviour, a range of other drivers emerged from the consultation phase. The horticulture sector has, not only market, economic and legislative forces, but also social, cultural, personal and environmental factors that influence decisions made by growers. The importance of these other drivers varies greatly based on the culture within the commodity group and region as well as the personal goals of growers. These drivers may be broadly classified as:

- Environmental Conservation;
- Community pressure;
- Citizenship and personal pride;
- Continuity of Farming; and
- Lifestyle.

These drivers will be discussed in the following section. However, while these other drivers may be powerful motivators for growers, the differing values of individuals and groups means that these drivers may be most useful in combination with business or compliance drivers. The use of a multi-pronged approach may yield the best results in terms of increased adoption.

Environmental Conservation

Growers, like most of the general community, have an environmental conscience and will, within reason, attempt to minimise their impact on the environment. As such, appealing to growers' sense of environmental responsibility is a useful technique for encouraging the adoption of GEM practices.

Community Pressure

Horticultural activities are often the focus of criticism from neighbours, environmental groups and/or government departments. This is particularly the case in peri-urban areas where horticultural production and residential areas are in close proximity. Growers in these areas may be criticised for the real or perceived environmental impacts of their activities. Growers, during the consultation, felt that they were often blamed for environmental problems that were more a result of activities in urban areas than horticulture. For example, one grower expressed frustration that his irrigation allocation was reduced when urban areas downstream were "irrigating large areas of lawn" (Consultation Meeting, Nambour, 14/08/01). In light of these frustrations and concerns, a number of growers stated their motivation for adoption of environmental measures was to demonstrate environmental consciousness. The *Enviroveg* project (profiled in Chapter 7) has used this driver as the activities of growers in the target areas have come under increasing scrutiny from government departments.

Citizenship and Personal Pride

The consultation phase revealed that many growers felt that they were perceived by the general community as being "environmental bad guys". Growers may be encouraged as good citizens to improve their environmental performance as a community service. Landcare has been particularly effective at linking community ownership in environmental issues to good citizenship. In some instances, Landcare is acting as a unifying force in a manner similar to the role of Lions or Rotary clubs (Consultation Meeting, Shepparton, 27/08/01). Once link has been made between citizenship and environmental responsibility, it may become an issue of personal pride. Growers do not generally wish to be viewed as substandard growers.

Continuity of Farming

Throughout Australia, growers expressed a desire to ensure that their families were able to continue to farm their land. The concern was expressed that current farming practices were jeopardising this. This motivation links closely with the economic driver of ensuring the long-term viability of the farming enterprise. These drivers, used together with environmental conservation drivers, are consistent with a classic ESD approach to environmental management. The combination of these drivers is an approach that is likely to result in a balanced approach to environmental management.

Lifestyle

During the consultation phase, growers indicated that they were likely to implement projects that were labour saving, time saving or less difficult to maintain. Growers felt that these practices would increase the efficiency with which they could operate their farms and thus improve their quality of life.

3.5. Summary

The more effectively drivers are utilised to motivate growers to adopt environmental measures, the more likely the environmental programs will succeed in changing grower behaviour. Some drivers are stronger than others and ultimately, environmental guidelines and programs need to be strategically tailored to the characteristics and needs of the target group of growers. The selection of appropriate tools for the stage of the target audience and their education needs should underscore the development and implementation of any environmental program.

The following chapters of the report are case studies of the implementation of environmental best practice into the horticultural sector. Three case studies have been undertaken to examine the way in which the principles, tools and drivers may be utilised in differing situations. Case Study 1, Lower Goulburn Broken Floodplain Rehabilitation Scheme, examines how economic drivers may be used to generate support for the adoption of regional environmental initiatives. This case study examines how the Adoption Process Model is effective in explaining difficult concepts and generates ownership in environmental solutions.

The *Enviroveg* project by the Victorian Vegetable Growers association examines how legislative and other drivers may be harnessed to generate industry support for a project. This case study also highlights the effectiveness of well-targeted adoption and awareness tools. The final case study examines the role of the environmental innovator in the adoption process. *Abbotsleigh Citrus* has been profiled to demonstrate the way in which environmental measures can be applied on-farm and the factors that motivate environmental innovators to do so.

4. Goulburn Broken Catchment Management Authority Deep Creek Floodplain Rehabilitation Scheme (Case Study of a Regional Initiative)

4.1. Overview

The Goulburn Broken Catchment Management Authority (GBCMA) is implementing a scheme that will return an area of the Lower Goulburn River floodplain to its natural state. The primary purpose of the project is to reduce the cost of flood damage and improve water quality in the Murray-Darling Basin. The direct benefits to the local area are reduced infrastructure maintenance costs after flood events. Significant water quality benefits will also occur for the Sunraysia and Riverland horticultural areas, downstream of the junction of the Goulburn and Murray Rivers.

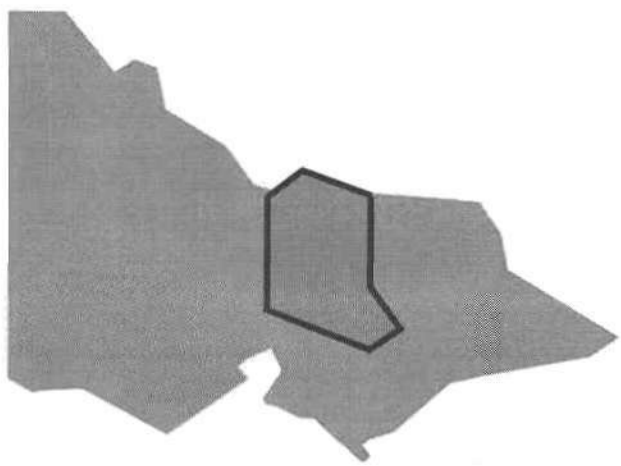
This scheme has been profiled for a number of reasons:

- It is an example of innovative whole catchment environmental management. No horticultural producers are within the direct boundaries of the project. However, the Sunraysia and Riverland horticultural regions will receive significant downstream benefits in the form of improved water quality for irrigation;
- It provides clear evidence of the economic benefits that effective environmental management can provide; and
- It is an excellent example of the way in which effective consultation can be used to generate the ownership of environmental projects by rural landholders.

4.2. Industry Profile

The Goulburn-Broken catchment is located in north-central Victoria and covers seven local government areas (Figure 4.1). The catchment is 2.5 million hectares in size and includes the important horticultural production zone of the Shepparton Irrigation Region (SIR) (250,000 ha) (Myfora Pty Ltd 2001). This relatively small area of the catchment produces 25% of the total value of Victoria's agricultural production (City of Greater Shepparton, undated).

Figure 4.1: Schematic map of the Goulburn-Broken catchment



The SIR is often described as 'Australia's Food Bowl' (City of Greater Shepparton, undated). It is a major centre for intensive irrigated agriculture (particularly horticulture and dairy) and food processing. Stonefruit, pome fruit, tomatoes and other vegetable commodities are the main horticultural products of the region. The processing of horticultural produce is a $734 million industry for the Goulburn-Broken catchment. Major food processing companies in, or adjacent to, the region include: Campbell's Soups, Cedenco Foods, Girgarre Country Foods-Heinz, Simplot, Unifoods, Ardmona Foods, Ducat's Food Products, SPC, Tatura Milk, Bonlac, Murray-Goulburn, Kraft, Nestle, National Foods, Greenhams & Sons.

Fruit Production

Fruit production in the Goulburn Broken catchment had a farm-gate value in 1996 of approximately $170 million (Myfora Pty Ltd 2001: 8). Orcharding is the dominant form of fruit production with approximately 9000 ha of orchards (Myfora Pty Ltd 2001: 21). Of the national crop, the SIR produces:

- 90% of kiwi fruit;
- 85% of pears;
- 80% of nashi;
- 45% of total stonefruit;
- 16% of apples; and
- 14% of Australia's fresh stone fruit (Myfora Pty Ltd 2001: 21).

The region also produces 90% of Australia's deciduous canned fruit, (Northern Victorian Fruit Growers' (NVFG) 2001: 1).

There are 12 active fresh fruit exporters operating from the region (NVFG 2001: 2). Sixteen percent of local fresh fruit production is exported to major export destinations such as South-East Asia, Europe and North America. These markets are also the main destinations for canned fruit, with approximately 70,000 tonnes or 55% of produce exported per annum (NVFG 2001: 2).

Vegetables

There are between 70-80 vegetable growers in the SIR (IHD 2000). The vast majority of vegetables produced in the SIR are tomatoes. Processing tomatoes dominate with close to 370,000 tonnes being produced in the 2000 season. Approximately 5,100 ha are used for processing tomato production. Fresh tomato production is significantly less, with 900 ha under production (Myfora Pty Ltd 2001: 23).

Potatoes are the second largest vegetable commodity grown in the catchment. The farm-gate value of the crop was just over $5 million in 1996 (Myfora Pty Ltd 2001: ii). Other vegetables grown in the catchment (in decreasing order of production) are: carrots, sweet corn, capsicum, eggplant, zucchini, broccoli, peas, snow peas, beans, pumpkin and squash (IHD 2000).

4.3. Environmental Issues

The Goulburn River supplies 11% of the Murray Darling Basin's water and is its largest tributary (Dainton 2000: 5). Total salt load discharges from the Goulburn-Broken Catchment are predicted to increase from 6,712 tonnes per year in 2000 to 165,160 tonnes per year by 2050 (Sinclair Knight Merz 1999: 5). The Goulburn River also contributes the most phosphates and nutrients into the Murray River from Victoria (O'Kane 2000: 16). The input of these nutrients is a factor in causing blue-green algae impacts on the Murray River (Dainton 2000: 16).

The lower reaches of the river are typical of Australia's inland river systems with the flow capacity of the river declining from 185,000 ML/day to 37,000 ML/day just before the junction with the Murray River (GBCMA 1998: 2). Under natural conditions, the floodplain and numerous ephemeral creeks would carry flood flows (Sinclair Knight Merz 1998: 6). Construction of a levee system to prevent flood flows onto the floodplain was commenced in the 1890s. The attempted confinement of flood flows to the river channels has had a number of significant environmental effects. These effects include:

- Minimal flow to 160 km of ephemeral streams on the lower Goulburn floodplain (Dainton 2000: 6);
- Elevated flood levels (Sinclair Knight Merz 1998: 6);

- Extensive scouring of the main river channel (Dainton 2000: 6);
- Erosion of the channel banks (O'Kane 2000: 16);
- Damage to riparian and aquatic habitats (Sinclair Knight Merz 1998: 6);
- Reduction in the number and health of floodplain wetland systems (Sinclair Knight Merz 1998: 6); and
- Large volumes of sediment being washed into the Murray due to increased erosion of the banks and lack of opportunity to deposit sediment on the floodplain.

The Lower Goulburn Corridor is one of the Victorian Government's seven biolink zones under the Flora and Fauna Guarantee Strategy (Weber 1998). These zones are areas of high priority to consolidate and extend native vegetation to provide habitat for native species (Weber 1998). The Lower Goulburn is an important native fish habitat and the floodplain contains a highly valuable wetland system. The vegetation type on the floodplain (Riverine Grass Woodland – Wetland Complex) has been extensively cleared in Australia (Weber 1998. In Victoria, only 2% of the original cover remains of this vegetation type, with only 1% in public ownership (O'Kane pers. comm 29/11/01). As such, the remnant vegetation on the Lower Goulburn Floodplain is of high conservation value.

4.4. Drivers for Change

The extensive levee system in place on the Lower Goulburn is unable to cope with moderate flooding events. Throughout the 1900s, flooding caused the levee system to be breached approximately every 10 years (Dainton 2000: 7). The average cost of flood damage on the lower Goulburn is $2.8 million annually (O'Kane 2000: 24).

In 1993, a 30-year flood caused a total of $21 million in loss of agricultural production, damage to the levee system and damage to infrastructure (Dainton 2000: 7). At this time, Disaster Relief Funding was forthcoming on the condition that strategies were implemented to reduce flood damage in the future (GBCMA 1998:2). Since 1995, alternative methods of floodplain management have been investigated. Three options were identified:

1. *The Minimalist Approach.* The current approach would be continued, however, Natural Disaster Relief funding for flood damage may not be forthcoming.
2. *The Engineering Solution.* Extensive construction and excavation work would be undertaken to increase the capacity of the main channel and spillways would be built for floodwaters. This would increase channel capacity to accommodate up to a 40-year flood or 185,000 ML/day. Environmental issues would not be addressed and may be exacerbated.
3. *The Floodplain Rehabilitation Scheme.* Involves rehabilitating the floodplain so that it operates similarly to a natural floodplain. This involves the removal of levees and the compulsory acquisition of private land (GBCMA 1998:4-5).

The Floodplain Rehabilitation Scheme was endorsed by the GBCMA in March of 1999 as the preferred option (Dainton 2000: 9).

Economic Drivers

The main drivers for the adoption of the Floodplain Rehabilitation Scheme have been economic. The present system was seen as unsustainable based on doubts surrounding the availability of Natural Disaster Relief funding, the cost of levee maintenance and the cost of flood damage. In-depth cost-benefit analysis of the scheme has been undertaken. Even without factoring in the local and downstream environmental benefits, the cost-benefit analysis showed substantial economic benefits. The way in which the costs of the project have been assessed is outlined in Table 4.1.

Table 4.1: Financial assessment of the Lower Goulburn Floodplain Rehabilitation Scheme

	2002 ($'000)	2003 ($'000)	2004 ($'000)	2005 ($'000)	2007 ($'000)	2009 ($'000)	2011 ($'000)	2013 ($'000)	2015 ($'000)	2017 ($'000)
Revenue										
Grazing Revenue	-	-	-	-	-	73	73	73	73	73
Lease Rental	-	-	-	300	300	151	151	151	151	151
Miscellaneous Revenue	-	-	-	-	-	9	9	-	-	-
Rating/Other Revenue	-	-	-	182	182	182	182	182	182	182
	-	-	-	482	482	415	415	406	406	406
Expenses										
Maintenance Expenses	-	-	-	(178)	(178)	(178)	(178)	(178)	(178)	(178)
Lease Rental Expenses	-	-	-	(90)	(90)	(45)	(45)	(45)	(45)	(45)
Rate Collection Expenses	-	-	-	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Parks Management Contract	-	-	-	-	-	(200)	(200)	(150)	(150)	(150)
Project Management and Sundries	(131)	(117)	(117)	-	-	-	-	-	-	-
	(131)	(117)	(117)	(272)	(272)	(427)	(427)	(377)	(377)	(377)
Total Revenue/(Expenses)	(131)	(117)	(117)	210	210	(12)	(12)	29	29	29
Capital Costs	(722)	(928)	(19,968)	-	-	-	-	-	-	-
Government Funding	8,092	13,980	-	-	-	-	-	-	-	-
Borrowing	-	-	-	-	-	-	-	-	-	-
Cash Flow for the Year	7,240	12,934	(20,085)	210	210	(12)	(12)	29	29	29
Cumulative Cash Flow	**7,240**	**20, 174**	**89**	**299**	**719**	**694**	**670**	**686**	**744**	**801**

Source: PriceWaterhouseCoopers (PWC) 2001: 23[4]

This assessment estimates a Benefit Cost Ratio of 1.78 and a payback period of 24 years (PWC 2001: 23). This is based on the following assumptions:

- The less sensitive areas of the floodplain will be leased for grazing;
- $22 million of funding will be obtained; and
- Natural Disaster Relief Funding will not be available (PWC 2001: 24).

Under the floodplain rehabilitation scheme, it is predicted that the cost of flooding and levee maintenance will be reduced from $2.8 million per annum to $250,000 per annum (O'Kane 2000: 24).

These economic benefits are largely costs to governments. Private benefits may also flow from this project, as the farming land on the site is marginal. One thousand hectares of the floodplain is public land and the remainder is privately owned (O'Kane 2000: 19). This land will be compulsorily acquired from the 95 landholders in the area (O'Kane 2000: 28). The 95 properties planned for compulsory acquisition have an estimated total farm-gate production of $650,000 per annum (Sinclair Knight Merz 1999: 2). The compulsory acquisition of the land may provide the opportunity for farmers to cost-effectively relocate or pursue other activities. The floodplain rehabilitation site is on the northern side of the Lower Goulburn River. This scheme will reduce flood damage to the southern side, where investments in infrastructure are

[4] Reproduced with permission from the Goulburn-Broken Catchment Management Authority.

greater. Water flowing from the Goulburn River into the Murray River will be of better quality for irrigation and domestic consumption downstream.

Environmental Benefits

The environmental benefits of the scheme have assisted in securing support from governments and the wider community. The project will rehabilitate a significant area to near-natural conditions. The floodplain may reduce the rate of flow of floodwaters, reducing bank erosion and scouring of the channel (O'Kane 2000:18). Nutrients and sediments should be trapped, improving the quality of water entering the Murray River (Mallory and Rudd 1998). As the floodplain becomes revegetated it will become more efficient in stripping nutrients and sediment from floodwaters (Mallory and Rudd 1998).

The scheme will return flows to 160 km of ephemeral streams (Dainton 2000:6). This will create habitat and breeding grounds for native fish including species listed as endangered, rare or vulnerable under or the *Flora and Fauna Guarantee Act 1998 (Victoria)* or the *Endangered Species Protection Act 1992 (Commonwealth).* These species include Murray Cod, Murray Rainbow Fish, Flat-headed Galaxias and Golden Perch (Weber 1998: 3).

The 10,500 ha of floodplain will be revegetated (actively in some areas and left to naturally revegetate in others) expanding the area of Riverine Grass Woodland in Australia. This may provide habitat for a number of endangered or threatened flora and fauna that have been recorded in the Lower Goulburn-Broken Catchment (Weber 1998: 3). The revegetation may also sequester a significant amount of carbon, offsetting greenhouse gas emissions (O'Kane 2000: 23).

Benefits for Horticulture

The main benefit to horticulture from the Lower Goulburn Floodplain Rehabilitation Scheme is improved water quality downstream of the site. This is likely to be the result of lower sediment and nutrient inputs in the Murray River. It is hoped this will occur through the:

- Trapping of nutrients and sediments in floodplain wetlands; and
- Reducing stream velocity during flood events resulting in reduced streambed and riverbank erosion (GBCMA 1998: 4).

This should lead to better water quality and lower turbidity in the Murray River. This would not only benefit downstream horticultural irrigators but all users of the Murray-Darling system downstream of the site.

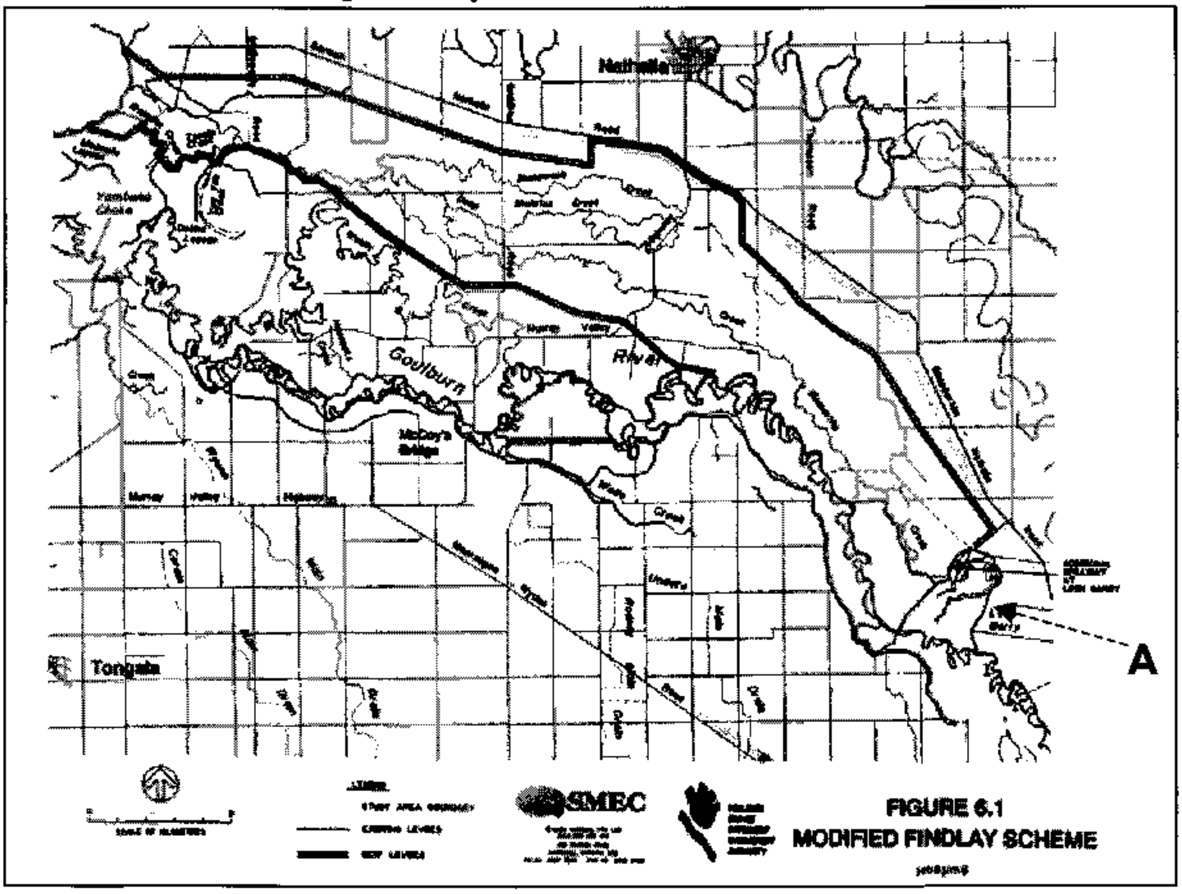
4.5. Project Profile

The Lower Goulburn Floodplain Rehabilitation Scheme proposes to return 10, 000 ha of the 50 km floodplain (Figure 4.2, over page) to near-natural conditions (GBCMA 1998: 4). The project will involve the construction of a spillway to allow floodwater to enter the Deep Creek floodway below Loch Garry (near Point A in Figure 4.2) (Mallory and Rudd 1998). This will involve the removal of existing levees to allow floodwaters to flow into this spillway. Additional levees will be created, and selected existing levees upgraded, to contain the floodwaters to the floodplain. This is necessary to protect the township of Nathalia and the Murray Valley Highway to the north and the area to the south of the Goulburn River (Mallory and Rudd 1998). The floodplain will be subject to a near-natural flood regime. The natural wetting and drying patterns of the floodplains will be restored.

The process of compulsory acquisition of private land has obviously generated significant public concern (O'Kane 2000: 31). However, through a highly effective consultation process the support of the majority of landholders in the area affected has been gained. The consultation process has closely reflected the Adoption Process Model outlined in Chapter 4. The approach taken by the Lower Goulburn Floodplain

Rehabilitation Scheme, in each of the stages in the Adoption Process Model, is outlined below.

Figure 4.2: Site-map of the Lower Goulburn Floodplain Rehabilitation Scheme detailing areas subject to inundation



Source: Mallory and Rudd 1998[5]

'See the Problem'

The flooding problems on the Lower Goulburn River have been well recognised over a long period of time. Flood mitigation measures have been employed since the 1890s when construction of the levee system began (Dainton 2000: 7). Since this time there have been a number of milestone events that have generated recognition of the problem:

- 1916 - The levees were breached by a record flood;
- 1925 - Construction was completed on the Loch Garry Flood Protection Scheme in an attempt to regulate flow and minimise levee breaches;
- 1968 - The Goulburn River Flooding Inquiry was held to response to ongoing problems;
- 1974 - Major floods led to the commissioning of a full Floodplain Management Study to investigate options;
- 1981 - Levees failed; and
- 1993 - Levees failed causing $20 million damage (Dainton 2000: 7-9).

Major floods and levee failure remain a regular occurrence, with flooding also occurring in 1995. This meant that the issue of floodplain management on the Lower Goulburn is

[5] Reproduced with permission from the Goulburn-Broken Catchment Management Authority.

well recognised by all relevant stakeholders. Media coverage of the flood events has also contributed to a wider recognition of the issue by the general community.

'Accept the Problem'

The extent of flood damage led to an acceptance of the problem and the need for an alternative management strategy for the floodplain. In 1995, the three options for floodplain management were investigated by the Lower Goulburn Water Management Authority (now a division of the GBCMA) (Dainton 2000: 9). In 1998, the options were outlined in an A4 colour brochure which was mailed to all Lower Goulburn landholders (O'Kane 2000: 30). This brochure presented the issues of floodplain management in the Lower Goulburn and the management options to the landholders and called for public input (O'Kane 2000: 30). Written responses to the request for submissions totalled 105 (O'Kane 2000: 30).

All reports commissioned for the scheme were made available on the GBCMA web-site (O'Kane 2000:30).

'Own the Problem'

Ownership of the problem was a relatively straightforward matter in the Lower Goulburn, as flooding directly impacts on the livelihood of landholders. This strong economic driver meant that a significant degree of ownership was already present. The proposal to compulsorily acquire properties on the floodplain also strongly motivated landholders to participate in the process.

'Own the Solution'

In order to generate support for the chosen management strategy, extensive consultation was conducted with the project stakeholders. In December 1998, a public meeting was held to:

- Present the findings of the investigation;
- Present details of the three options;
- Discuss these options; and
- Discuss issues associated with the process of land acquisition (O'Kane 2000:30).

Two hundred landholders attended this meeting (O'Kane 2000:30).

In response to questions about land acquisition and compensation arising from this meeting, a further public meeting was held later that month. The Department of Infrastructure and VicRoads Property Services presented comprehensive information on the process to 100 landholders (O'Kane 2000:30).

Objections to the compulsory acquisition of land have been the major obstacle for the scheme (McLennan 2001). However, the strength of the economic benefits has largely overcome these (McLennan 2001). The results of this consultation process were independently assessed to strongly favour the Floodplain Rehabilitation Scheme (O'Kane 2000:30). Of the written submissions that expressed a preference, 70% were in favour of the scheme (O'Kane 2000:30).

'Change Behaviour'

In 1999, the Floodplain Rehabilitation Scheme was endorsed by the GBCMA as the preferred option (Dainton 2000: 7-9). Strong funding support at State level has been obtained, however, funding commitment is still being sought by the GBCMA. The GBCMA remains confident that the funding will be obtained.

Horticulture's perspective

This project is a government initiative occurring on a site dominated by agriculture and grazing activities. The horticulture sector has had little direct involvement in the project. However, as a catchment management initiative, the project has implications for all stakeholders in the catchment and particularly those downstream of the floodplain.

Horticultural sectors downstream of the floodplain, notably those in the Sunraysia and Riverland production zones, stand to benefit from improvements in water quality resulting from the project. As irrigators at the lower end of the Murray-Darling Basin, heightened salinity levels since the 1970s and 1980s placed limitations upon production. Notably, the use of overhead sprinklers in citrus was restricted by the absorption of salt through the leaves of the citrus trees leading to salt scalding. This has lead to growers and industry professionals in these areas having a strong awareness of catchment issues. While salt interception schemes have improved salinity levels, catchment management groups in the Berri area have strong membership numbers with active participation by growers. Response to the floodplain rehabilitation scheme in Berri was positive with growers in the area indicating were in favour of any project likely to improve water quality.

Response to the scheme from the processing tomato industry in the Echuca, Rochester and Boort areas was also positive. These areas are also part of the Murray-Darling catchment but located on Murray River tributaries and thus are not directly downstream of the scheme. These growers are aware of catchment management issues and are active in catchment management groups. However, the use of filters on drip irrigation systems largely reduces the effects of poor water quality upon their production.

Growers in the Shepparton area are unlikely to receive any direct benefits from the project, as they are upstream of the site. However, awareness of the scheme is higher in this area due to local publicity and consultation. It was indicated that growers in the area are generally comfortable with the project, however, growers tend to have a stronger focus toward on-farm management of environmental issues than catchment management. For example, growers may seek to improve water-use efficiency or plant wind breaks for on-farm production reasons (i.e. to reduce irrigation costs or spray drift respectively). While these activities have catchment benefits, this is not the primary motivation of the grower. The reason for this is likely to be linked to phase 1 of the Adoption Process 'see the problem'. Growers can more readily see on-farm issues and benefits from environmental measures than they can catchment effects. Therefore, these growers are more likely to be motivated by on-farm factors than catchment issues.

4.6. Summary

While the Lower Goulburn Floodplain Rehabilitation Scheme has yet to be implemented, it represents an innovative solution to a long-term environmental problem. The success of the project is demonstrated by the way in which a solution that was perceived by some as radical and controversial, has been largely accepted and supported by the rural stakeholders. As such, the communication and consultation strategy adopted by the project is a good example of effective change management where rural landholders are the primary stakeholders.

The key elements of the project which enabled this support and acceptance were the:

- Use of a variety of different awareness tools (a brochure, web-site and media);
- Use of public meetings as an adoption tool;
- Individual consultation or consultation with small groups to explain difficult concepts;
- Strong emphasis on the economic benefits of the project; and
- Flexibility in holding additional meetings as required.

5. *Enviroveg* (Case Study of an Industry Initiative)

5.1. Overview

The *Enviroveg* Project aims to proactively and voluntarily improve the environmental performance of the vegetable growers in the Werribee and south-east Melbourne areas. The project is a joint initiative of the Victorian Vegetable Growers Association (VGA) and Horticulture Australia, with collaboration from the Environment Protection Authority (EPA) Victoria, Department of Natural Resources and Environment (NRE), University of Western Sydney, NSW Agriculture, Melbourne Water and Southern Rural Water. This project has been developed at a grassroots level to address community and departmental concern at the perceived environmental impact of horticulture.

Enviroveg has been selected as a case study as it encompasses many of the key tools and principles necessary for generating grower adoption of environmental best practice. *Enviroveg* is still in its formative stages, however, the project demonstrates an innovative approach to environmental management at an industry level. This project illustrates the way in which the principles outlined in Chapter 3 can be selected and adapted to suit the region and industry involved. The *Enviroveg* project is intended to be adapted and used later by the vegetable industry nationally.

5.2. Industry and Regional Profile

The Victorian vegetable industry has a gross annual production value in excess of $487million, which represents 27% of the Australian total (Institute of Horticultural Development (IHD 1999). Production for the domestic market is the major focus of the industry, however, $35million was exported in 1998-99 with broccoli, asparagus and tomatoes being the most valuable exports. The *Enviroveg* project focuses on the Werribee and south-east Melbourne vegetable production areas on the outskirts of Melbourne (Figures 6.1 and 6.2).

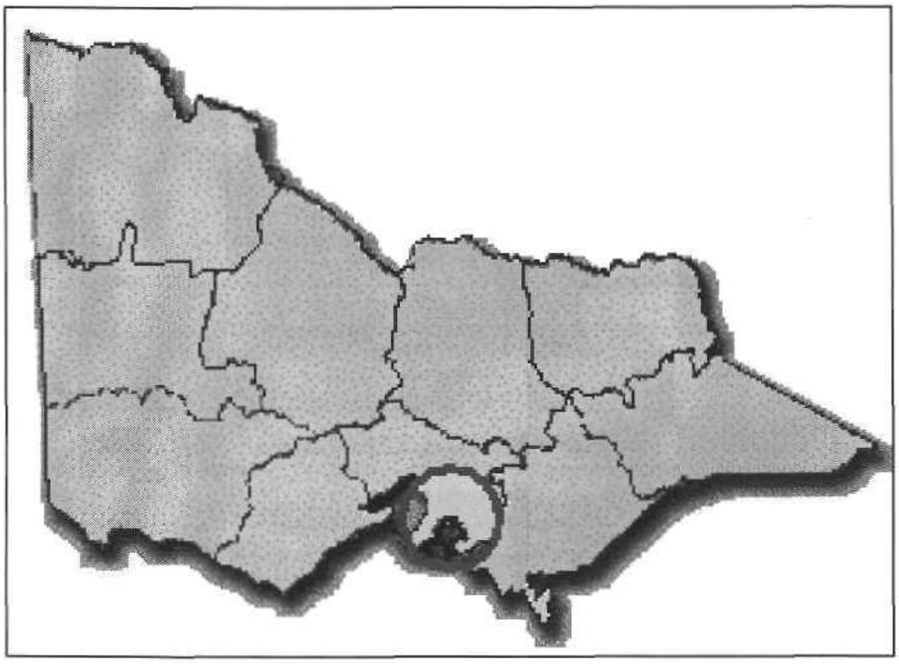
South-East Melbourne

The south-east Melbourne area encompasses Cranbourne, the Mornington Peninsula and the Koo Wee Rup Swamp. Within this area, there are approximately 200 farms and around 6000ha of land under vegetable production (IHD 2000). The gross annual production value from south-east Melbourne is around $80-90million per annum (IHD 2000). The primary commodities produced are asparagus, carrots, leeks, parsley, parsnip, radish, silverbeet and spring onions.

Werribee

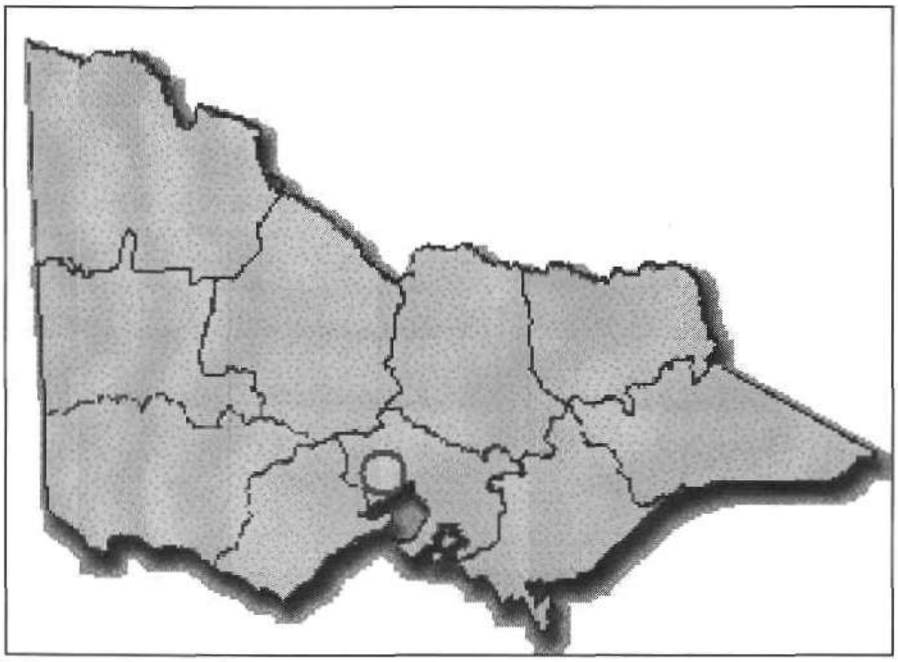
The Werribee region is located 32km south-west of Melbourne on the alluvial delta of the Werribee River. Within this area, there are between 150 and 200 farms and around 3000ha of land under vegetable production (IHD 2000). In recent years, there has been a trend towards larger farm size and fewer growers as producers either expand their holdings or leave the industry. Many of the farms are family-owned and have operated over 40 years (IHD 2000). The main crops grown in the area are broccoli, lettuce, cauliflower, onions and cabbages. The area also produces a significant proportion of Victoria's production of fennel, artichokes and cos lettuce. The main export destinations of produce from Werribee are Singapore, Japan and Hong Kong.

Figure 5.1 South-East Melbourne vegetable production area



Source: NRE Horticulture web-site (www.nre.vic.gov.au)

Figure 5.2 Werribee vegetable production area



Source: NRE Horticulture web-site (www.nre.vic.gov.au)

5.3. Environmental Issues

A number of environmental issues have been identified in the south-east Melbourne and Werribee areas. However, the primary environmental issue in the horticultural areas has been water quality. EPA Victoria and Melbourne Water had expressed concern at the nitrogen and phosphorus loads in local waterways. This has stemmed from increased concern for the health of Port Phillip Bay and Westernport. The Port Phillip Bay Environment Study recommended that nutrient inputs to the bay be reduced by 1000 tonnes of nitrogen per annum (CSIRO 1996: 13). This recommendation has been adopted through State Environment Planning Policy (Waters of Port Phillip Bay) which states that this target must be reached by 2006 (Port Phillip and Westernport CALP Board 1998: 4).

As nitrogen and phosphorus are the two main nutrients applied to horticultural crops, irrigated horticulture has been identified as a major contributor to the nutrient loads in the bay. Horticulture has been estimated to contribute 25% of the phosphorus load and 12% of the nitrogen load of the Werribee River (Port Phillip and Westernport CALP Board 1998: 30). As such, horticulture is a high priority for nutrient management in the Werribee River catchment (Port Phillip and Westernport CALP Board 1998: 33). In the south-east Melbourne area, Melbourne Water has also found nutrient contamination in local waterways, which may have been contributed by vegetable growers in the local area.

5.4. Industry Drivers for Change

Werribee and south-east Melbourne have been areas of increasing urban development in recent years. As residential and horticultural land-uses are in close proximity, environmental issues are under increased scrutiny. Community concern for water quality in the south-east Melbourne area has led to the formation of local environmental groups to lobby for increased environmental regulation of the level of nutrient run-off from horticulture. The presence of NRE and EPA Victoria in both areas is increasing. The EPA has recently commenced the testing of run-off from horticultural properties and NRE has begun an education program on irrigation scheduling and monitoring. In this environment, growers are increasingly under pressure to account for the quality of run-off from their properties.

It was these factors which led to growers in the Cranbourne area approaching the VGA to request an industry response. This request was the catalyst for the *Enviroveg* project. The project framework was conceived in 1998 by the Vegetable Industry Development Officer, Patrick Ulloa. Funding was obtained and the project designed through extensive consultation with growers and collaboration with government departments. These groups each have different motivations for change and varied perspectives on the environmental issues facing the vegetable industry around Melbourne. When contacted, both EPA Victoria and NRE expressed their support for the project, however, these organisations indicated that they would like to collaborate more closely with the *Enviroveg* project team.

Market forces have been a significant driver of this project. When quality assurance (QA) was implemented with Victorian vegetable growers, there was strong resistance from the growers. The growers felt that an undue financial burden had been placed upon them, with no reimbursement from the retailers pushing for QA to be implemented. There is general opinion among industry professionals that environmental performance may be added to QA requirements. *Enviroveg* is attempting to pre-empt this requirement to give the growers time to develop their own practices and procedures to demonstrate environmental responsibility. It is unclear at this time whether price premiums or incentives will be forthcoming. Through *Enviroveg*, growers will be able to spread the cost of implementing environmental measures over time.

Another factor driving the development of *Enviroveg* is a desire to demonstrate that environmental issues are being addressed by vegetable growers. The consensus among the growers is that they are being targeted by government departments and environmental lobby groups as having a negative environmental impact. The growers have desired a mechanism to assess, demonstrate and monitor the environmental initiatives of the industry in a manner that is transparent and acceptable to other stakeholders. As such, social and legislative drivers are motivating factors for the growers to participate.

5.5. Project Profile

The *Enviroveg* project aims to develop a set of practical and realistic environmental practices for Victorian vegetable growers. The primary initiative of the project is to develop a set of guidelines that will act as a self-assessment tool for growers. Complementing the guidelines will be a communication strategy and the establishment of water testing stations. The project is currently in the development and early implementation stages and, as such, results from the study are not yet available. The project design has focussed on flexibility to ensure that the project model may be readily altered to allow the project model to be applied in other industries and other regions.

Guidelines

A set of environmental guidelines is currently being developed and will be available in mid 2002. The guidelines are being developed from domestic and international literature with intensive consultation with growers. Once complete, the guidelines will form a checklist of environmental practices. The guidelines will encompass a range of GEM practices for vegetable production (for example, irrigation scheduling, soil moisture monitoring and targeted irrigation systems). The environmental practices included in the guidelines may be adapted to allow the model to be applied elsewhere.

Each environmental practice or technology will be assigned a value. Participating growers will complete the checklist and determine their score indicating present environmental performance. Scores can be improved by implementing other environmental practices from the checklist. *Enviroveg* staff will provide information and support to assist this improvement. In this way, growers will be able to demonstrate environmental performance to the community, government departments and customers as required. The tool also furthers the project's stated objective of focussing on "continuous improvement rather than on current performance".

The self-assessment tool is structured to sit within the existing quality assurance systems. This would minimise the cost to growers and allow growers to meet market driven environmental requirements.

Communication Strategy

The primary focus of the communication strategy is to ensure that *Enviroveg* remains a grower-led initiative. The centrepiece of the strategy is extensive consultation and collaboration through a series of workshops and field days. Guest speakers have included government departmental officers and experts in environmental best practice. These workshops allow growers to gain information on environmental issues and practices, and provide input into research and initiatives being undertaken. Interstate soil and horticulture experts have been brought to Werribee and south-east Melbourne to visit farms and speak at workshops to provide advice specific to the growers' needs.

A web-site and brochure are currently being produced to provide a range of communication options for growers to access.

Water Testing Station

EPA Victoria monitors the nutrient concentrations in Port Phillip Bay. However, growers and the VGA wanted more information on the specific level of nutrients contributed by horticulture. Water testing stations have been established to enable a better understanding of the water entering into catchments from horticultural areas.

Two water testing stations have been established; one on Watson's Creek near Cranbourne and one on Werribee South Drain 5. The purpose of these testing stations is to:

- Collect accurate information on the impact of vegetable production on water quality;
- Actively involve growers in monitoring environmental quality; and
- Enable growers, Southern Rural Water and the NRE to review current practices and identify more appropriate practices as required.

The stations test for a number of parameters including nitrogen, flow levels and flow rates. Preliminary results of Drain 5 at Werribee South have been received. The findings have shown a clear correlation between large rainfall events, increased flows within the drain and high concentrations of nutrients. The results indicate that there is no runoff from farms on a regular basis. This has led to a preliminary conclusion that the loads of nitrogen and phosphorus from the irrigation district found in the drain may be primarily rainfall-induced. Water samples taken during these rainfall events have shown to be high in nitrogen and phosphorus concentrations. However, while EPA Victoria agrees with this finding they also suggest that there are discharges from some washing operations contributing to the problem which are not weather related.

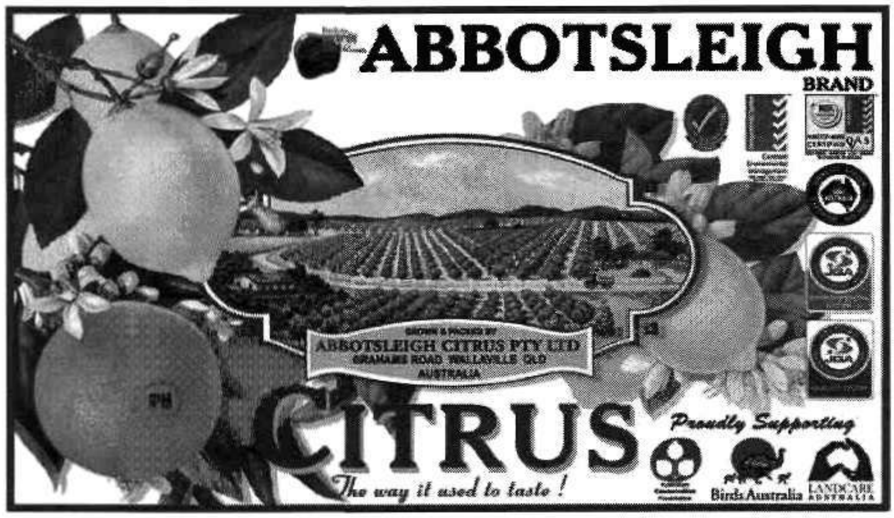
5.6. Summary

Enviroveg employs many of the implementation principles considered necessary to generate grower ownership and increase the adoption of GEM practices. The way in which Enviroveg has applied these principles is summarised in Table 5.1. *Enviroveg* has been based on issues identified by the growers and developed in conjunction with growers, which is fundamental to project success. *Enviroveg* has been designed to allow for adaptation and application nationally. The principles used in designing and implementing the *Enviroveg* project may prove to be a useful model for the development of environmental programs.

Table 5.1: Principles for increasing the adoption of environmental best practice in horticulture used by the *Enviroveg* Project.

Principle	*Enviroveg* Approach
Clearly identified and recognised environmental issue or need	• Nutrient residues in local waterways adjacent to horticultural production zones have led to community and departmental scrutiny of the industry.
Research which involves growers participation at all stages	• Establishment of a water testing stations on-farm with results are held confidential within the industry. • Visits to growers' farms by interstate soil and water experts occur. Researchers meet other growers in the area in the evenings to present initial findings and discuss their work. • Workshops for growers with the EPA Victoria, NRE and other consultants are held.
Presence of legislative pressure	• Victoria has a trend towards increasing water quality legislation. • The presence of EPA Victoria, NRE and water authority concern has led to a perception by growers that there is likely to be increased regulation if they are not seen to be acting.
Evening meetings	• Meetings are held in locations close to growers' farms.
Support and infrastructure present	• VGA, NRE, Melbourne Water, EPA Victoria Southern Rural Water, NSW Agriculture, University of Western Sydney and Horticulture Australia are involved in the project. • The project facilitates workshops and field days to enable growers to access these agencies.
Ease of implementation	• A range of measures will be selected which vary in complexity, implementation approaches and maintenance. This will allow growers to choose the implementation path most appropriate to their needs.
Market pressure (real or perceived	• The grower and industry perception is that environmental performance will be "the next QA". *Enviroveg* integrates into the existing QA systems giving growers time to adjust to market pressures. • *Enviroveg* is structured to allow practices to be audited should the market require.
Low cost or cost dispersed over time	• The project allows growers to select measures, which they will adopt on a cumulative basis. This allows growers to choose the suite of measures that is most appropriate to their budget.
Voluntary participation	• Participation by growers is not mandatory. This will encourage growers to participate when they are comfortable and willing to become actively involved.
Tangible and visible Benefits	• Participating growers will be able to display a sign on their properties. This sign will have the *Enviroveg* logo and a statement such as 'This is an environmentally friendly farm'. • Growers may potentially be able to use the *Enviroveg* logo for marketing purposes.

6. *Abbotsleigh Citrus* (Case Study of an Award Winning Enterprise)



6.1. Overview

Abbotsleigh Citrus is an environmentally innovative citrus operation located 56 km from Bundaberg (Queensland) near Gin Gin on the Burnett River. Since its establishment in 1996, the enterprise has operated according to two philosophies:

1. "*To fully embrace the concept of sustainable agriculture, which includes the protection and enhancement of the environment*"; and
2. "*To strive for excellence in all facets of the operation*" (*Abbotsleigh Citrus* Company Profile 2001: 4).

This unique business philosophy has brought *Abbotsleigh Citrus* a prestigious Banksia Award in the 'Small Business Responsibility and Leadership' Category.[6] As well as this award, *Abbotsleigh Citrus* has attained 10 different national and international certifications including:

- International Standards Organisation (ISO) 9002 (Quality Systems);
- ISO 14001 (Environmental Management Systems);
- Hazard Analysis and Critical Control Point (HACCP);
- HACCP-9000
- Safe Quality Food 2000 (SQF2000);
- IQNet;
- Japan Quality Assurance JIS Z 9902; and
- Japan Environmental System JIS Q 14001 (*Abbotsleigh Citrus* Company Profile 2001: 6-7).

The operation has "*the most comprehensive and wide-ranging environmental management system for any farm in the country*" (*Landline* 22/09/01). This enterprise has been profiled as a case study to demonstrate the way in which environmental best practice can be implemented at farm level.

6.2. Company Profile

The original *Abbotsleigh Citrus* site was a cane farm purchased in January 1996 and has since been expanded by the purchase of two adjoining properties (*Abbotsleigh Citrus* Company Profile 2001: 2). The site is bordered by the Burnett River on three sides (Plate 6.1), which forms a natural buffer for the Integrated Pest Management

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[6] This accolade is awarded to "a small business that demonstrates environmental commitment through the adoption and implementation of environmentally sound business management policies and strategies" (Banksia Awards Program 2001).

(IPM) programs undertaken on the property. The location of the property in a river meander means the soils are deep alluvial sediment, which is very fertile. Water licences are held for 843 ML, which is sufficient for existing and planned trees (*Abbotsleigh Citrus* Company Profile 2001: 12).

Plate 6.1: View of the *Abbotsleigh Citrus* property from the air with the Burnett River in the foreground

Source: *Abbotsleigh Citrus* 2001

Approximately 48,000 citrus trees are planted on the property (*Abbotsleigh Citrus* Company Profile 2001: 11). Varieties include Honey Murcott mandarins, Clementine mandarins, Star Ruby grapefruit, lemons and several varieties of oranges. Currently, only 50% of the arable land on the property is under production (*Landline* 22/09/01), the other 50% is being revegetated with indigenous vegetation (Plate 6.2).

Plate 6.2: Rainforest trees replanted in the riparian zone after weed removal

Source: *Abbotsleigh Citrus* 2001

The company has fixed assets of $18.5 million, including a $7 million packhouse, which utilises state of the art technology including ozone post-harvest treatments, and centralised computer monitoring of the packing process. Approximately $2 million worth of environmental works have been undertaken on the property. While the company has yet to make a profit, production is projected to double in 2001, with output to increase as the orchard matures (*Abbotsleigh Citrus* Company Profile 2001: 12).

Abbotsleigh Citrus is also well placed to take advantage of the increasing level of investment interest being shown by ethical investment funds in agriculture (Chris Benedict, *Agribusiness Research* pers comm.).

6.3. Environmental Initiatives

In line with the principles outlined in Chapter 3, *Abbotsleigh Citrus* implemented a whole farm environmental management framework at start-up, which incorporated several of the elements of GEM. As such, the enterprise is an excellent example of how the initiatives discussed in Chapter 3 can be put into practice.

Abbotsleigh Citrus has a certified environmental management system (EMS), which acts as the framework for environmental management on the property. An EMS is used to fully integrate quality and environmental concerns into every aspect of the decision-making process (Ray Whear 14/12/00). ISO 9002 and ISO 14001 are integrated into the *Abbotsleigh* EMS.

The reasons for this are that:

1. The requirements of the ISO standards are more stringent than other quality or environmental accreditations. As, such separate auditors for each certification are not required; and
2. As the decision-making process is integrated, issues can be identified and addressed prior to a problem being caused. (Ray Whear 14/12/00).

All areas of farm operation are covered by the EMS including:

- Citrus cultural practices;
- Water management;
- Chemical storage and handling;
- Air management;
- IPM; and
- Native flora and fauna regeneration and rehabilitation processes (Ray Whear 14/12/00).

Co-ordinated through the EMS, *Abbotsleigh Citrus* has adopted a number of environmental best practice elements. These elements, outlined in Table 6.1, represent environmental best practice in a number of cases.

Table 6.1: Elements of good environmental management employed by *Abbotsleigh Citrus.**

Elements of Good Environmental Management	*Abbotsleigh Citrus* Initiatives
Water Management	• Water is applied to all trees through under-tree micro sprinklers. This system ensures highly targeted application with minimal runoff, making maximum use of the available water. • Soil moisture is assessed prior to water application and then applied minimally and often to a set schedule. This practice ensures efficient use of water by only applying what is needed at a rate that avoids waste through runoff. • Use of water flocking and sterilisation treatments for wastewater from the packhouse is currently being investigated. The aim is to eventually have the capacity to recycle all water used in the packing process. • Native vegetation cover within the riparian zones aids in the filtration of any runoff from the farm restricting the entry of sediments, nutrients and pollutants into the Burnett river system.
Soil and Land Management	• Erosion is minimised by the planned layout and design of roadways, drains and tree row orientation. • Grass is maintained in all inter-rows and drains. This grass is slashed under the trees providing mulch that aids in soil moisture retention and increases soil organic matter content. • All washouts that existed when the property was purchased have been in-filled and stabilised with native tree species and grass. • Heavy metal content of the soil is monitored on a yearly basis to ensure levels are managed. • Fertilizers are applied based on the results of soil and leaf analysis. This ensures trees receive optimum levels of nutrients while avoiding long term environmental impacts like soil acidity, algal blooms, ground water contamination and soil salinity.
Pest, Disease, Weed and Insect Management	• Use of biological control agents either naturally occurring or as supplementary additions to those already in the crop. The aim of biological control is to establish and sustain populations of predatory insects in the crop thus maintaining pest populations below economically damaging levels. The crops are monitored for both beneficial and pest species and decisions made based on the level of control being achieved as to what (if any) action should be taken. • Cultural Control (Management Controls): Cultural control practices are adopted to ensure the development of an orchard environment, which encourages the predatory insect population and promotes excellent overall tree health. For example, Rhodes grass is planted in the inter-row spaces, providing supplementary nourishment for predatory insects thus encouraging establishment and continued existence of the predatory insect population. • Insecticides are only used when necessary, as determined by systematic monitoring, to back up the other two controls. Insecticides become the backup method, rather than the first choice in controlling pests. When used, insecticides are carefully selected to give control over the target pest with minimal disruption to biological control agents. The combination of biological control, better management and carefully selected insecticides (used only where necessary) gives better control of pests with fewer insecticides.

Air Management	• The spraying of chemicals is avoided when wind conditions are likely to result in the drift of spray into sensitive areas. • Buffer zones created by the retention of native vegetation act as a barrier to spray drift. • Grass is maintained on all areas of the farm including roadways minimising the generation of dust.
Waste Management	• Waste oil from machinery is collected and recycled. • All chemical containers are recycled. • Wastewater from the packhouse is directed to a septic system where it is neutralised then released into a holding dam. Water from this dam is tested on a yearly basis to enable the detection of any unwanted build-up of chemical compounds.
Biodiversity	• Eradication programs within remnant vegetation and riparian areas targeting environmental weeds such as cats claw creeper, lantana and balloon vine. Abbotsleigh aims to have eradicated 90% of these weeds within the 8km riparian zone within the next three years. • Currently approximately 1400 native tree species have been planted within the riparian zone. Benefits of this include increased native habitat, bank stabilisation and improved filtration of runoff. • Upwards of 700 native trees planted within and bordering on remnant dry vine scrub. This is one of the largest dry vine scrubs remaining on the Burnett River. These projects aim to rehabilitate and expand this area after years of cattle grazing and weed invasion has hindered its natural regeneration processes. • Upwards of 38 000 native trees planted within a 90 hectare rehabilitation area. This land has been severely degraded by the overgrazing of cattle in the past. These trees will recycle nutrients from deep within the soil profile improving the soil quality for the future. • Eradication of feral animal species such as foxes, rabbits and cane toads.

*Source: Statement by Scott Yeoman (Quality/Environmental Manager *Abbotsleigh Citrus)* 2001

6.4. Motivations for Implementation

Sustainability has been an objective of the enterprise from the outset using the philosophy of "getting it right from the start" (Ray Whear 2000). The approach to environmental management, adopted by *Abbotsleigh Citrus* has a number of motives. When asked to explain these motivations, Brad James, Orchard Manager at *Abbotsleigh Citrus* described it this way:

> *"Many people in agriculture say that it's just to expensive and too difficult to do. The long-term viability of Abbotsleigh is jeopardised by not doing it. Yeah, it does cost a lot of money. We believe that the cost in the long-term will be far greater than the cost in short-term if we don't embrace these philosophies".*
>
> (*Landline* 22/09/01)

This emphasis on sustainability reflects a common concern about the horticultural community in Australia. The consultation undertaken for this study has revealed that an emphasis on sustainability was one of the top five reasons why projects succeed in increasing on-farm adoption of environmental measures.

Abbotsleigh Citrus' motives for implementing GEM practices also have market and regulatory advantages. *Abbotsleigh Citrus* lists the benefits of environmental certification as including:

- "Enhanced corporate image and role in environmental stewardship;
- Evidence to support due diligence;

- Competitive edge in domestic and international trade;
- Improved identification and management of environmental risk;
- Potential for improved access to finance and insurance;
- Potential bottom line benefits through efficient resource use, pollution reduction, lower waste treatment and disposal costs;
- Potential benefits from regulatory authorities; and
- Assurance of environmental equipment." (*Abbotsleigh Citrus* Company Profile 2001: 8).

Five years into the operation, evidence to support these claims is beginning to emerge. *Abbotsleigh Citrus* now exports to Singapore, Malaysia, Indonesia, the Philippines and Hong Kong (*Landline* 22/09/01). Supply contracts from major wholesales have been secured (*Foodweek* 05/03/01). *Abbotsleigh Citrus'* management believes this potential will continue to increase, as 20% of the Australian fresh food market is already in sales of organic and organic-related produce and rising (*Abbotsleigh Citrus* Company Profile 2001: 9).

Integrated Pest Management

One of the centrepieces of *Abbotsleigh Citrus'* EMS is the Integrated Pest Management (IPM) Strategy. IPM is a control strategy in which a combination of biological, chemical, mechanical and cultural methods are used to ensure long term sustainable management of weeds and pests. IPM is a widely adopted strategy to suppress weed and pest problems by shifting the focus from 'quick fix' chemical strategies to a more holistic long-term approach.

Given that pests and weeds will never be fully controlled and eliminated, this approach aims to manage pests in a sustainable manner. The emphasis of IPM is on anticipating and preventing problems before they occur whenever this is possible and using chemicals only when it cannot be avoided.

Abbotsleigh Citrus has been using IPM since the orchard was established in 1996. The enterprise sees the benefits of IPM as being:

- *"The development of pest resistance to pesticides is delayed or avoided due to the less frequent use of chemicals;*
- *Long term control of citrus pests is improved through the increased abundance and diversity of natural predators;*
- *As a result of reduced pesticide use, safety is improved for people working in orchards;*
- *As a result of reduced pesticide use, environmental contamination is reduced; and*
- *Pesticide residues in or on fruit are minimised, enhancing consumer acceptance of the produce" (Abbotsleigh Citrus Company Profile 2001: 9).*

IPM is already showing financial benefits. Ray Whear cites chemical costs as an example;

> *"Last year with 48,000 trees in (three times more than the first year), our chemical costs were $40,000 less than they were in our first year"* (Ray Whear 2001).

6.5. Environmental Management System Benefits

In most instances the benefits of the *Abbotsleigh Citrus* EMS are directly linked to the environmental outcomes achieved through the actions undertaken. Whilst it has been relatively easy for management to track expenditure associated with environmental actions, it has been very difficult to link actions to measurable financial outcomes. Attributing specific values to actions is more difficult as there are in most instances, limited short-term financial benefits associated with implementing a whole farm EMS.

To show a positive benefit from the implementation of the EMS, it is necessary to directly link favourable financial outcomes to environmental management actions. At present, establishing this link is not possible as there is no evidence to link price paid for fruit to the EMS actions. *Abbotsleigh Citrus'* price premiums, rather than coming as a direct result of EMS actions, stem primarily from the strategic location of the farm in an area that allows it a timing advantage in getting to market before competing orchards.

The decision to develop and implement a whole farm EMS from day one was both philosophically and financially driven. The benefits from the EMS will not be seen in the short term. Rather the EMS will aim to provide long-term sustainability through continuously improving environmental conditions on-farm. This has already led to on-farm cost savings and better operational performance. Further, some market advantage could be expected should wholesalers, retailers and consumers become more willing to pay price premiums for fruit produced under such systems. While there are currently no apparent price premiums available for fruit produced at *Abbotsleigh Citrus,* there is evidence to suggest from other industries that such positive steps taken on the environment may lead to improved market access and position the business to benefit from future premiums. At the very least, *Abbotsleigh Citrus* could be expected to realise some 'first mover' market advantage in the period before this type of product becomes more widely available leading to a reduction on achievable price premiums.

The company responsible for marketing *Abbotsleigh Citrus* fruit stated in correspondence that *"the work (by Abbotsleigh Citrus) in securing the many quality and environmental accreditations certainly went a long way towards attracting interest from exporters who needed to satisfy the demands of their overseas customers. Interest in the accreditation and awards was also shown by many leading domestic buyers".*

Measuring success

It should be recognised that success is not always measured in dollars, and return on investment, whilst identified throughout this report as a major driver, is not always the primary catalyst for change. The consultation phase of the best practice study indicates that a number of change-drivers are not directly linked to financial outcomes (e.g. lower costs, increased profitability, higher prices) and must be measured in other ways to determine the success or failure of specific environmental initiatives.

Benefits of the *Abbotsleigh Citrus* EMS, that are difficult to quantify, include:

- Reduction in runoff and pollution of waterways;
- Enhanced corporate image;
- Improved safety for personnel working in orchards as a result of reduced pesticide use;
- Enhanced native wildlife corridors providing a sanctuary for native birds and animals and endangered species; and
- Education of local community and schools on sustainable environmental practices.

The primary difficulty associated with determining the financial benefit associated with an EMS is the linking of specific actions and associated environmental outcomes to financial outcomes. *Abbotsleigh Citrus* have in place systems to measure specific aspects of the EMS, including chemical and fertiliser usage and cost. This information will over time enable a more complete set of data to be compiled, which will assist other growers in determining the applicability of the EMS or parts thereof, to their specific circumstance.

Measurable benefits of the *Abbotsleigh Citrus* EMS include:

- A reduction in the costs of pesticides used with IPM;
- Pest resistance to chemical pesticides is delayed or avoided due to the less frequent use of chemicals;
- Long term control of citrus pests is improved through the increased abundance and diversity of natural enemies;
- Pesticide residues in fruit are minimised, potentially enhancing consumer acceptance of the produce and aligning the produce with chemical residue traceability requirements stipulated by governments and the supply-chain;
- Reduced fertiliser costs through improved monitoring of orchard nutrient requirements;
- Lower waste treatment and disposal costs;
- Higher water use efficiency and a reduction in the irrigation costs; and
- Reduced waste treatment and disposal costs.

6.6. Cost Benefit Analysis

Measuring the specific cost-benefit of improved environmental management practices is difficult if approached on a whole farm basis. Determining linkages of specific actions to measurable financial outcomes is only made possible when information has been captured in such a manner as to ensure that linkages can be established.

Abbotsleigh Citrus has in place a financial system that allows the examination of direct production variable costs. Measuring variable costs such as fertiliser, weed control and insect/disease control provides an opportunity to benchmark performance against industry standards.

To calculate cost savings flowing directly from improved environmental management practices, the *Abbotsleigh Citrus* costs have been directly compared to information from the Queensland Department of Primary Industries (Queensland Horticulture Institute, Agrilink Citrus Information Kit, 1997, ISSN 1328-0457, Agdex 220/10) and the *Economics of Growing Citrus* by Peter Hardman (JR Peter Hardman, Economics of Growing Citrus in the Central Burnett Region of Queensland, May 1994 QDPI Publication Q194016). In addition un-published gross margins for citrus in the Central Burnett region of Queensland have been examined and utilised to determine cost changes since publication of the two reference sources.

The following table illustrates cost comparisons between *Abbotsleigh Citrus* and published gross margins.

Table 6.2: Cost comparisons between *Abbotsleigh Citrus* and published gross margins

Cost Area	Unit	QDPI Estimate ($)	Abbotsleigh Citrus ($)	Data Source
Production and Marketing	$/ha/year	20,000	16,291	QDPI, 1997, Agdex 220/10, Sec 2, P6.
Fertiliser	152 ha	90,237	54,489	QDPI, Agdex 220/10, 1997, Sec 2, P6. and J.R Hardman, Economics of Growing Citrus in the Central Burnett Region of Queensland, May 1994
Weed Control	152 ha	46,376	24,272	QDPI, Agdex 220/10, 1997, Sec 4, P7. and J.R Hardman, Economics of Growing Citrus in the Central Burnett Region of Queensland, May 1994
Insect and disease control	152 ha	237,136	124,007	QDPI, Agdex 220/10, 1997, Sec 4, P7. and J.R Hardman, Economics of Growing Citrus in the Central Burnett Region of Queensland, May 1994

The cost comparison to QDPI data suggests that there is significant potential for farmers to gain financially from the implementation of improved environmental practices. *Abbotsleigh* has succeeded in gaining cost advantages from the environmental management system put in place. Overall production and marketing costs have been reduced by 18%, fertiliser by 39%, weed control by 47% and insect/disease control by 47% of the comparative data.

Unlike most farming operations *Abbotsleigh Citrus* was able to put in place a holistic EMS from the beginning of the project to convert a functioning cane farm to a citrus orchard. Most growers operating in the industry do not this luxury. The grower consultation process indicated that the majority of growers implemented GEM on an incremental basis. They are selective in their approach, with those experiencing positive outcomes (e.g. improved profitability, lower costs, good neighbour, etc) being more likely to extend the use of GEM to other areas of the farm.

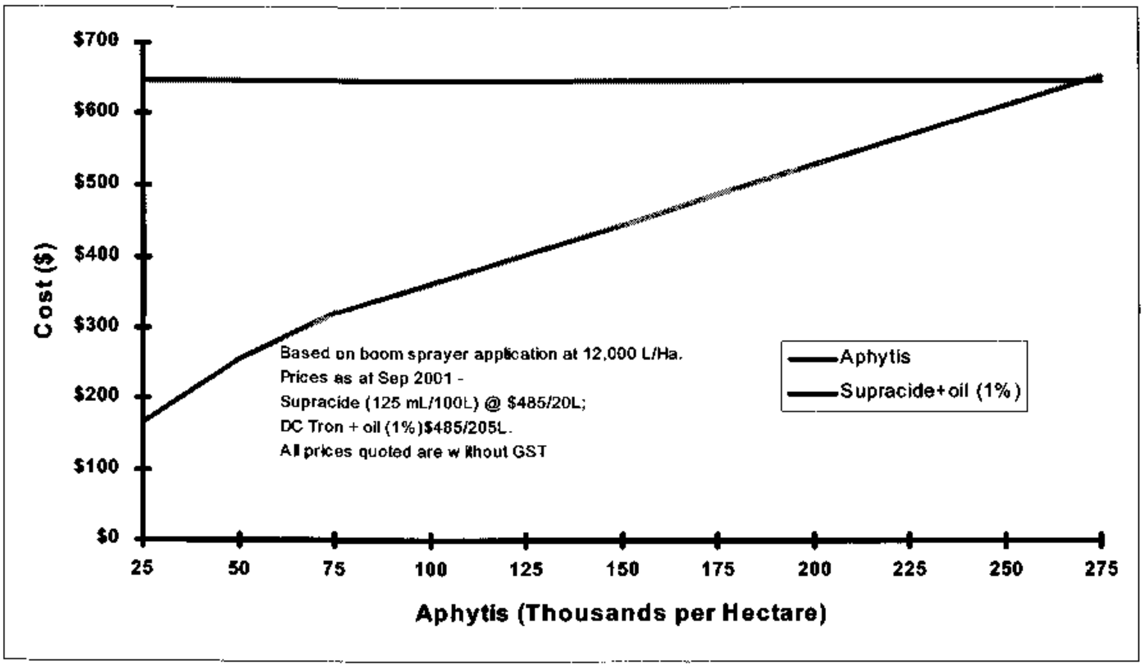
IPM Cost Benefit – Control of Red Scale

At *Abbotsleigh Citrus* chemical application for pest and disease control is minimized whenever possible through the use of IPM. This is not to say that chemicals do not play a part in control, rather management monitor the level of damage being caused and make a measured decision on the approach to control.

In the case of red scale, an insect pest that causes significant damage to citrus if left untreated, the IPM consultant to *Abbotsleigh Citrus,* Dan Papacek has developed a model which measures the benefit of utilising a natural predator (Aphytis) approach to control. The model also allows the user to determine the point at which natural control measures become more expensive than chemical control.

Figure 6.1 (following) shows the cost of chemical application versus the scaled use of natural predators to match pest levels. The graph clearly indicates the dollar benefit at any given level of natural predator release, up to the point when the cost curves cross and chemical application becomes a cost alternative.

Figure 6.1: Cost comparison between the use of Aphytis and Supracide+oil to control red scale



Source: Dan Papacek, Integrated Pest Management Pty Ltd, Sept 2001

As information on specific GEM improves, particularly with reference to cost and profit comparison with traditional horticulture systems, it is likely that a higher rate of adoption will occur. The *Abbotsleigh Citrus* operation shows that it is possible to implement a holistic system, though more difficult to separate and measure the benefits of their approach on a whole farm basis. As this section of the case study shows, it is much easier to illustrate cost benefit on a micro level.

6.7. Summary

There are very few examples of large-scale growers implementing EMS on a whole farm basis. *Abbotsleigh Citrus* is an industry innovator in this regard and as such will play an important role in guiding future implementation of similar EMS (as a whole or adopting parts of) by growers in the horticulture industry.

The key elements of the *Abbotsleigh Citrus* EMS which have made the business an industry role model are:

- The adoption of a whole farm approach from start-up phase;
- Conversion of cane farming land to high value citrus production, whilst incorporating a whole farm EMS;
- Corporate farm espousing core environmental values;
- National awareness and recognition of the *Abbotsleigh Citrus* EMS, through awards, accreditation and PR;
- Dedicated, enthusiastic and experienced management and personnel;
- Clear and well articulated business philosophy; and
- Access to capital and finance.

7. Conclusion

7.1. Findings

The scope of the Best Practice Study encompassed a broad range of detailed and complex issues. The key findings are discussed below.

a) The most effective means of increasing GEM adoption are:

i. Direct and indirect financial drivers; and

Throughout the study, financial incentives were found to be the strongest drivers of change in attitude amongst growers. Australian horticulture operates in a highly competitive marketplace in which profit margins are often tight. In this context, both growers are stakeholders recognised that financial factors are the strongest influence on the decision-making processes of growers. Direct financial drivers include price premiums, increased market access, grants, tax incentives and subsidies. Indirect benefits include on-farm or at gate cost savings.

ii. Legislative reforms.

Legislative reforms (including legislation, regulation and policy changes) were found to be historically effective in forcing change in the horticulture sector. Legislative drivers are often appropriate in situations where voluntary adoption of GEM practices was neither feasible nor likely due to a lack of financial incentives.

There is a trend toward increasing environmental regulation in Australia involving:

- Increased restrictions on private property use (through restrictions on land clearing, water use and chemical use);
- Pricing mechanisms for public goods and services(such as water and waste);
- The use of market mechanisms to regulate the quality of environmental systems (e.g. salinity trading in the Hunter Valley of New South Wales, water trading in most Australian states and carbon trading); and
- The use of a precautionary approach to identify and address potential environmental hazards before they happen (e.g. implementation of food safety programs, chemical application and genetically modified organisms).

These trends are indicative of a broader movement in policy and legislation towards a sustainable management approach to natural resource management.

b) A systems based decision-making framework encourages consistent adoption

Decision-making frameworks (such as EMS, AEAM and whole farm planning) offer a structured approach to business management and allow environmental adoption to be factored into on-farm decisions. An effective decision-making framework will facilitate proper medium to long term financial planning and should create the relative financial stability necessary for the achievement of quality environmental outcomes.

An increasingly recognised approach is to base decision-making frameworks on a 'systems' view of production that focuses inputs and outputs. This includes assessing, managing and monitoring the:

- Type, quality and quantity of inputs;
- Complex transformation processes occurring in production; and
- Type, quality and quantity of outputs.

A systems approach promotes a clearer understanding of the most important variables and external impacts acting upon and within the horticulture sector. This understanding may encourage more effective farm management across the industry, catchments or production units.

c) Rates of adoption vary

The change management characteristics that determine rates of adoption of environmental best practice are complex and abstract set of psychological and sociological factors. These include:

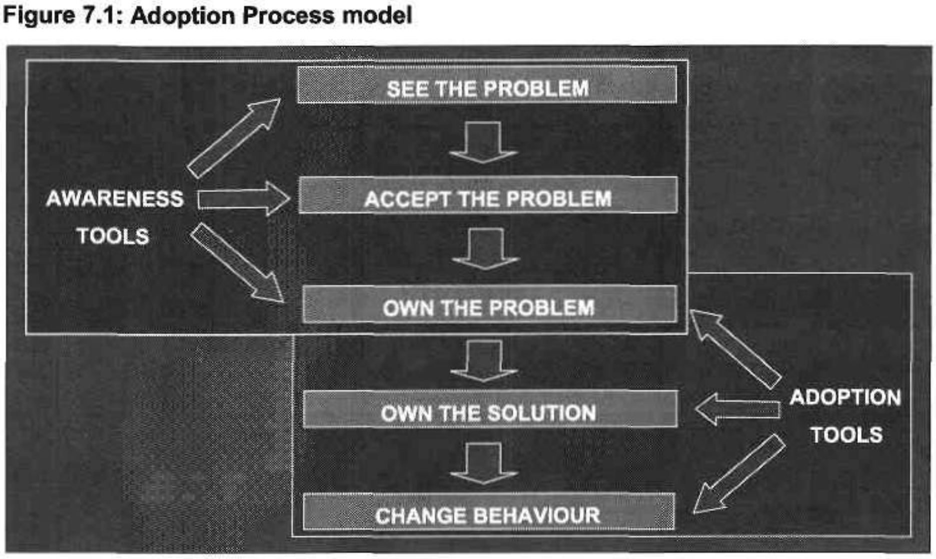
- Age;
- Gender;
- Industry;
- Ethnicity;
- Values;
- Beliefs;
- Literacy;
- Level of training;
- Commodity; and
- Location.

In light of these factors, defining the target audience and assessing change management characteristics are paramount to the success of any environmental initiative. Local knowledge of environmental issues, production systems and growers' personalities are essential components of understanding and influencing rates of adoption.

d) Behavioural change among growers occurs in defined stages

The process of behavioural change among horticultural producers has many common elements. These elements are defined in the Adoption Process model, which indicates the distinct phases of grower understanding required before the adoption of environmental measures can be achieved. The rate of progress through the model is determined by the strength of drivers for change. Understanding and actively managing grower progression through the phases of the Adoption Process is essential to ensuring maximum uptake of GEM practices.

Figure 7.1: Adoption Process model



e) Awareness does not equal adoption

A misconception of those implementing environmental programs is that awareness naturally leads to adoption. Although awareness raising is a critical component of the various stages of the Adoption Process, heightened knowledge and understanding of the issue does not necessarily lead to changes in grower behaviour. Successful programs tend to lead the target audience through all phases in the process with using a combination of tools that are audience specific and relevant to the individual adoption phases.

f) Different adoption phases require different extension tools

The extension needs of growers change as they move through the Adoption Process. Tools for managing the Adoption Process may be classed as either Awareness Tools or Adoption Tools. Awareness tool focus on communication and information distribution and are most useful early in the Adoption Process. Examples include:

- Newsletters;
- Fact sheets;
- Media;
- Decision-support software;
- We-sites; and
- Meetings with speakers.

These tools do not actively engage growers and are primarily useful in generating recognition and acceptance of issues, problems and potential solutions.

Adoption Tools provide a level of practical and technical assistance required by growers in the later phases of the Adoption Process to implement GEM practices. Examples include:

- Field days;
- Videos;
- Conferences;
- Demonstration sites;
- Open trials;
- Tours to regions of successful implementation of GEM;
- Individual consultation; and
- Training courses.

7.2. Recommendations

Based on the above findings, issues to be considered by Horticulture Australia in developing a forward strategy in the adoption of GEM may include:

a) Restructuring R&D funding processes to include defined communication strategies as a fundamental component

The findings of the study revealed a strong need for improved communication of research to growers. Horticulture Australia should examine the restructuring of its R&D funding processes to include a communication strategy as an essential component of funding applications.

Communication strategies should:

- Address grower change management needs as defined the Adoption Process model;
- Include both Adoption and Awareness Tools;
- Include mechanisms for direct grower involvement at all stages of the project (such as a project 'launch' involving growers, open days or field demonstration sites);
- Include mechanisms for ensuring the research results are communicated nationally (for example through industry newsletters); and
- Link milestone payments to the communication strategy.

This approach should allow the more effective dissemination of information, proactively involve growers in R&D and ensure all recipients of Horticulture Australia funding are committed to ensuring the communication of their research findings to growers.

b) All future environmental programs should include clear, simple cost-benefit analyses

The findings of the study clearly indicate the strong degree of influence that financial considerations have in the adoption decisions by growers. The inclusion of cost-benefit analyses would allow program managers to more accurately assess the most appropriate adoption drivers to promote in the program. Cost-benefit analysis also allows financial benefits to be readily demonstrated to growers, thus harnessing financial drivers for adoption. This technique is likely to be particularly useful where financial benefits are realised in the medium to long term.

c) Attracting private sector GEM investment in the horticultural sector

Where cost-benefit analysis shows private financial benefits form the adoption of environmental measures, Horticulture Australia should seek to attract private sector investment in adoption programs. Horticulture Australia should seek to actively engage the owners of environmental technologies and processes to facilitate greater adoption of these measures. As a logical first step in this process, an investigation of the most appropriate and effective structures for such initiatives should be undertaken.

d) Encouraging governments to develop financial incentives for the adoption of GEM practices

Where cost-benefit analysis indicates that the adoption of specific elements of GEM does not have significant private financial benefits, government should be encouraged to provide financial incentives for adoption. In general in Australia, public goods (such as air quality and catchment health) are externalities and thus do not have a direct financial value to growers. As such, it is the role of government to protect the integrity of these goods. In the absence of financial benefits to growers, the government should be lobbied to provide financial incentives for adoption of these elements of GEM. Examples of financial incentives include: taxation incentives, grants and subsidies.

e) Develop models/strategies to better promote the inclusion of environmental issues into the business decision-making tools

National trends currently show an increased use of decision-making frameworks in the rural sector (particularly EMS). Horticulture Australia should encourage the adoption of such frameworks. Horticulture Australia should seek to endorse the use of frameworks that are systems based and promote the inclusion of environmental considerations in on-farm business decisions.

7.3. Concluding Remarks

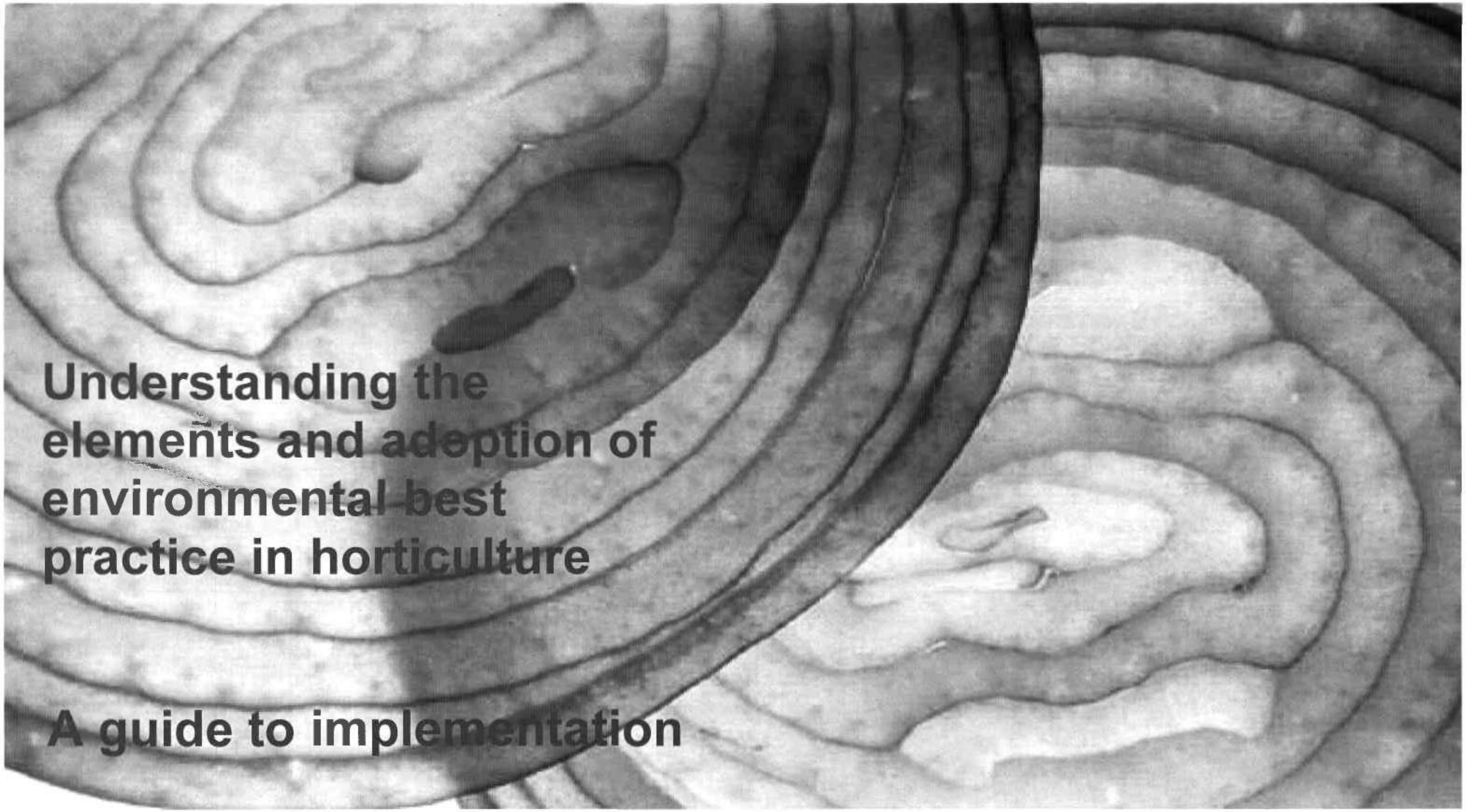
Encouraging the adoption of GEM by the horticulture sector is a complex and challenging task. It involves a strong understanding of the:

- Environmental issues facing horticulture (local, regional and national levels);
- Environmental best practice for the specific commodity and region in which increased adoption is sought;
- Change management characteristics of the target audience;
- Tools for encouraging increased adoption; and
- Drivers for adoption of GEM practices.

As the national representative body, Horticulture Australia is in a strong position to effect stronger adoption of GEM practices within the sector. Horticulture Australia should consider developing a proactive position on environmental matters as an advocate of the change management needs of its members. This will involve engaging both with private sector stakeholders and government to facilitate effective environmental programs for its industry members.

Horticulture Australia

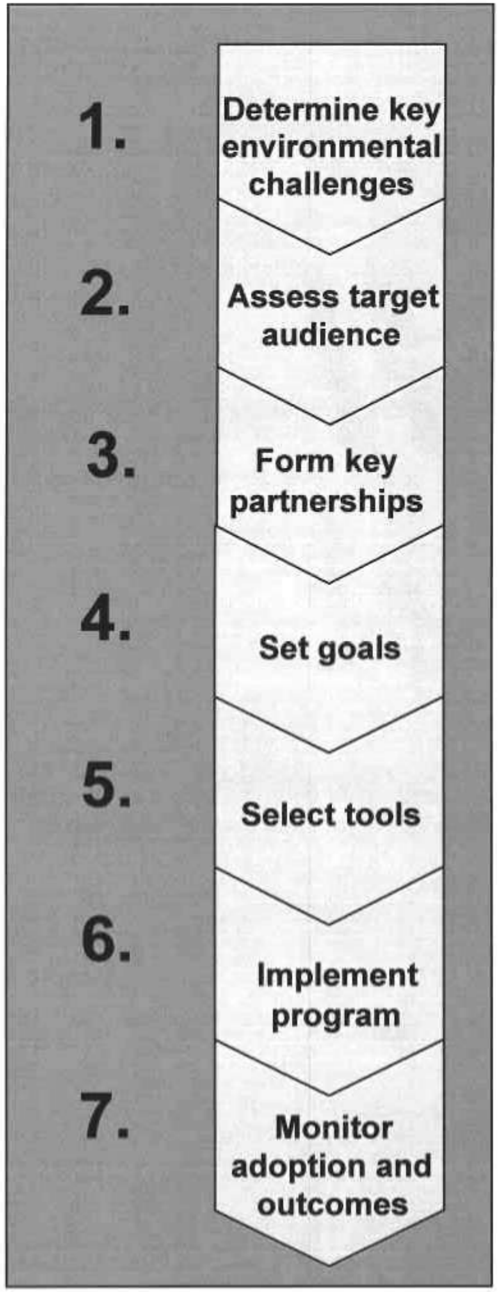
ANDERSEN



Understanding the elements and adoption of environmental best practice in horticulture

A guide to implementation

Introduction



Purpose

The purpose of this document is to assist industry associations and other relevant bodies to develop programs to increase the adoption of good environmental management (GEM) practices by horticulture.

Enhanced management of the environmental issues facing the horticulture sector requires a collaborative approach with local solutions tailored to the unique environmental conditions of the area and the change management characteristics of the target audience. The following document provides a guide for the development of effective environmental programs. Outlined in the following pages are seven key stages:

1. Determine content;
2. Assess target audience;
3. Form key partnerships;
4. Set goals;
5. Select tools;
6. Implement program; and
7. Monitor adoption and outcomes.

These stages provide a framework to allow industry associations to develop their own approaches to GEM.

Background

'Understanding the elements and adoption of environmental best practice in horticulture' is a joint initiative of Horticulture Australia limited (HAL) and the National Land and Water Resources Audit (a Natural Heritage Trust project). This project forms part of the second stage of the 'Horticulture Environmental Audit'.

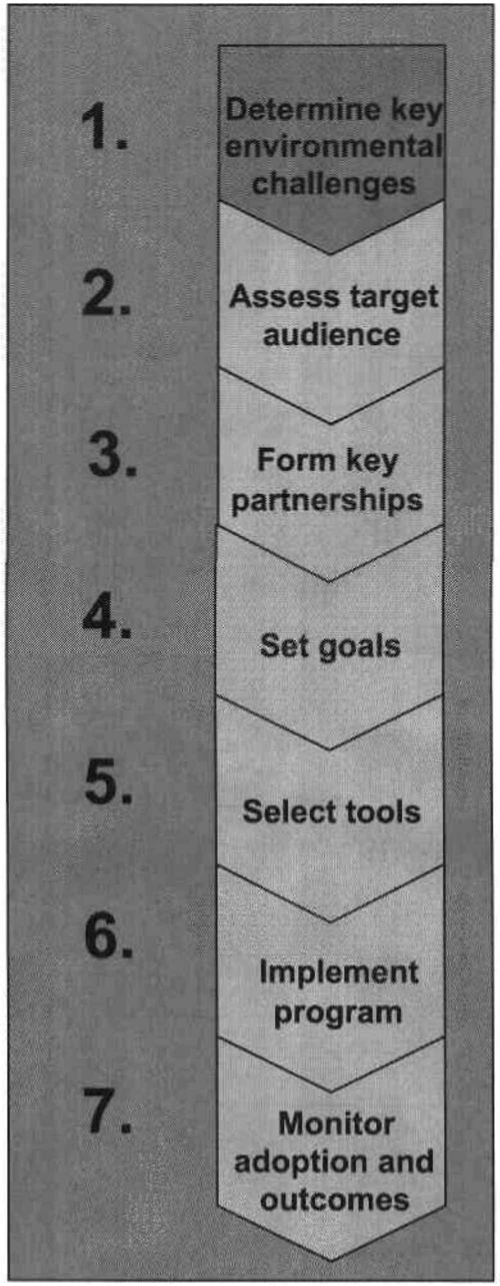
Stage 1 commenced in 1999 with the purpose of documenting the use of natural resources by horticulture, assessing the extent of current impacts on those resources, assessing the adoption of good environmental management (GEM) practices and the need for more sustainable management practices.

In commissioning Stage 2 of the project, HAL sought to build on this with two further studies:

1. Understand the nature and breadth of GEM practices and the capacity of Australian horticulture to adopt such practices (The Best Practice Study); and
2. Develop plans to increase Australian horticulture's capacity to capture, store, assess and make available relevant information on natural resource management, including information generated externally to HAL's activities (The Information Study).

Andersen (which has since merged with Ernst and Young) was commissioned in April 2001 to undertake the Best Practice Study. The approach adopted involved:

- A review of domestic and international literature;
- National industry consultation; and
- The development of three case studies in GEM.



Stage 1: Determine Key Environmental Challenges

Central to achieving environmental outcomes for the horticulture sector is to ensure consistent content in environmental programs. The dominant environmental issues facing the horticulture sector in a specific region or recent legislative changes should guide the selection of content for environmental initiatives. GEM for the horticulture sector can be summarised into decision-making frameworks and GEM practices. These elements should form the basis of program content.

GEM practices

GEM practices in the horticulture sector fall into the following categories:

- Water;
- Soil and land management;
- Pest, insect, weed and disease management;
- Air;
- Noise;
- Waste; and
- Biodiversity.

Specific elements of GEM vary based on the critical issues effecting a region, the industry or industries involved as well as financial, social, cultural and institutional factors. Environmental management has very few generic, prescriptive solutions. Environmental programs should be tailored to the industry and region involved. Local solutions have the greatest chance of increasing on-farm adoption and achieving significant environmental outcomes. Local and industry research and consultation should be conducted to identify and / or develop GEM practices.

Decision-making frameworks

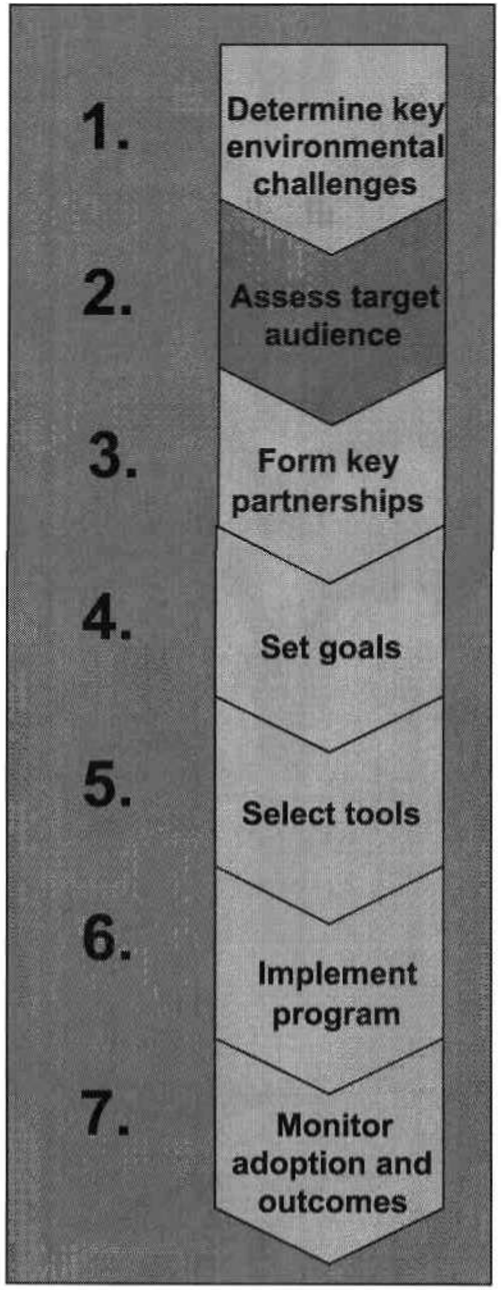
Effective environmental management requires a decision-making framework to formalise the process for assessing, managing and monitoring the financial, personal, social and environmental variables in the production process. An effective decision-making framework facilitates proper medium to long-term financial planning. This relative financial stability enables quality environmental outcomes to be achieved. Examples of decision-making frameworks include:

- Environmental management systems (EMS);
- Quality assurance (QA) programs;
- Total catchment management strategies; and
- Whole farm planning initiatives.

The selection of an appropriate decision-making framework hinges on a variety of factors but particularly scale. Some frameworks may be universally implemented (such as environmental management systems) while others require a more specialised approach that is applicable at industry or regional levels (e.g. total catchment management). A widely recognised method is a systems-based approach which focuses on the:

- Type, quality and quantity of inputs;
- Complex transformation processes occurring in production; and
- Type, quality and quality of outputs.

A systems approach promotes a clear understanding of the important variables affecting the horticulture sector and their external impacts. Understanding these variables and external impacts may encourage more effective farm management across the sector.



Stage 2: Assess Target Audience

Horticultural producers in Australia have unique and specific change management needs. These needs are based on number of sociological and psychological factors including level of training, literacy, commodity, age, gender, industry, ethnicity, values, beliefs and location. These characteristics need to be identified and then integrated into any environmental program. Surveys of the grower population or of participants in grower groups (such as Cittgroups) are useful in assessing the characteristics of the target audience.

Despite the high degree of variation in the characteristics of growers, it is possible to identify a number of defined phases leading to the adoption of new technologies or practices. The *Adoption Process* Model (shown over page) describes:

- Phases of acceptance growers pass through to change their behaviour (orange boxes);
- Appropriate tools to assist the growers at different phases; and
- Motivating factors that drive growers to move from one phase in the process to the next (green arrows).

When assessing the characteristics of the target audience, it is important to identify which phase of the model they belong to.

The Adoption Process

Phase 1: "See the Problem"

At this stage the grower recognises a problem is present. This recognition is most effectively triggered through tangible evidence of the problem. This may occur through the observation of physical signs (such as erosion on the grower's property) or the problem being brought to the growers' attention (for example through an industry newsletter or media attention).

Phase 2: "Accept the Problem"

At this stage, the grower accepts that the issue is a problem and action needs to be taken to address it. Recognition of the impact of an environmental issue on productive activity is often a crucial part of this. This phase involves a heightened understanding of the problem. This stage is often reached through specific local cause-and-effect evidence being provided to the grower. During this phase, growers will look to others to solve the problem.

Phase 3: "Own the problem"

When growers enter this phase, they have accepted a personal responsibility for addressing the problem. Growers will therefore be responsive to any information on potential solutions and may be proactive in seeking these out.

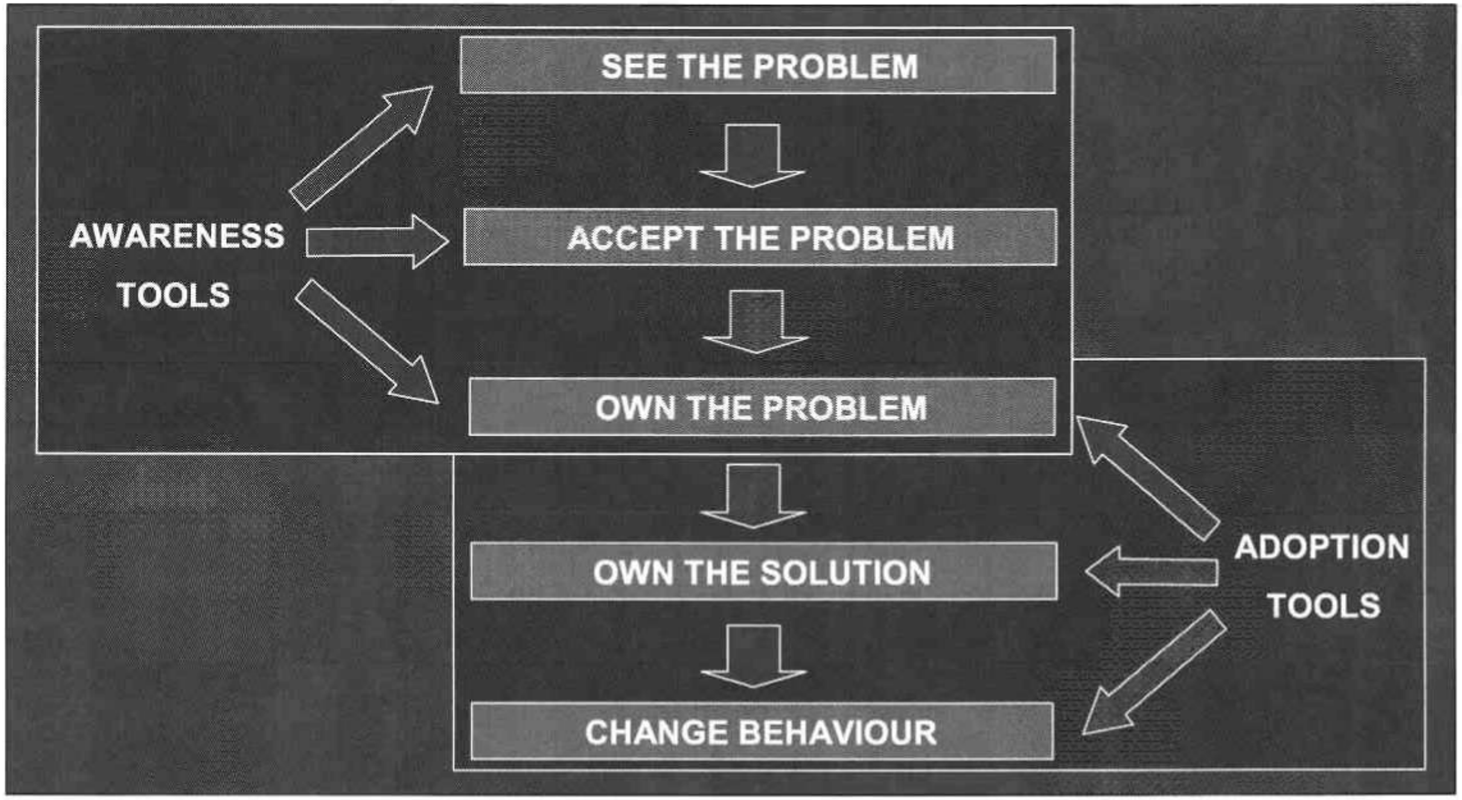
Phase 4: "Own the Solution"

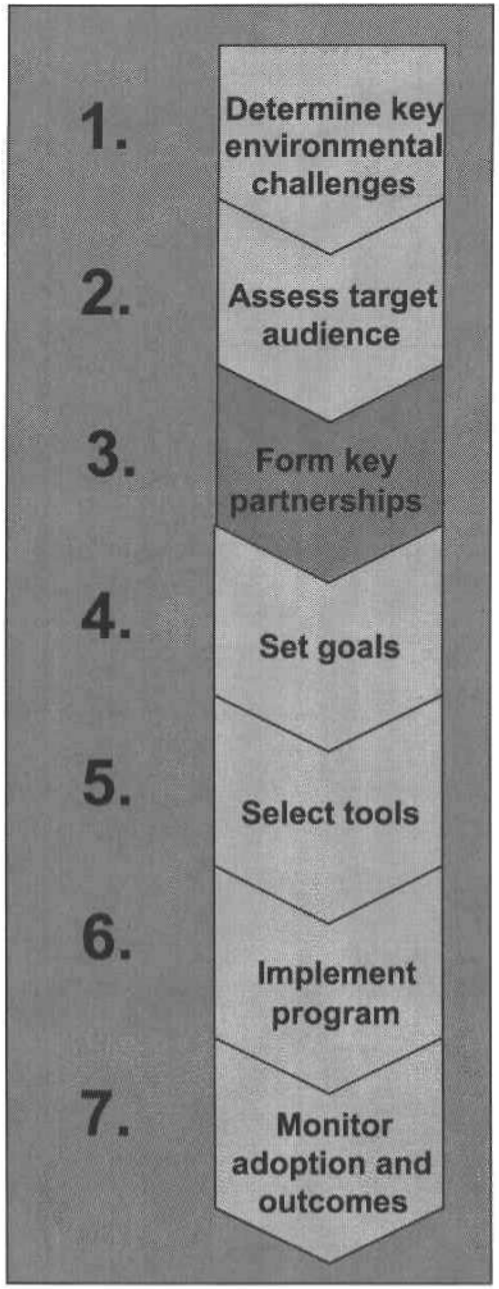
For environmental measures to be readily adopted, it is important that growers feel ownership of those measures. If growers are included in research and development processes, adoption is more likely to occur. Where technologies or practices are being transferred, local trials or demonstration sites are considered important.

Phase 5: "Change Behaviour"

Guiding growers to change their behaviour and adopt GEM practices is the ultimate objective of environmental programs. It is important to understand that each phase of the process is required for change to occur. However, the time in each phase and the total time required to move through the *Adoption Process* varies. Environmental leaders move more rapidly through the entire process whereas change resistant individuals require significantly more time in each phase.

The Adoption Process Model





Stage 3: Form Key Partnerships

The formation of key partnerships with relevant stakeholders has a number of advantages in developing environmental programs. First, partnerships allow access to technical expertise on environmental issues and industry funding through partnerships with government departments and other environmental programs.

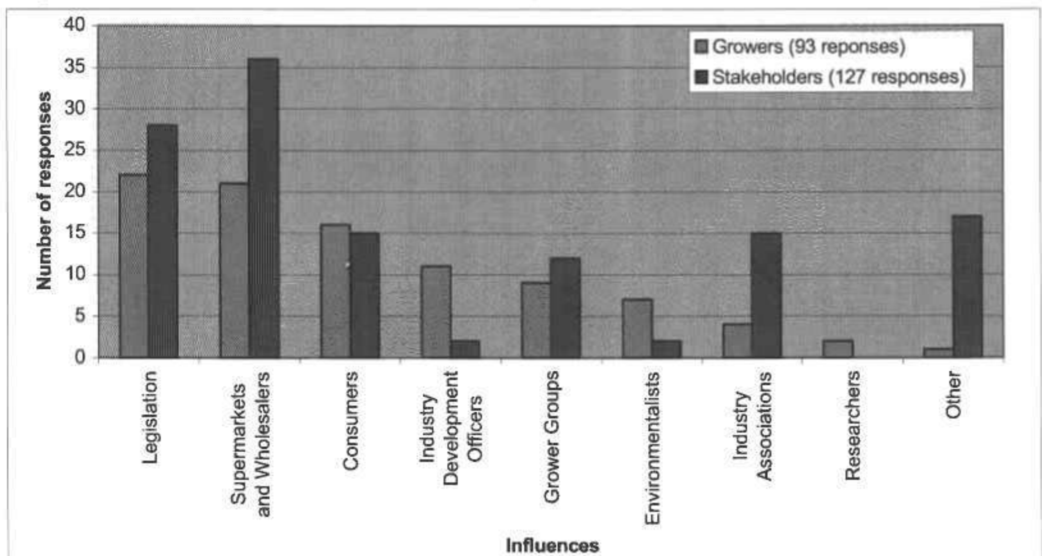
Second, there is genuine concern from growers that horticulture is perceived by communities and governments as having an adverse impact on the environment. In this context, growers are under pressure to demonstrate GEM practices. By involving government departments, community groups and other stakeholders in environmental programs, these concerns may be addressed in a co-operative fashion to assist in developing an integrated approach.

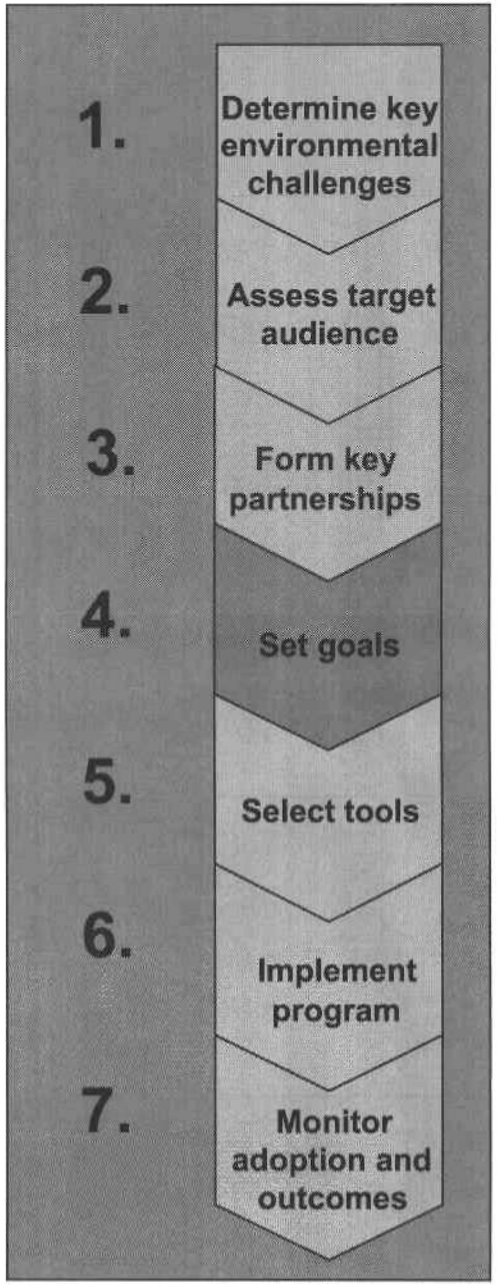
Finally, different organisations have differing levels of influence upon growers' decisions. As shown in the figure below, legislation (in the form of regulatory bodies), the supply chain and industry development officers have a significant level of influence in the decision-making processes of growers. Through the formation of strategic partnership with these groups, this influence may be utilised to increase the adoption of GEM practices.

Enviroveg (case study of an industry initiative)

The *Enviroveg* Project aims to voluntarily improve the adoption of GEM practices by vegetable growers in the Werribee and south-east Melbourne areas. The project is a joint initiative of the Victorian Vegetable Growers Association and HAL with collaboration from collaboration from the Environment Protection Authority (EPA) Victoria, Department of Natural Resources and Environment (NRE), University of Western Sydney, NSW Agriculture, Melbourne Water and Southern Rural Water. It has been developed at a grassroots level to address community and departmental concern at the perceived environmental impact of horticulture. *Enviroveg* employs many of the principles necessary to generate grower ownership and increase the adoption of GEM practices. The principles used in designing and implementing the *Enviroveg* project may prove to be a useful model for the development of environmental programs.

Organisations that influence the decisions of growers





Stage 4: Set Goals

The key to effective goal setting is to select goals which are challenging but achievable within the time and funding available. The goal for a particular program will be based on a number of factors:

- Phase of the Adoption Process in which the growers predominantly reside; and
- Whether the type of adoption required is voluntary or forced.

Phase of the Adoption Process

To a large extent the phase of the Adoption Process in which the growers are predominantly residing will determine what may be achieved. If the majority of growers in the target group are in Phase 1 of the Adoption Process significant time and resources would be required to facilitate behavioural change. A reasonable first goal may be to move the majority of the group into Phase 3 'Own on the Problem' where they will be receptive to information on solutions to environmental problems. From this point, a forward goal of increasing adoption of GEM practices may be set.

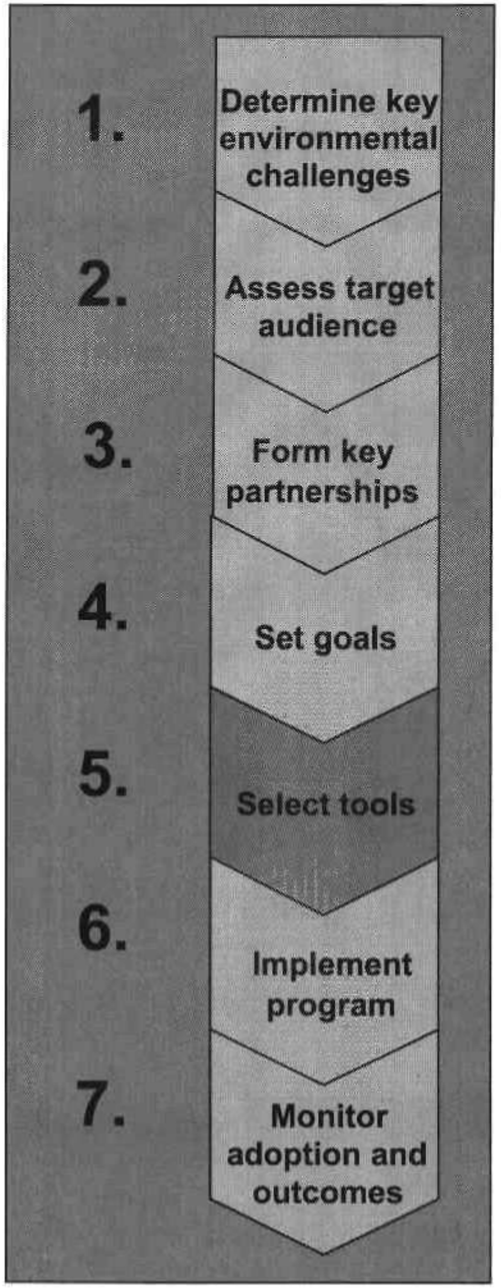
Type of Adoption

It is generally recognised that two forms of adoption exist: voluntary and forced adoption. Forced adoption occurs where growers are required to change their behaviour in order to remain in viable production. Forced adoption tends to be characterised by penalties for failure to adopt. Legislation and supply chain requirements are two of the most common forms of forced adoption. Where legislation or market requirements occur, growers are moved directly into Phase 3 of the Adoption Process, as they must "Own the Problem" or cease viable production. Where forced adoption occurs the goals for the project may be set at a high level of behavioural change.

Voluntary adoption occurs where growers may decide whether or not to adopt certain measures. Where voluntary adoption is sought, some form of incentive is usually required (for example increased market access or price premiums). As such, 100% adoption of voluntary measures is not a feasible outcome of extension programs. This is particularly the case for environmental measures where many of the benefits are public goods and direct, short-term benefits to growers may be minimal. The most appropriate measure of the success of a voluntary program is to identify the proportion of the group who are receptive to change. Program success should then be measured against that proportion.

Abbotsleigh Citrus

Abbotsleigh Citrus is an environmentally innovative citrus operation located 56 km from Bundaberg (Queensland) on the Burnett River. Since its establishment in 1996, the enterprise has aimed *"to fully embrace the concept of sustainable agriculture, which includes the protection and enhancement of the environment"*. The pursuit of this ambitious goal has brought *Abbotsleigh Citrus* a prestigious Banksia Award in the 'Small Business Responsibility and Leadership' Category. The operation now has *"the most comprehensive and wide-ranging environmental management system for any farm in the country"* (*Landline* 22/09/01).



Stage 5: Select Tools

Different phases in the *Adoption Process* require different communication and information tools. Although raising awareness is a critical component of the *Adoption Process*, increasing understanding will not necessarily lead to changes in grower behaviour. Successful programs lead the target audience through all phases in the process with the appropriate combination of communication and information tools. There are two types of tools: *Awareness Tools* and *Adoption Tools*. The selection of tools should be based on which phase the target audience is at in the *Adoption Process* Model.

Awareness Tools

Awareness Tools are used for communication and information distribution. These tools are passive, as growers are not proactively involved. Examples of awareness tools include newsletters; fact sheets; media; videos; decision support software; web-sites; and meeting with speakers.

Awareness Tools are primarily used to generate recognition and acceptance of issues, problems and potential solutions. These are most effective in Phases 1 and 2 of the *Adoption Process* and are also useful in Phase 3 to provide information on solutions. The appropriate mix of *Awareness Tools* varies greatly based on the commodity group(s), spatial distribution of growers and the general level of grower sophistication. Assessing target audience characteristics is critical to achieving consistent implementation.

Adoption Tools

Individuals in Phases 3-5 of the *Adoption Process* are proactive. *Adoption Tools* are those that actively engage growers, providing practical and technical assistance to enable the implementation of environmental measures.

A South Australian industry professional aptly surmised the role of *Adoption Tools*:

"Growers need to be more than just told they need a sediment trap. They need to be shown how to dig one" (Consultation, Virginia 31/08/01).

Examples of effective Adoption Tools include:

- Field days;
- Conferences;
- Demonstration sites;
- Videos;
- Individual consultation;
- Training courses; and
- Tours to regions of successful implementation.

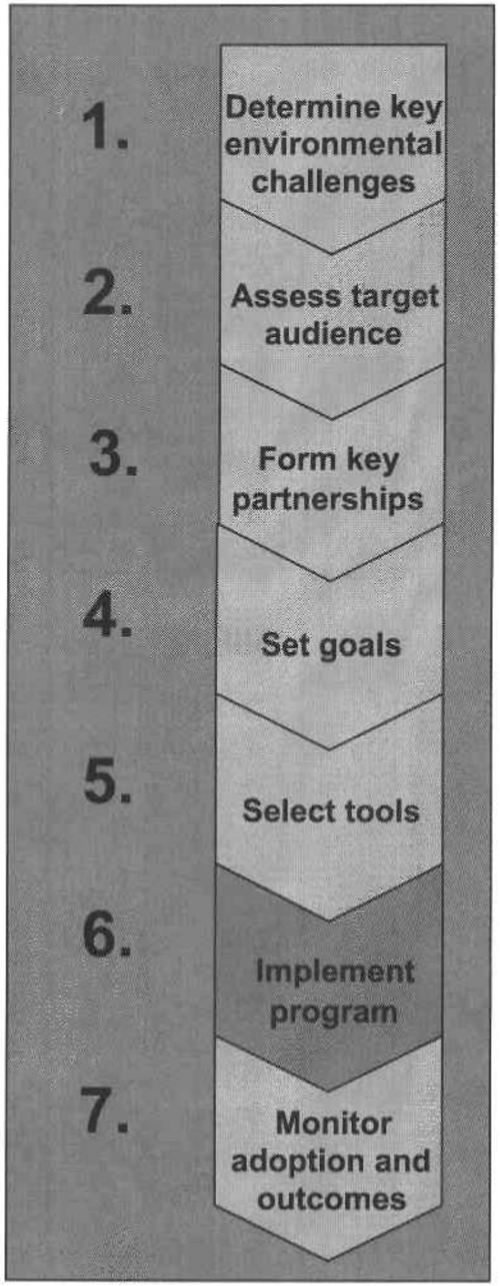
During the consultation phase, meeting participants were asked reasons why some projects succeed in increasing adoption. Three of the top four responses were:

The provision of technical assistance and support;

- Ease of implementation; and
- Tangible and visible benefits.

These responses emphasise the importance of *Adoption Tools* as practical explanations and demonstrations of GEM practices. All commodity groups and all regions nominated field days as the most effective *Adoption Tool*. Field days demonstrate and explain practices and technologies in an interactive way. At one Tasmanian meeting, the reason for the success of field days was explained as:

"Growers are practical people, they need to see the benefits, ie: this is what I did, this is how it worked, this is the result" (Consultation, Launceston, 10/08/01).



Stage 6: Implement Program

The implementation phase of an environmental program, involves utilising the tools selected to address the key environmental challenges and achieve the project goals. This phase of the program has a number of key task including:

- Determining timeframes for implementation;
- Assigning key responsibilities; and
- Collaborating with other relevant stakeholders to integrate the program with other environmental programs.

The success of this implementation will largely be determined by how well the tools are used to drive change in the target audience. As such, the unique suite of drivers in region or industry groups should form the focus the implementation strategy. Where changes are being forced by legislation or market requirements, this should be emphasised in the implementation of the program. Where financial incentives exist, this should also be emphasised.

While the relative significance of drivers will vary between target horticultural groups, The Best Practice Study has found that several drivers are dominant within the Australian horticultural sector (as shown over the page). The more effectively drivers are used to motivate growers, the more likely the program will succeed in changing grower behaviour.

Financial drivers

The top three drivers, with a combined response of 70%, for the implementation of environmental measures were financial (sustainability, cost savings and profit). Therefore, financial factors are the strongest drivers for change in the industry. Economic sustainability is the major driver and focusses on the ability of growers to be financially viable in the long term with profitability being the dominant concern. Direct financial drivers include: price premiums; subsidies; increased market access; and tax incentives. Indirect benefits include on-farm or at gate cost-savings.

The inclusion of a cost-benefit analysis to of an environmental practice or technology should be considered for all environmental programs to utilise economic drivers. This will be particularly useful where voluntary adoption is required. The Goulburn Broken Floodplain Buyback Scheme (profiled over page) is an example of how cost-benefit analysis can be effectively used to drive change.

Market drivers

Changes driven by market requirements are a specific type of financial driver. The current market for horticultural produce is highly competitive, complex and dynamic. This highly competitive environment means that producers are sensitive to factors that may influence their margins. Market forces are highly effective drivers and are generally in the form of: changes to market access; price premiums; and marketing opportunities.

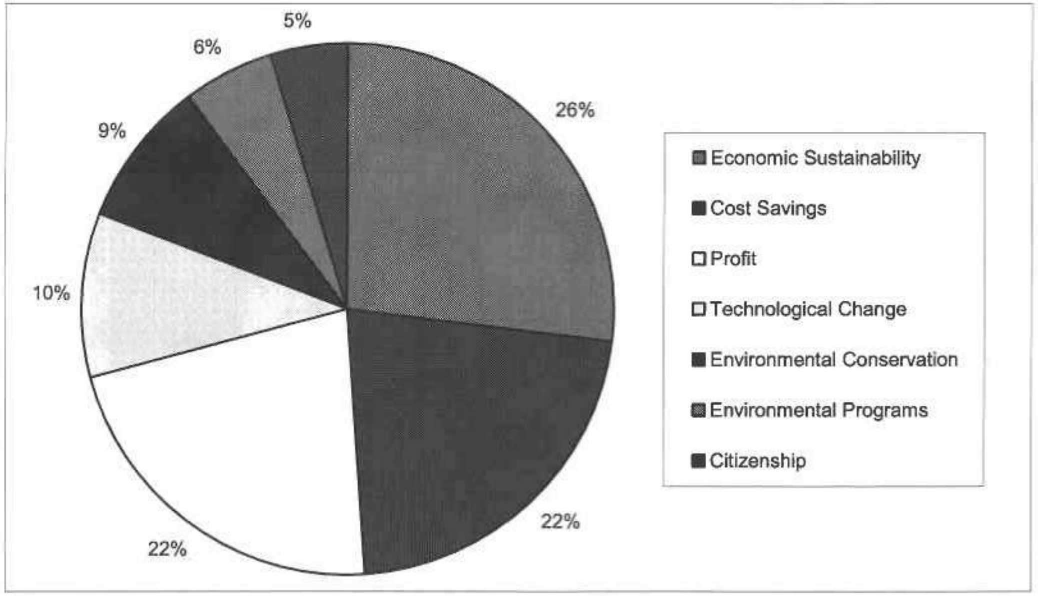
Legislative drivers

There is a trend toward increasing environmental regulation in Australia involving:

- Increased restrictions on private property use (through restrictions on land clearing, water use and chemical use);
- Pricing mechanisms for public goods (such as water quality);
- The use of market mechanisms to regulate the quality of environmental systems (e.g. water trading in most Australian states); and
- The use of a precautionary approach to identify and address potential environmental hazards before they occur (e.g. implementation of food safety programs and chemical application).

These trends are indicative of a broader movement in policy and legislation towards a sustainable management approach to natural resource management. Where possible, these trends should be employed in implementing an environmental program.

Drivers for Change (based upon industry analysis)



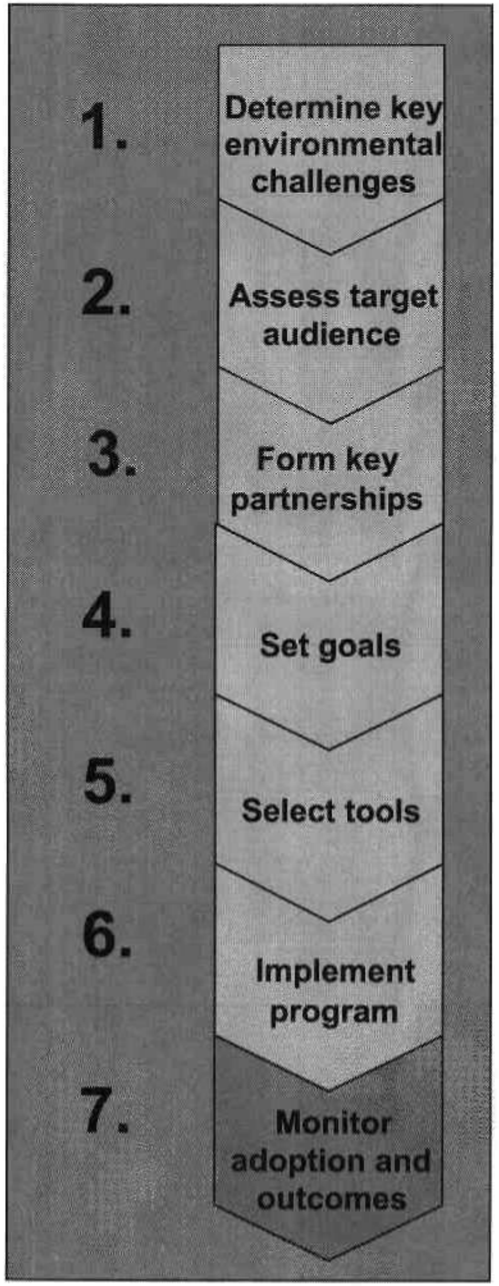
Lower Goulburn Broken Floodplain Rehabilitation Scheme (case study of a regional initiative)

The Goulburn Broken Catchment Management Authority (GBCMA) is implementing a scheme that will return an area of the Lower Goulburn River floodplain to its natural state. The extensive levee system in place on the Lower Goulburn is unable to cope with moderate flooding events. Throughout the 1900s, flooding caused the levee system to be breached approximately every 10 years. The average cost of flood damage on the lower Goulburn is $2.8 million annually. In light of these financial drivers, the GBCMA sought to implement a long-term management plan for the area. Through cost-benefit analysis of several options, the Floodplain Rehabilitation Scheme was found to be the most cost effective.

The primary purpose of the project is to reduce the cost of flood damage and improve water quality in the Murray-Darling Basin. The direct benefits to the local area are reduced infrastructure maintenance costs after flood events. The main benefit to horticulture from the Lower Goulburn Floodplain Rehabilitation Scheme is improved water quality downstream of the site. This is likely to be the result of lower sediment and nutrient inputs in the Murray River. It is hoped this will occur through the:

- Trapping of nutrients and sediments in floodplain wetlands; and
- Reducing stream velocity during flood events resulting in reduced streambed and riverbank erosion.

This should lead to better water quality and lower turbidity in the Murray River. This would not only benefit downstream horticultural irrigators but all users of the Murray-Darling system downstream of the site.



Stage 7: Monitor adoption and outcomes

In order to gauge the success of the project and distil lessons learned, the outcomes of the project should be monitored. This stage of the environmental program should involve three tasks:

- Benchmarking;
- Feedback; and
- Developing a forward strategy.

Benchmarking

One particularly useful means of monitoring project success is through benchmarking the adoption of GEM practices. Benchmarking is a process that involves measuring performance to provide a basis for comparison and continued improvement.

Benchmarking allows the reassessment of the target audience's progress through the *Adoption Process* Model. It can operate at a variety of levels including industry, catchment and farm. The process of benchmarking commences with growers gathering data about their current practices. This level can then form a basis for improvement or be compared to an industry average, catchment average or a target figure (such as the articulated goals for the project).

Benchmarking is particularly useful when reported in terms of key performance indicators (KPIs). KPIs report performance in terms of commonly understood terms. For example, some commonly used irrigation KPIs include:

- Yield per hectare;
- Gross return per megalitre; and
- Tonnes per megalitre.

Feedback

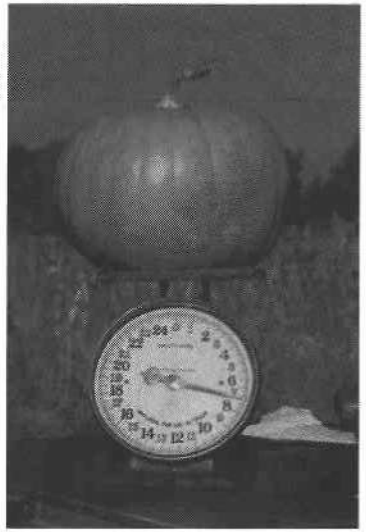
Feedback should be sought from the target audience on the strengths and weaknesses of the program. This information should provide specific insights into the reasons for project success or failure and allow future improvement in environmental programs. One useful feedback technique is to ask for feedback on specific tools such as workshops or conferences at the time of the event.

Develop forward strategy

GEM is a dynamic and constantly evolving concept. The emphasis is on enabling change, change management and constant improvement. At the conclusion of each program a forward strategy should be developed to allow achievements to be built upon.

This forward strategy should contain:

- Outcomes of current program;
- Strengths of the current program;
- Recommendations for improvement;
- Recommended content areas for future projects;
- Suggested goals for future projects;
- Suggested timelines; and
- Estimations of budget requirements.



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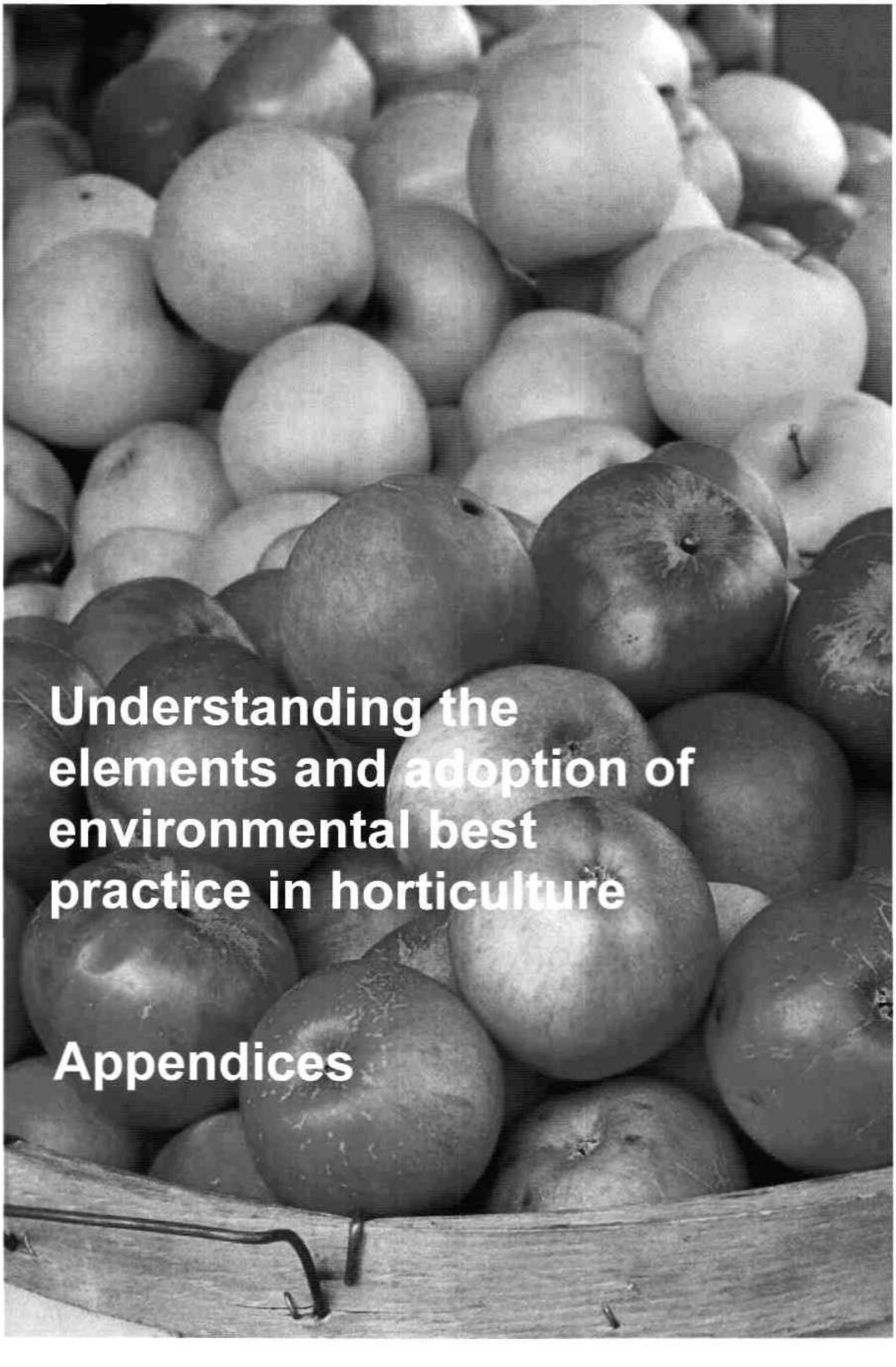

Understanding the elements and adoption of environmental best practice in horticulture

Appendices

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List of Abbreviations and Acronyms

AEAM	Adaptive Environmental Assessment and Management
AFFA	Agriculture, Fisheries and Forestry Australia (Commonwealth)
ARS	Agricultural Research Service
BCG	Birchip Cropping Group
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industry Research Organisation
DPIWE	Department of Primary Industry, Water and Environment (Tasmania)
DNRE	Department of Natural Resources and Environment (Victoria)
EMS	Environmental Management System
EPA	Environment Protection Authority
GEM	Good Environmental Management
GMO	Genetically Modified Organism
HACCP	Hazard Analysis Critical Control Point
HRDC	Horticulture Research and Development Corporation
ICM	Integrated Catchment Management
IDO	Industry Development Officers
IPM	Integrated Pest Management and Integrated Weed Management
ISO	International Standards Organisation
LEAF	Linking Environment and Farming
LWRRDC	Land and Water Rural Research Development Corporation
NIASA	Nursery Industry of Association of Australia
QA	Quality Assurance
QDPI	Queensland Department of Primary Industries
QFVG	Queensland Fruit and Vegetable Growers
R&D	Research and Development
RDI	Regulated Deficit Irrigation
SHEF	Self-Help Evaluation Framework
SQF	Safe Quality Food
TCM	Total Catchment Management
USDA	United States Department of Agriculture
WUE	Water use Efficiency
WVQMS	Woolworths Vendor Quality Management Standard

Appendix A: Project Methodology

A.1. Overview

The primary objective of the Best Practice Study was to develop a methodology, which was broad enough to capture information from all horticultural sectors nation-wide, while generating findings and data with enough detail so as to be useful and meaningful to the horticultural sector. The challenge faced by the project team was to develop such a methodology in the absence of similar studies for the sector. The project team has sought to identify principles, practices and strategies that are relevant across all horticulture groups. At the same time, specific, illustrative examples have been used to highlight the variation within groups. An emphasis has been placed on the importance of understanding the target audience for guidelines, their specific needs and the specific environmental solutions required on a case-by-case basis.

The Best Practice Study approach comprised three key phases:

1. Review of domestic and international literature;
2. National industry consultation; and
3. Case study development.

The approach to each of these three phases is discussed below, along with explanation of validation and data analysis methods.

A.2. Scope

The project scope included Australian horticulture in all areas nationally. For the purposes of this project the following industry sectors comprise Australian horticulture: apple, bananas, pear, nashi, strawberry, cherry, fresh and processing potato, vegetable, fresh stonefruit, canning fruit, nursery, citrus, avocado, macadamia, custard apple, fresh and processing tomato, melon, mango, pawpaw, pineapple, pyrethrum and nut industry sectors. Other horticultural commodities have been considered where appropriate.

The scope and approach has precluded a number of issues from being addressed in this project. These issues include:

- Quarantine;
- Retail nurseries; and
- Hydroponic production.

These issues present a unique and complex range of environmental management issues, which are considered outside the scope or are peripheral to the study.

A.3. Review of Domestic and International Literature

The purpose of the literature review was to:

- Identify and assess decision-making frameworks;
- Identify the generic elements of good environmental management; and
- Investigate the current understanding of change management in the rural sector, specifically as it applies to Australian horticulture.

This literature review has formed the basis for Chapter 3 and detail provided in section 4.4 relating to detailed discussion of drivers for adoption of GEM practices. The literature review is included in its entirety in Appendix 2. The approach taken to Chapter 3 is to outline appropriate frameworks for decision-making and examples of GEM practices which may be implemented within these frameworks. Special focus has been placed upon decision-making frameworks as these are at once highly topical and relevant to all industries within the horticultural sector. GEM practices have been discussed at a high level only so as to avoid creating the impression that general prescriptive solutions are available.

The approach to identifying relevant literature involved 3 strategies:

1. Traditional library research strategies (through the State Library of Victoria and the Ballieu and Agriculture libraries University of Melbourne);
2. Internet research; and
3. Liaising with key industry professionals and researchers (both domestic and international).

This strategy allowed the project team to identify material in the public domain which may or may not be included in library collections. Examples of this material include: government reports, policy documents, brochures, publicity material and press releases. Liaison with industry professionals and researchers allowed material of high relevance to be identified including scientific work in progress, unpublished reports and industry specific information. Liaison with these parties took the form of emails and telephone discussions.

Telephone contact with industry development officers (IDOs) was particularly emphasised by the project team. Through their roles IDOs are often responsible for ensuring growers are provided access to information pertinent to their industry. As such, IDOs were thought to have a strong understanding of the information and literature available. This contact also established the industry networks required for the success of the consultation phase and case studies.

A.4. <u>National Industry Consultation</u>

National industry consultation was the primary research tool employed by the project team and was predominantly based upon 'participant action research'. Participant action research is a technique in which the team operates inside and outside the group which is the subject of the study (in this case the horticulture sector) (Robinson 1998: 422). The team networks within the group to derive opinions, perceptions and information which may not have been revealed through formal interview processes (Robinson 1998: 422). As such, the unpublished and undocumented expertise of key figures in the industry or 'gatekeepers' as the literature formally describes then, may be accessed (Smith 1998: 23).

The issues addressed by this study are both complex and abstract. In order to effectively explore these issues, the project team adopted a qualitative approach to complement quantitative techniques. Through the workshops and forums, participants explored, in detail, the complex issues surrounding adoption of GEM practices, adoption pathways and drivers for change. Conducting the survey generated quantitative data to support these findings.

Further challenges lay in designing a national consultation strategy sophisticated enough to draw out the complex and abstract data required from a diverse target audience. The audience included growers and stakeholders from a range of: ethnic backgrounds, levels of education, commodities and professions. The project team therefore employed three strategies:

1. Formal grower and stakeholder workshops;
2. Facilitated discussion forums; and
3. A survey of meeting participants.

During the national industry consultation 230 individuals participated in the 21 meetings held in 15 locations (as shown in Table A.1). These individuals included: growers, agribusiness companies, processors, agricultural supply companies, researchers (both public and private), IDOs, representatives of industry associations, extension officers, environmental and agricultural professionals, academics and government employees in related fields. As shown in Figure A.1[1] representatives from all horticultural sectors were consulted. These individuals were from all states of Australia, with the relative proportion from each state shown in Figure A.2.

Table A.1 Locations, dates and types of meetings

Location	Date	Meeting Type
Melbourne	19.07.01	Stakeholder discussion forum
Hobart	1.08.01	Stakeholder workshop
		Grower discussion forum
Launceston	2.08.01	Stakeholder workshop
Devonport	2.08.01	Grower workshop
Windsor	13.08.01	Stakeholder workshop
		Grower workshop
Nambour	14.08.01	Stakeholder workshop
		Grower workshop
Bundaberg	15.08.01	Stakeholder discussion forum
		Grower workshop
South Johnstone	20.08.01	Grower and stakeholder workshop
Shepparton	27.08.01	Grower and stakeholder workshop
Griffith	29.08.01	Stakeholder workshop
		Grower workshop
Berri	30.08.01	Grower and stakeholder discussion forum
Virginia	31.08.01	Grower and stakeholder discussion forum
Perth	03.09.01	Stakeholder workshop
		Grower discussion forum
Kununurra	05.09.01	Grower and stakeholder workshop
Darwin	07.09.01	Grower and stakeholder workshop

[1] Meeting participants were commonly involved with more than one commodity. As such, the numbers of individuals are not mutually exclusive.

Figure A.1: Commodity groups consulted during the national industry consultation of the study

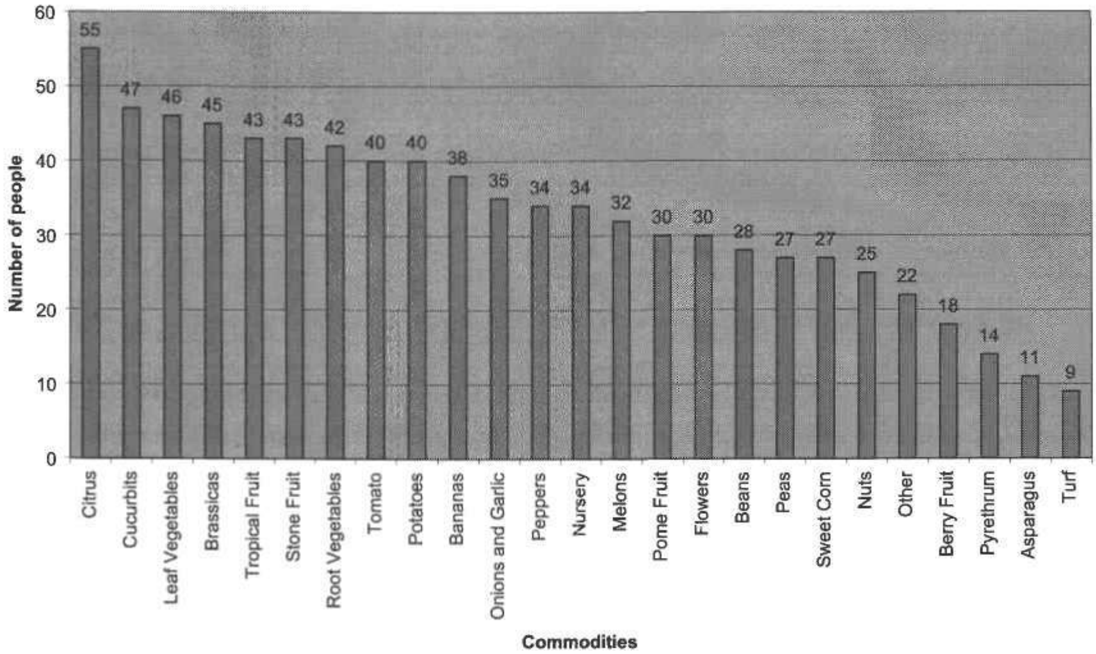
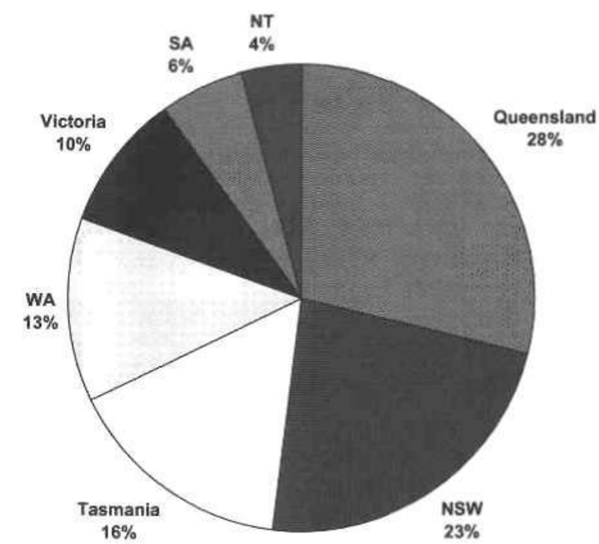


Figure A.2: Meeting participants by state



A.4.1. Formal grower and stakeholder workshops

Formal grower and stakeholder workshops were conducted where meeting attendance allowed the participants to work in small groups. As shown in Table A.1, 14 formal workshops were held. Where practical, separate workshops were held for growers and stakeholders. This allowed the perspectives of both parties to be captured and contrasted. Meetings were arranged in conjunction with local IDOs. Stakeholder meetings were held during business hours, while the times for grower meetings varied to accommodate growers in each area (generally this meant morning or evening meetings).

Meetings were conducted in accordance with the guidelines set out in the Bureau of Rural Sciences Australia '*Consulting Communities: A policy maker's guide to consulting with communities and interest groups*' (1999). Workshops were structured such that participants were divided into groups of between three and five individuals. Groups were asked to discuss each task and to nominate the three most important points discussed in their group. These were reported to the entire meeting with explanation. Plates A.1 and A.2 illustrate the use of small groups by the project team to facilitate the meetings (below).

The agenda for the workshops is outlined in Table A.2 followed by discussion on each task.

Plate A.1: Grower and Stakeholder Workshop, South Johnstone. 20.08.01

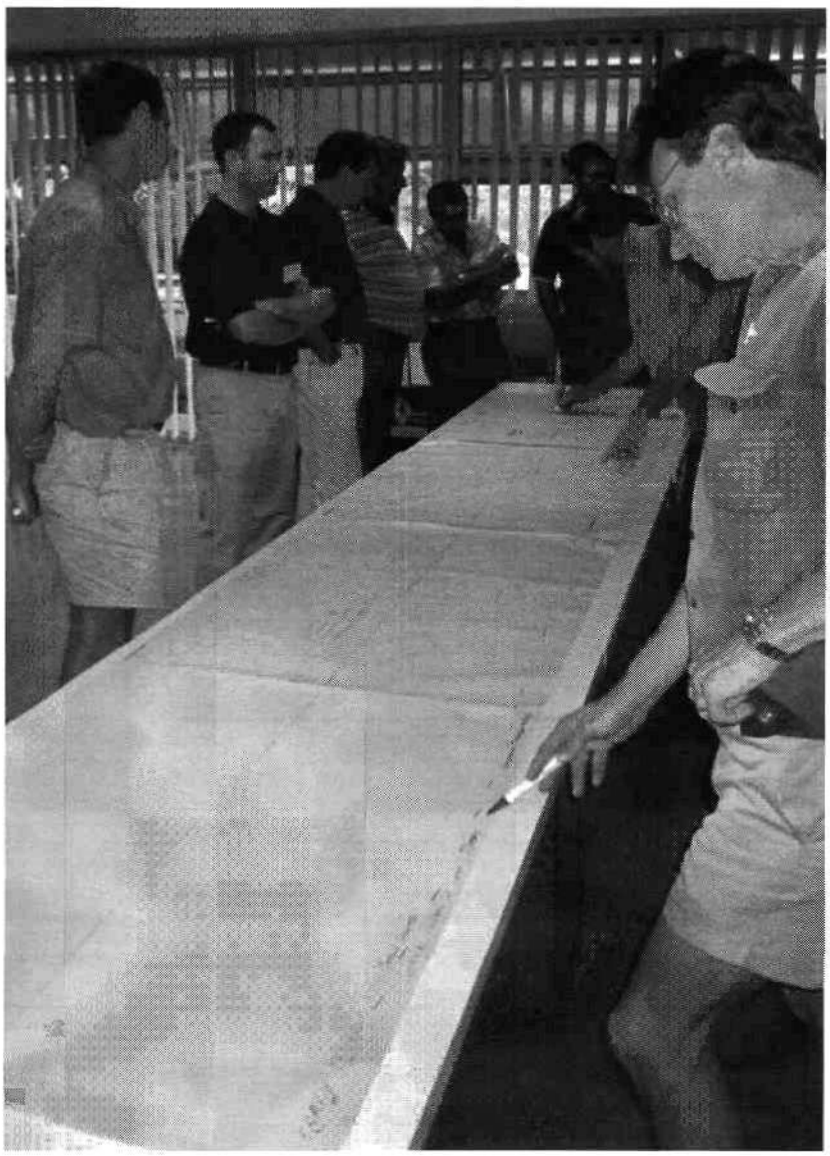


Plate A.2: Grower and Stakeholder Workshop, Kununurra. 05.09.01.

Table A.2: Meeting agenda for formal workshops

Agenda Item	Comments
Welcome and Introduction	• Welcome • Overview and explanation of The Best Practice Study. • Overview of workshop and objectives for the meeting.
Environmental Issues	A brainstorming exercise to focus the meeting participants on environmental issues and best practice. At the conclusion of this task, participants were asked to nominate the three most important environmental issues facing horticulture in their area. These were then fed back to the main group and discussed.
Industry Time-line	This task involved meeting participants tracking major changes in horticulture in their area over the past forty years.
Survey	Completion of the survey discussed in section A.4.3
Break	Brief 10-minute break.
'Keep, Change, Try'	This task asked meeting participants to discuss environmental practices or technologies which they would like to keep, change or try. At the conclusion of this task, participants were asked to nominate one from each category. These were then fed back to the main group and discussed.
'Carrot and Stick'	This task explored the motivations for change driven by (real or perceived) rewards or punishment.
Conclusion	• Thanks for attending the meeting were expressed. • Timelines for the completion of the study. • Distribution of the Information Study surveys.

Task 1: Environmental Issues

The primary purpose of this task was to focus the workshop participants on environmental issues and environmental best practice. Within the groups, participants were asked to brainstorm important issues facing their region. In order to guide discussions, the following topic areas were provided:

- Water;
- Soil and Land;
- Biodiversity;
- Chemicals;
- Waste; and
- Noise, air and other issues.

These headings were provided to assist participants to generate relevant information. Each group was asked to nominate the three issues which they deemed most important or most critical to horticulture. These were reported back to the entire group for discussion.

The scope of The Best Practice Study did not require the current status of the horticulture sector's environmental resources to be assessed. As such, the results of this task during the workshop have not been reported in the main body of this report. However, these results are included in Appendix C.

Task 2: Industry Timelines

The purpose of this task was to assess the industry perceptions of the causes of major change in the industry. Workshop participants were asked to record on a timeline the major events which had shaped horticulture in their region. Through these timelines the project team was able to assess the drivers of change in horticulture. These changes were not necessarily related to environmental best practice but formed a clear picture of the factors influencing change in the sector. The project team was then able to use this information as the basis for discussion of drivers in section 4.4.

Task 3: Keep, Change, Try

This task sought to draw together the themes raised in the previous two tasks by examining willingness to change to GEM practices among workshop participants. Participants were asked to the environmental practices or technologies they would like to:

- Keep – those elements of GEM which are working well or need of only minor reform;
- Change – those elements of GEM which are non functional, need to be dropped or radically modified; and
- Try – those elements of GEM which they have heard or read about being applied elsewhere and may be willing to trial. In some cases, areas for further research were also nominated.

This task was designed not to simply identify individual practices and technologies, but provide insight into the type of initiatives that were likely to result in either strong or poor uptake by growers. Through defining these characteristics the project team was able to distil a greater understanding of the elements which lead to increased on-farm adoption of environmental measures.

Task 4: 'Carrots and Sticks'

Consistent with the proverb, this task explored the rewards and punishments (real or perceived) that drive behavioural change in the horticultural sector. Carrots were defined as those motivations for change that may offer some reward (for example price premiums or increased market access). Sticks are defined as those motivations for change which resulted in penalties for non-compliance (eg legislation or decreased market access). Consistent with the other tasks, these were discussed in groups and reported back. This allowed the team to derive an understanding of the relative effectiveness of change drivers.

At the Kununurra workshop time constraints did not allow this task to be conducted. However, adequate information had been derived from the industry timelines and 'Keep, Change, Try'.

A.4.2. Facilitated discussion forums

Facilitated discussion forums were held where insufficient attendance prevented formal workshops. During the forums, the facilitators guided the discussion such that much of the same type of data was obtained. The forums gave the facilitators an opportunity to explore, in detail, issues raised at the workshops or in the literature. For example, a number of workshops raised the issue that the selection of the individuals responsible for delivering a project was critical to the success of that project.

The Melbourne discussion forum was held two weeks prior to the national consultation phase with the purpose of:

- Obtaining information relevant to the study (in line with the tasks of the formal workshops); and
- Assisting the team in further developing and refining the design and delivery of workshops.

This allowed the team to refine the workshop strategy prior to the national rollout of consultation.

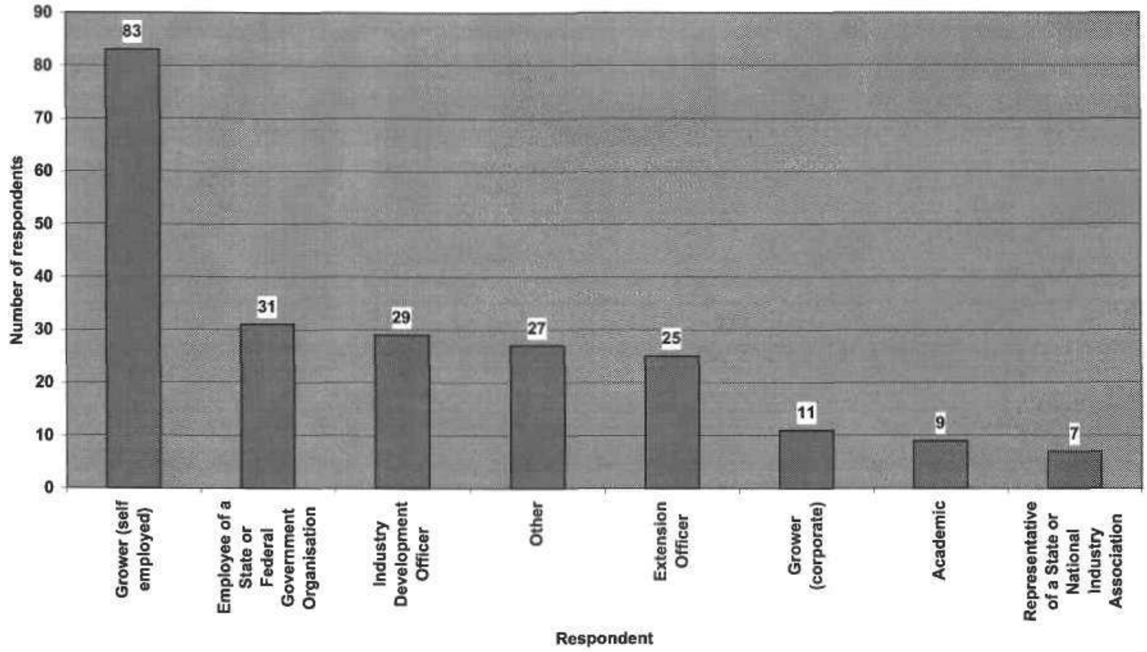
A.4.3. Survey of meeting participants

A survey of meeting participants was conducted to generate quantitative data to support qualitative information obtained during the workshops and forums. These surveys explored the same issues as the tasks in the workshops, namely:

- Environmental issues;
- Influences on change;
- *Motivations and barriers to change; and*
- Reasons why environmental projects succeed and fail in increasing on-farm adoption of environmental measures.

The survey is included as Attachment 1 and the quantitative data obtained form these surveys is reported in Appendix C. In order to generate a maximum response from meeting participants, the survey was designed to be completed in less than 10 minutes. In total, the project team obtained 222 completed surveys. As Figure A.3 shows, the main group of survey respondents were growers, dominantly self-employed (38%) with some corporate growers (5%) also responding. The remaining respondents are spread between industry association representatives, industry professionals and researchers (from both the public and private sectors). Twenty-seven respondents (12%) are classified as belonging to other professions. These respondents are dominantly agricultural and environmental consultants with some representatives of processing companies.

Figure A.3: Profile of survey respondents



A.5. <u>Data Analysis</u>

A.5.1. Meeting data

The qualitative data obtained from the meetings (workshops and discussion forums) comprised the bulk of the data obtained from the national industry consultation. This data has been qualitatively analysed, synthesised and assessed to derive the key findings found in Chapters 4 and 8. Outcomes of the workshop tasks are provided in Appendix C.

A.5.2. Survey data

The quantitative data obtained through the meeting participants' survey has been analysed using the Microsoft Excel program. The Andersen project team sought to analyse the data in such a way that the information was simply presented so as to remain accessible to the maximum number of stakeholders. As such, statistical analysis has been avoided in favour of graphical analysis and simple percentages.

The quantitative survey results are presented, in full, in Appendix C.

A.6. <u>Case Study Development</u>

Three case studies were developed during The Best Practice Study as examples effective environmental management and the benefits flowing from this. The project team identified the case studies through extensive collaboration with industry stakeholders, during both the literature review and national industry consultation. In order to emphasise the importance of scale in environmental management, the three case studies selected were:

- The *Goulburn-Broken Floodplain Rehabilitation Scheme* (case study of a regional initiative);
- The *Enviroveg* Project (case study of an industry initiative); and
- *Abbotsleigh Citrus* (case study of an award-winning enterprise).

Through highlighting the way in which GEM practices and the adoption process model are applicable at different scales, the project team aimed to generate three highly relevant case studies.

The project team utilised two strategies concurrently in order to develop the case studies. All relevant documentation (published and also unpublished material sourced from key stakeholders) was reviewed. This literature was identified through collaboration with the relevant project staff, that is the GBCMA, *Enviroveg* through the Victorian Vegetable Growers' Association and the staff at *Abbotsleigh Citrus*. These stakeholders collaborated extensively with the project team through a series of formal and informal interviews.

The project team endeavoured to emphasise the perspectives of relevant stakeholder wherever possible. The Andersen project team liased with growers, industry professionals and industry representatives, throughout the development of the case studies. The conducted site visits to each of the projects, which in the case of *Enviroveg*, involved attending grower meetings.

A.7. Validation of Findings

In order to ensure that the final report is accurate and representative of the horticultural sector, validation was sought from key stakeholders within the industry. Chapters 2 through 7 were sent to 13 stakeholders for feedback and comment prior to the finalisation of the report. These stakeholders represented a range of industries and were from all states of Australia. Where applicable, comments and feedback were incorporated into the report.

A.8. Limitations and Assumptions

The by definition of the scope, The Best Practice Study has focussed on complex material. The motivations and drivers for behavioural change remain complicated and subjective fields of study. Data on this type of material is highly reliant on accurate information being obtained from participating stakeholders. The project team has endeavoured to validate and verify all information obtained, however, accuracy remains reliant upon stakeholders.

In the context of the present study, objectivity has been maintained through the range of interactions undertaken by the Andersen project team. Stakeholders were working within a diverse range of organisations and interactions with each stakeholders were, wherever possible, kept independent. This allowed the validity of the information provided to be assessed in the context of all information and data obtained. Information gained via participant action research was, wherever possible, critically analysed in the context of relevant literature. The validation of the findings enhanced the ability of the team to deliver conclusions representative of the sector.

Within the Australian horticultural sector, grower information is held confidential by relevant industry associations. As such, the project team liaised closely with relevant IDOs to facilitate grower participation. This limited the study, to the extent that the project team was reliant on IDO co-operation to promote and organise the meetings. The project team assisted IDOs as necessary but were however limited in their ability to influence attendance and participation at the meetings.

A.9. Summary

Throughout this study, the project team has placed primary emphasis upon communication and collaboration with stakeholders. The rationale behind this is based on providing a representative and accurate profile of the adoption process within the horticultural sector. The methodology applied is general in its approach in order to capture information from all horticultural sectors nation-wide, while generating findings and data with enough detail so as to be useful and meaningful. The approach has focussed on qualitative research techniques to represent the complex and abstract concepts inherent in this subject area. The team has endeavoured to validate qualitative information with other stakeholders and through the relevant literature wherever feasible, however, where information has been misrepresented, Andersen is not responsible.

Attachment 1: Survey of meeting participants

Horticulture Australia Limited

ANDERSEN

Understanding the Elements and Adoption of Environmental Best Practice in Horticulture

Best Practices Study

1. Meeting Attended

(a) Location ______________________

(b) Time ______________________

2. Please indicate your involvement with horticulture (please nominate one category only)

(a) Producer

(i) Self-Employed ☐

(ii) Corporate ☐

(b) Extension Officer ☐

(c) Industry Development Officers ☐

(d) Academic ☐

(e) Member of a State or Federal Government organisation. Please specify:

____

(f) Representative of a State or National industry association. Please specify:

____

(g) Other

____

3. Please indicate the horticultural commodities you work with

Nuts (almonds, cashews, chestnuts, hazelnuts, macadamia, pecans, pistachios, walnuts) ☐

Bananas ☐

Berry Fruit (blackcurrants, blueberries, gooseberries, loganberries, raspberries, strawberries) ☐

Citrus (grapefruit, lemons, limes, mandarins, oranges, tangelos) ☐

Melons (rock, water, other) ☐

Pome Fruit (apple, nashi, pears) ☐

Stone Fruit fresh [ ] canning [ ]
(apricots, cherries, nectarines, peacharines, peaches, plums, prunes) ☐

Tropical Fruit (avocados, carambola, custard apples, guava, jackfruit, longans, lychees, mangoes, pawpaws, passionfruit, pineapples, rambutans) ☐

Asparagus ☐

Beans ☐

Brassicas (broccoli, brussel sprouts, cabbages, cauliflower, Chinese cabbage) ☐

Cucurbits (cucumbers, gherkins, marrows and squash, melons (bitter), pumpkins, zucchini) ☐

Leaf Vegetables (celery, lettuce, French endive, silverbeet, spinach) ☐

Onions & Garlic (garlic, leeks, spring onions, onions (white and brown)) ☐

Peas ☐

Peppers (capsicum, chilli) ☐

Potatoes ☐

Root Vegetables (beetroot, carrots, parsnips, radish, swedes, sweet potatoes, turnips) ☐

Sweet Corn ☐

Tomato (fresh and processing) ☐

Pyrethrum ☐

Flowers ☐

Nursery ☐

Turf ☐

Other. Please specify:

____

4. Please indicate which are the top three environmental issues (please rank from 1 to 3 with 1 being the most important issue)

- Salinity ☐
- Soil Structure Decline ☐
- Soil Acidification ☐
- Soil Erosion ☐
- Nutrient Loss ☐
- Fertiliser Application ☐
- Spray Drift ☐
- Water Quality ☐
- Water Efficiency ☐
- Run-Off Water and Drainage ☐
- Land Clearing ☐
- Managing Remnant Vegetation ☐
- Dust ☐
- Noise Pollution ☐
- Chemical Container Disposal ☐
- Waste ☐
- Soil Contamination ☐
- Weed Management ☐
- Managing Feral Pests ☐
- Other. Please specify:

____

Understanding the Elements and Adoption of Environmental Best Practice in Horticulture

Best Practices Study

5. Please indicate who the three most important influences on change are (please rank from 1 to 3 with 1 being the most important issue)

- Industry Development Officers ☐
- Legislation ☐
- Environmentalists ☐
- Industry Associations (eg QFVG) ☐
- Supermarkets and wholesalers ☐
- Consumers ☐
- Researchers ☐
- Grower Groups (eg Cittgroups) ☐
- Other. Please specify:

____

6. What are the top three *barriers* to on-farm adoption of environmental measures

- Cost ☐
- Complexity ☐
- Time ☐
- Lack of Support ☐
- Lack of financial benefits ☐
- Lack of understanding ☐
- Lack of information ☐
- Other. Please specify:

____

7. What are the top three *motivations* to on-farm adoption of environmental measures

- Cost Savings ☐
- Profit ☐
- Environmental Conservation ☐
- Technological Change ☐
- Sustainability ☐
- Environmental Programs (eg Landcare) ☐
- Citizenship ☐
- Other. Please specify:

____

Understanding the Elements and Adoption of Environmental Best Practice in Horticulture

Best Practices Study

8. **Please give three reasons why you think some projects *fail* to increase on-farm adoption of environmental measures**

1. ____
2. ____
3. ____

9. **Please give three reasons why you think some projects *succeed* in increasing on-farm adoption of environmental measures**

1. ____
2. ____
3. ____

10. **If you have any other comments or feedback on the workshop material or the way the meeting was conducted, please elaborate below:**

Appendix B: Literature Review

B.1. Introduction

Andersen has been engaged by Horticulture Australia to undertake a best practice study of environmental management in the Australian horticultural sector. This study forms Phase 2 of the Horticulture Environmental Audit (AH00018). This continues the research undertaken in Phase 1 that described the key characteristics of the horticultural sectors within Australia and identified the environmental issues of concern to growers and government agencies.

This review has been conducted with the aim of identifying elements of generic good environmental management for horticulture and issues which are likely to impact on their rate of adoption. This literature review has been completed as part of Phase 1 of the present study as a precursor to the development of draft environmental guidelines and intensive consultation with growers Australia-wide.

B.1.1. Approach

A full range of domestic and international literature was reviewed including work published by:

- Horticulture research organisations;
- Horticulture industry associations;
- Government departments and research units;
- Academic research;
- Private research organisations;
- Environmental research organisation; and
- Andersen KnowledgeSpace™ and Global Best Practice™ databases.

This literature was identified using traditional research techniques and through consultation with horticulture industry development officers as well as prominent researchers, academics and professionals in the fields of environmental management and horticulture both in Australia and selected countries overseas

B.1.2. Exclusions

The scope and approach has precluded a number of issues from being addressed from this literature review. These issues include:

- Quarantine;
- Genetically Modified Organisms;
- Air quality;
- Noise Minimisation;
- Retail nurseries; and
- Hydroponic production.

These issues were considered outside the scope or are peripheral to the study. These issues present a unique and complex range of environmental management issues, which are, generally, outside the concern and control of the average horticultural producer. By focussing on a systems based approach to traditional horticultural production greater value to the industry as a whole may be derived.

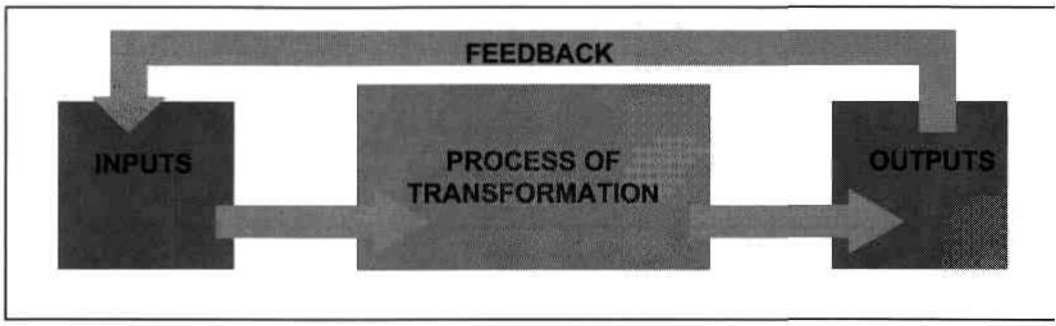
B.2. Frameworks for environmental management

B.2.1. Introduction: A Systems Based Approach

The movement towards a sustainable horticultural industry is a challenging prospect not only for growers, but all stakeholders. The barriers to this process can be social, cultural, political, technological and economic. Horticulture operates within a complex, dynamic and inter-related system, of which, environmental considerations are increasingly significant concern.

A systems approach incorporates all these factors and allows the inter-relationships between issues to be modelled at a variety of scales depending of the level of complexity required. A systems approach identifies inputs to the system, analyses complex processes and identifies outputs (Figure B.1). Through this approach a holistic perspective is obtained and best practice is identified.

Figure B.1: Schematic diagram of a systems level approach



The systems approach has a number of strengths. These include:

- Goals and objectives are stated;
- Performance criteria can be measured and monitored;
- Variable inputs and outputs that can be measured;
- Systems can be analysed at varying degrees of complexity;
- Changes to systems can be predicted and monitored; and
- Systems can be benchmarked and adapted both tactically and strategically.

Via a systems approach, growers and industry professionals gain a clearer understanding of the variable acting upon and within their industry, as well as their external impacts. This understanding promotes more effective farm management across the industry or catchments, or production units within that industry.

B.2.2. Current Methods of Systems Management

There is a general acknowledgement in environmental literature of the value of a systems-based approach. Many institutional and policy regimes designed to improve environmental quality embrace a system-based approach. The most widely adopted approach is that of 'environmental management systems' (EMS). EMS are increasingly being utilised by all types of businesses to manage environmental performance. Within horticulture and agriculture a number of prominent environmental management programs incorporate the principles of systems management.

These examples include:

- Landcare;
- Farm business and whole farm planning;
- Codes of Practice;
- Total catchment management;
- Quality assurance;
- Self-auditing schemes; and
- Adaptive environmental assessment and management.

The various methods of systems management employed by these examples are discussed below.

Environmental Management Systems

EMS are a formal methodological approach adopted by enterprises who wish to manage their impact on the environment. The approach institutionalises environmental planning, implementation and review. Production of EMS are guided by policies and practices relating to:

- Actual or potential environmental impacts;
- Actions to prevent environmental harm; and
- Actions to use environmental resources efficiently (Piccone 1999: 14).

The first priority for any management system is to create a structure that ensures that the system is simple, clear and achievable as well as dynamic and evolving (IHD 2000: A3). Therefore, EMS are often most successful when they integrate existing systems and processes. Effective consultation with the process operators is also critical as it is these people who have the most thorough understanding of the process.

The greatest benefit of an EMS is that it formalises the process of measuring change. It can be monitored over time and adapted to improve performance or respond to external changes (such as policy or market shifts). Furthermore, EMS's must be credible and transparent to the market (which includes both suppliers and purchasers), they must be industry led, and partnership based to ensure optimal levels of adoption (Carrathurs 1999: A3). A good EMS will identify all stakeholder positions and define both general and specific guidelines.

The International Standards Organisation (ISO) series 14000 is the set of international standards for environmental management systems. Corporations with EMS can seek ISO accreditation to ensure their EMS meets internationally recognised standards of transparency and accountability.

EMS are currently being considered by many sectors of agriculture and government. Principles of an effective EMS (as outlined in the outcomes of a National Workshop on EMS in Agriculture) require a clearly defined purpose and objectives that are criterion based, measurable, and give feedback for progress (Carrathurs 1999: A3). Sunraysia regions of Victoria are pilot sites for EMS in the horticultural industry. The Yarra Valley and the Pome Fruit Industry has also developed an EMS. Agricultural industries with EMS include cotton and viticulture (Carrathurs 1999: A3).

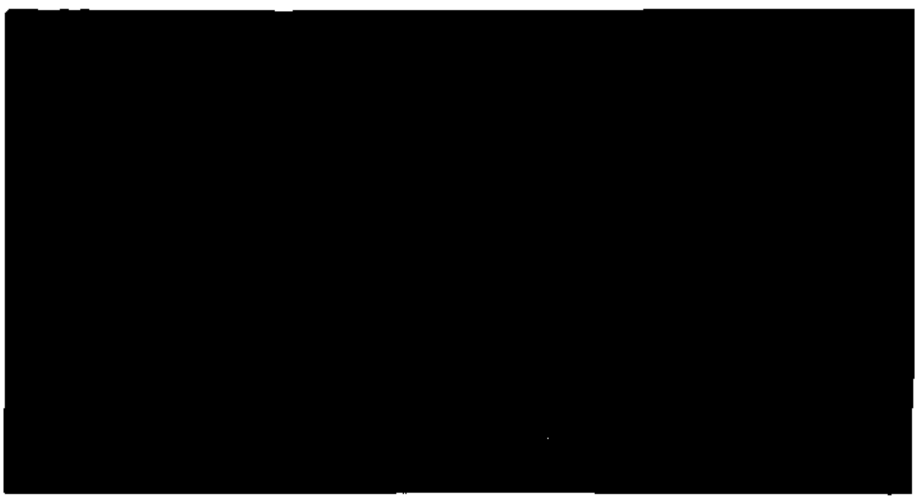
Suggestions have been made for Australia to use overseas innovation in the adoption of EMS in Australia. These include "development of demonstration farms, increasing knowledge of EMS in other industries, targeted information packages, ensuring that assessments are science based and knowledge driven, developing an adaptable system that can be applied to local conditions and industry requirements, design rigorous EMS's that have sound environmental indicators and compliance records, and ensure that there are strong partnerships between all parties involved in the system" (IHD 2000: 22).

Adaptive Environmental Assessment and Management (AEAM)

AEAM is a methodological framework for integrated catchment management designed to deal with uncertainties inherent in environmental change. It recognises that precise prediction of ecosystem responses to human management activities and natural change is not practically feasible. Instead, an adaptive approach to modelling 'whole system' responses is used to make management decisions. AEAM uses computer simulation which can predict the response of the system to the development of a set of preferred management actions. (Grayson and Doolan 1995: 3). AEAM provides a useful alternative to EMS as its approach focuses on the way natural systems operate as opposed to EMS, which is more anthropogenically based. AEAM may prove to be of particular merit when integrated as a tool into other management programs such as Total Catchment Management (TCM) and Landcare. For example, the Ovens Basin Water Quality strategy was developed using the framework of AEAM as a document that addresses the key issues affecting water quality within the catchment (Ovens Basin Water Quality Working Group 2000).

Landcare

Landcare is a unique system of environmental management. It promotes improved land management practices on Australian farms through participation, education, and project funding. It is renowned for developing stewardship amongst its members. The goal of Landcare is sustainable land use of farming lands and enhanced biodiversity. In the Decade of Landcare (1990's), many integrated programs and initiatives have been developed and implemented to further this goal (ABARE 1998). Landcare tends to focus on the pastoral zone and mixed farming rather than horticulture. Its success relies on the platform of stewardship, community action and the promotion of best practice techniques that are applicable to the horticultural industry. Furthermore, "Landcare is a model for rural development in Australia that is now being examined closely by many other developed countries" (Curtis 1997: 137). While generally viewed as a positive program, there are many different views on the actual success of Landcare. The negative issues associated with Landcare generally focus on under representation of minority groups, funding and resource allocation issues, and the lack of integration of science and policy in the objectives of Landcare groups.



Quality Assurance

The food industry across the globe is increasingly required to be fully accountable for the integrity of the products they produce and the methods that are used in the production. Consumers are becoming better educated and informed about food issues like genetically modified organisms,, dioxins, Bovine Spongiform Encephalopathy (BSE or mad cow disease), and Listeria and regulators are becoming increasingly active in safeguarding the food we eat. As regulation on environmental management and quality assurance is introduced, the possibility of a similar system for environmental aspects of quality assurance could emerge. Therefore, the need for transparent and accountable systems of management for environmental assurance is increasing.
Quality management systems in Australia have usually adopted a 'top quality' objective aimed at high value markets. Product defects are identified and an 'inspect and reject' system is implemented (Piccone 1999: 10). These systems often involve grading of products and specifications to prevent spoilage, and they tend to incorporate post-harvest measures.

A good quality assurance system will improve farm business performance by using systems to pinpoint internal management strengths and weaknesses, increasing efficiencies, quantifying and reducing costs, and further strengthening relationships within the market.

The ISO 9000 series outlines international quality management standards while the Hazard Analysis Critical Control Point (HACCP) technique is used to identify and control food safety hazards. Other codes have been developed such as the SQF2000 (Safe Quality Food Certification) and the Woolworths Vendor Quality Management Standard (WVQMS) that are based on the ISO 9000 series with additional components such as HACCP (Piccone 1999: 14). SQF (Safe Quality Food) 2000 is a HACCP (Hazard Analysis and Critical Control points)-based food safety and quality risk management system provided to all the stakeholders of the Food chain. It includes the identification of food safety and quality risks, and the validation, verification and monitoring of control measures. The benefits of SQF 2000 include protection and enhancement of brands and private labels, increased consumer confidence, conformity to regulatory and market requirements, alignment with the Codex Alimentarius Commission Guidelines for the application of HACCP, a complete program dealing with both safety and quality issues, and compatibility with ISO 9000. (SGS Services 2000)

However, SQF2000 and WVQMS are seen by Piccone (1999: 16) as "watered down" and "customer compliance" codes respectively. Whilst referencing the relevant ISO 9000 standards, they "equate to a missed business opportunity" as the ISO quality standards can be used as an excellent management resource, regardless of whether certification to the standard is sought or not. The elements of the ISO series include management responsibility, quality system, contract review, design control (ISO 9001 only), document and data control, purchasing, control of customer supplied product, product identification and traceability, process control, and inspection and testing (Piccone 1999: 19). ISO 9002 is the standard most used by businesses involved with all aspects of horticultural products as this standard applies to businesses that supply to an agreed specification (Piccone 1999: 20).

Self-Auditing Schemes

Self-auditing schemes are a systems-based approach that are widely used, both domestically and internationally to promote environmental management principles among farmers and horticulturalists. Self-auditing schemes provide a basis for the facilitation of continual improvement in a way, which is easily quantified by the primary producer.

Several examples of self-auditing schemes exist among the horticultural and agricultural industries. These include:

- The Australian Professional Nursery Operators have developed a self-auditing tool designed to assess and improve environmental performance (Nursery Industry Association of Australia 1998). This tool is a quick self-help tool to determine how well "best practice" standards are being met.
- CSIRO (2001) have developed a Self-Help Evaluation Framework (SHEF) for Integrated Catchment Management (ICM). This publication aims to help stakeholders understand ICM and to gradually work towards a sustainable catchment by tracking progress, sharing viewpoints, evaluating goals and promoting communication about ICM.
- Enviroveg is a program designed to assist Victorian vegetable growers to adopt sustainable farming practices. The program includes a self-audit scheme that rewards progress with logos and branding which may be applied to the product. This project is in its initial stages and is using grower input to develop the framework, guidelines and manual for the scheme.
- Farm *A*Syst is a United States scheme of self-audit designed to "educate farmers on how their activities, storage structures and well design may affect the quality of their drinking water". It is based on increasing awareness and responsibility, risk minimisation, protection, and stewardship. It is a voluntary program and the assessment system is confidential. The Farm *A*Syst program uses computer decision support which enables electronic assessment, user queries, and report generation.

Codes of Practice

Codes of practices have been widely used for some time, across industry, as a way of encouraging best practice. Codes of Practice are emerging as a means of promoting standard goals and measurable objectives. These are integral to a systems approach and encourage improved environmental performance.

The Queensland Fruit and Vegetable Growers have developed a code of practice for environmental management. This example is profiled over the page:

Code of Practice, Queensland Fruit and Vegetable Growers

The Code of Practice, Queensland Fruit and Vegetable Growers (QFVG 1998), identifies different areas of environmental management and provides guidelines for good farm management within those classifications. It provides an extremely thorough analysis of the issues and the generic elements of good environmental management. The Code of Practice outlines a system whereby farmers should adopt all "reasonable and practicable measures within the constraints of a sustainable agricultural system to conserve environmental values".

The Code of Practice places the emphasis on the farmer to:

a) "consider the potential harm of a management practice;

b) consider the sensitivity of the receiving area;

c) consider the current state of technical knowledge for the activity;

d) consider the likelihood of successful environmental outcomes from different measures that might be used; and

e) to consider the financial implications of implementing those measures".

The first three considerations are designed to allow farmers to identify general elements of good environmental management, while the last two considerations have been designed for farmers to move from the general principles to the particular constraints of a single farm.

Whole Farm Planning

Also known as Farm business planning or integrated farm management, whole farm planning considers the farms physical, financial and human resources for both now and the future. Planning can greatly influence the ability of a farm to achieve best environmental practice and best long-term economic outcomes. It is also important in integrating the economic and environmental objectives important for sustainability. Whole Farm planning embraces the systems approach to manage farming operations from a holistic perspective.

In Europe and North America, quality assurance standards have extended to encompass the entire farming process (DNRE 2001). Farmers are on notice to demonstrate sound environmental practices which minimise off site impacts such as soil loss, contamination of ground and run-off water, loss of biodiversity and water use efficiency (DNRE 2001). As such, Whole Farm Planning has been widely accepted as an integral part of farming operations. The LEAF program in the UK is an example of one such response:

[redacted]

An example of an Australian initiative to encourage whole farm planning, is the NHT funded "FarmBis". This program is profiled below:

[redacted]

Total Catchment Management

By examining environmental issues from a catchment perspective, total catchment management (TCM) is a high level, holistic systems approach. Catchments from a horticultural perspective are important because virtually all of their environmental impacts can be contained within the catchment or system.

TCM has been widely adopted by state governments in Australia. The Department of Land & Water Resources Conservation in NSW administrates a region-by-region TCM program. TCM often involves a large number of stakeholders, for example the four states spanned by the Murray-Darling Basin. As such, these systems are designed to manage high-level resource management issues from a stakeholder perspective. An example of a TCM program is Rivercare, a program administered by the Natural Heritage Trust. This program is outlined over the page:

The National Rivercare Program

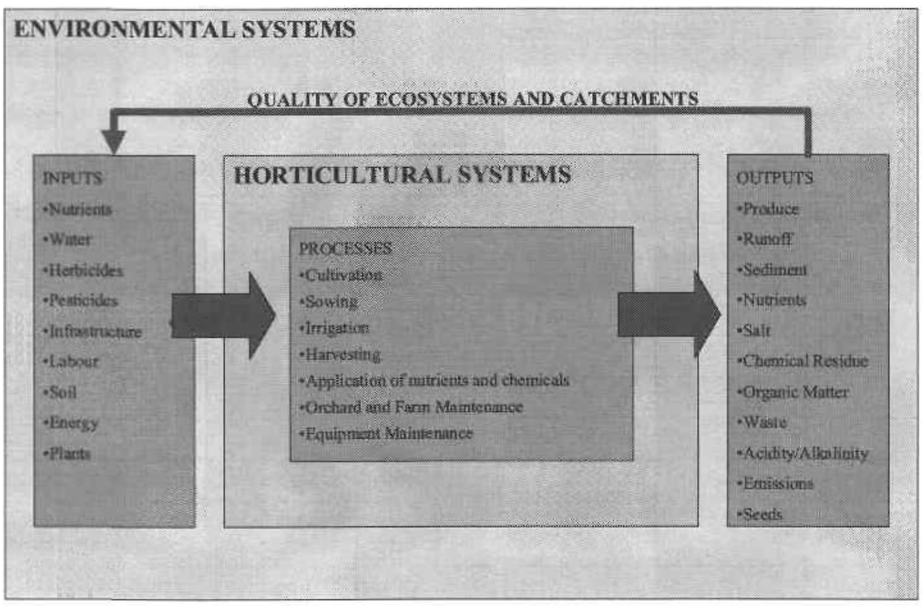
Rivercare aims to ensure progress in the sustainable management, rehabilitation and conservation of rivers in Australia, outside those under the Murray-Darling Basin Commission. The aim of this program forms the basis of a systems approach to tackling the issues related to environmental management of rivers. The objectives, outlining the processes used to achieve this aim, are to:

- increase community awareness and understanding of river issues and involvement in developing responses;
- promote integration of riverine action plans with land and vegetation management issues;
- address critical impediments to improved river health, particularly within catchments or regions, through targeted management responses;
- assist and further stimulate investment in activities which address national, state and regional strategies for improved river outcomes;
- assist in providing high quality data and decision support systems that support investment and decisions relating to environmental water provisions (Douglas-Hill 1999: 1).

B.2.3. A Systems Approach for Horticulture

The frameworks described above each provide useful methodological tools for the development of systems-based approaches to the environmental management of horticulture. One approach to modelling horticulture from a systems level is illustrated in Figure B.2 (below).

Figure B.2: A horticultural system



When modelled in this way it is possible to gain an understanding of the way horticulture interacts with the natural environment. It is clearly shown that the environment is the source of inputs and the sink of outputs. For example, irrigation water used by a horticultural enterprise may lead to run-off it may containing salt, nutrients, sediments and/or chemical residues. These then impact on the quality of water available to downstream users, adversely impacting on catchment health.

Good environmental management fundamentally seeks to manage the inputs to the horticultural operation to improve the quality or reduce the quantity of outputs. This literature review examines the current measures and future trends in Good Environmental Management. These have been classified into three major areas that dominate the inputs and outputs of horticultural production. These are:

1. Water Management
2. Soil and Land Management
3. Insect and Pest Management

If these three areas are effectively managed then other issues such as air quality and waste will also be reduced.

The final section of this literature review provides the background to the largest component of this project, change management. The literature on the barriers to adoption of sustainable farming practices is explored and possible mechanisms for overcoming these, identified.

B.3. Water Management

B.3.1. Overview

Water is one of the most critical inputs to horticultural systems. In 1995, 70% of annual crops and 50% of perennial crops used irrigation to augment natural rainfall supplies (MacArthur Agribusiness and Sinclair Knight Merz 2001: 78). However, the environmental impact of irrigation by horticulture at a national level is relatively low compared to other agricultural activities (Wasson et al 1996: 7-11), although at a regional level impacts may be higher. Table B.1 (over page) indicates that whilst irrigated horticulture has only a slight to moderate environmental impact, compared to other irrigated commodities, it remains a crucial catchment management issue.

Inefficient management of water is a significant contributing factor to a number of environmental problems facing horticultural producers. Salinity, declining water quality, nutrient run-off, aquifer shrinkage and waterlogging are caused and/or exacerbated by poor water management. Excessive water inputs and/or poor management of water outputs cause these problems (Figure B.3 over page). They will impact on the profitability of horticultural enterprises in either the short or long term. The impact and extent of these issues will vary based on a number of crucial factors including; horticultural region, location within the catchment, type and scale of the horticultural enterprise, previous horticultural practices and current levels of environmental awareness and protection.

Australia has the highest per capita water storage of any country, with over 300 large dams including 120 on the Murray-Darling alone (Toyne 1996: 145). Water is, therefore, largely a government allocated commodity; controlled not only by the weather, but by policy and legislation. The allocation of this water involves choices between users in different parts of catchments and in different enterprises while ensuring adequate water supply and quality for domestic consumption and environmental systems. Not surprisingly, the issue of water allocation has become a political hotbed.

Despite the geographic nature of river systems, water allocation is essentially a state government responsibility. Approaches vary between states, as does the degree of Commonwealth involvement on specific issues. However, under the Council of Australian Governments water reform framework, water is set to become a tradeable commodity, segregated from land title (MacArthur Agribusiness and Sinclair Knight Merz 2001: 77). As such, the efficient use of water has significant economic benefits for horticulturists in this market environment.

Good Environmental Management (GEM) for horticultural growers relies on systems and practices that increase water-use efficiency. This should insulate growers against the impact of allocation changes to a degree, while ensuring water availability for catchment health (often described as 'environmental flow'). Horticulturalists should accept and participate in the establishment of environmental flows to maintain river health, conserve aquatic ecosystems and dilute salt concentration peaks (Bell et al 2000: 154). Growers in areas of low rainfall, located downstream in catchments and with relatively high water requirements particularly need to optimise their water usage.

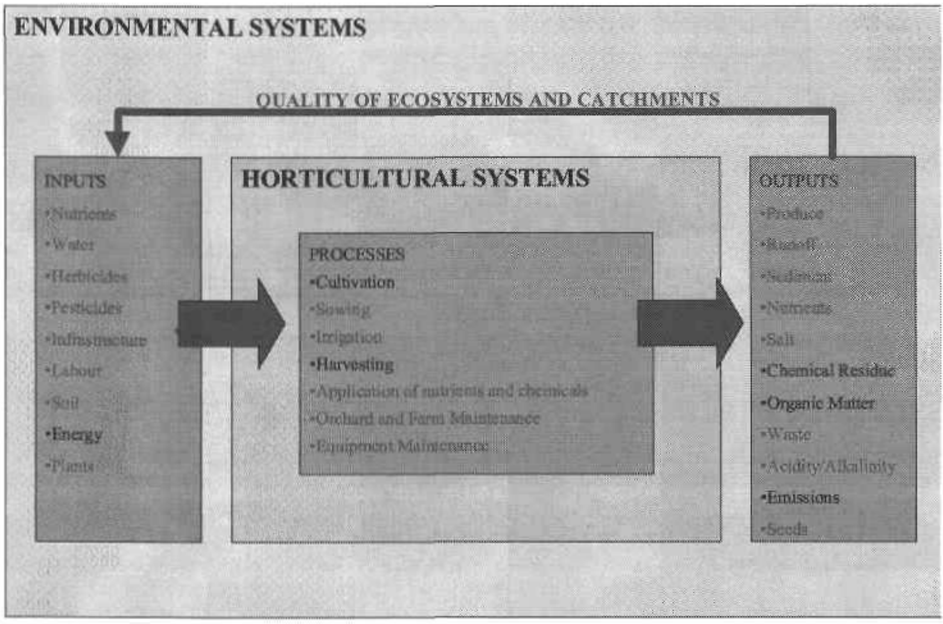
Table B.1: The economic and environmental status of irrigated commodities in Australia

Source: State of the Environment Australia (Wasson et al 1996:7-11).

Commodity	Production Value ($million)[a]	Irrigation Export Value ($million)[b]	Irrigated Area (ha)	Total Water Use (GL)[c]	Environmental Impacts
Horticulture	2600 (Fruit 1490 Vegetables 1110)	496 (Wine 247)	214 000	1400 (@6.5 ML/ha)	Slight to moderate impact: Localised impact of pesticides, sub-surface saline drainage water
Dairy products	104	476	280 000	2500 (75% perennial pasture @ 11ML/ha 25% annual pasture @ 3.5 ML/ha)	Moderate impact; Regional, localised and downstream impacts of nutrients and organic matter generally as point sources, regional impact on rising water tables
Sugar Cane	367	447	183 000	1007 (@ 5.5ML/ha)	Moderate impact; Localised downstream impact of oil loss and phosphorus, as well as nitrate leaching into estuarine and inshore marine waters, regional impacts of rising water tables and salinisation
Cotton	565	603	264 000	1800 (@7ML/ha)	Moderate to significant impact; Regional and downstream impact of pesticides, large-scale water-use in an area of limited water availability and reliability, potential for nitrate leaching into the groundwater.
Rice	164	228	123 000	1900 (@15.5ML/ha)	Significant impact; Regional impact on rising water tables, salinity, and pesticide and herbicide use, potential for soil acidification in some areas.
Irrigated Pasture	144 (livestock production)	?	850 000	3000 (@3.5ML/ha annual pastures)	Significant to sever impact; Large scale regional impact on rising water tables and salinisation, and downstream impact of saline drainage

Note (a) 1992-93 value at farm gate, (b) 1992-93 value free-on-board source ABS, pers comm. Australian Irrigation Council pers comm (c) Estimated water use rates, source W. Meyer pers comm., for all commodities except sugar cane, source M Everson and G Kingston pers comm for sugar cane (d) Generally excluding the direct impact of water use.

Figure B.3: Schematic diagram of the horticultural system elements impacted by water management



B.3.2. Good Environmental Management Practices

There is a plethora of information on irrigation systems and irrigated water-use efficiency (for example see James et al 1997, Queensland Fruit and Vegetable Growers 1998, Hickey et al 2000 and Hickey and Hulme 2000). Due to the high level of variance in factors influencing irrigation it is advisable that individual growers seek local, expert opinions in regard to the irrigation needs of their properties. Useful contacts include the departments of primary industries or agriculture in each state, the Irrigation Association of Australia and relevant industry associations. Complementing this information with soil testing, water testing and assessment of properties is advisable to ensure the appropriate range of measures is selected and implemented.

Cost saving and water management

"Heyne's Wholesale Nursery has a water management strategy involving a range of water efficiency measures which, when fully implemented will substantially reduce consumption. The installation of more efficient sprinklers and the future introduction of a new evaporation monitoring system will potentially reduce water consumption by approximately 30% resulting in an annual saving of approximately $21,000. Further savings of $30,000 are expected" when water is obtained from alternative sources. (EPA South Australia 2001)

- **Targeted Irrigation Systems**

Drip, trickle, microspray and spitter irrigation systems are commonly used by horticulturalists in Australia, as Table B.2 illustrates. These targeted irrigation systems are the most water efficient means of delivering water to horticultural crops. Targeted systems allow the volumes of water required to be more precisely delivered (Cresswell and Huett 1996: 1). Flood, overhead sprinkler and furrow irrigation have low water-use efficiency (Hickey et al 2000; 3, Hickey and Hulme 2000: 32). Indeed, one study suggests that targeted irrigation systems can deliver two to three times the yield from the same volume of irrigation water consumed by flood and furrow irrigation (Tolley 1996: 380).

Table B.2: Irrigation methods used in horticulture (% of respondents)

	Drip/ trickle	Microspray	Handshift	Solid Set	Furrow	Hydroponics	Soft Hose Winch	Hard Hose Winch	Boom	Lateral Move	Centre Pivot	Other
Annual	38.5	0.2	19.6	17.4	1.6	0.2	8.9	1.8	4.9	4.1	1.4	1.4
Perennial	15.8	67.8	0.5	7.6	0.5	0.0	1.5	0.0	2.3	1.7	1.8	0.5

Source: MacArthur Agribusiness and Sinclair Knight Merz 2001: 81

Advantages of drip irrigation systems include (but are not limited to):

- Lower water loss through evaporation;
- Less discharge into groundwater table;
- Evenly distributed water along rows;
- Decreased water availability to weeds;
- Allows soluble pesticides and fertilisers to be applied precisely through irrigation lines (pestigation and fertigation);
- Fields remain accessible during irrigation;
- Can be installed on marginal soils; and
- Foliage is kept dry thus retarding the incubation and development of plant pathogens

Greater water-use efficiency can be achieved when targeted irrigation systems are coupled with other GEMs such as Regulated Deficit Irrigation, opportunistic cropping, scheduling and soil moisture monitoring.

The cost of the installation of targeted irrigation systems can be prohibitive and maintenance may be more intensive. However this should be weighed against the likelihood of increases in the price of water and the decline in yield resulting from the impacts of poor irrigation systems (Tolley 1996: 380).

- **Soil Moisture Monitoring**

Evidence suggests that maximum water-use efficiency without yield reduction is achieved through the application of a range of soil moisture monitoring techniques. These should include a soil-based technique (such as neutron probes or EnviroSCAN) combined with weather monitoring and personal observation of the crop and conditions (Hickey et al 2001: 2). Through these techniques it is possible to determine whether irrigation is required and to calculate the volume and timing of irrigation such that water is not lost below the root zone into the groundwater table (Muldoon et al 2001: 10). There are four widely available technologies to measure soil moisture (Hickey et al 2001: 28). These are:

- *Tensiometers.* These are relatively cheap and easy to use but only indicate when to irrigate not how much and if incorrectly installed give inaccurate readings
- *Gopher.* Again, relatively cheap and easy to use but manual readings are required which can be time-consuming
- *EnviroSCAN.* Greater scope and accuracy of information is provided but the system can be prohibitive expensive and requires computer support
- *Neutron probe* operated by a consultant. Very accurate and moderate in cost but a license and training are required to use the probe.

(Hickey et al 2001: 26-29).

The location of soil moisture monitoring instruments will often determine effectiveness. A site representative of average water-use by the crop should be chosen (NSW Agriculture 2001:9) and instruments placed within and below the root zone (Muldoon et al 2001: 10).

- **Scheduling**

Irrigation scheduling involves a plan of when and how much water is required to generate maximum yields without water wastage (Boland et al 2000 : 581). Scheduling requires a comprehensive understanding of the water requirements of the crop at various stages of development, times of the day and under different weather conditions (Slack 2000: 3). Grower experience is an excellent guide but should be coupled with soil moisture monitoring and evaporation/rainfall data (available from various state departments of agriculture and primary industries as well as the Australian Bureau of Meteorology at www.bom.gov.au) (Queensland Fruit and Vegetable Growers 1998: 31). Using these techniques it is possible to replace only the soil moisture which is absorbed by the crop and lost by evaporation. This increases water efficiency, potentially reduces plant stress and groundwater effects.

Scheduling in Processing Tomatoes

NSW Agriculture has produced *Best Management Guidelines for Irrigation of Processing Tomatoes* (Hickey et al 2001). Included in this document is a guideline for appropriate scheduling. It provides a high level example of the type of information and planning required for appropriate scheduling.

Phase 1	Phase 2	Phase 3	Phase 4
Germination to first flower	**Flowering to first colouring of fruit**	**To 50% fruit colour**	**50% colour to harvest**
Shortly after sowing, bring the soil to field capacity to promote germination. The nest irrigation should occur once the soil at 200mm has reached refill point – after two weeks depending on the season.	During flowering, maintain the soil moisture between field capacity and refill point. This is the most critical time to avoid moisture stress	Peak demand for water. Maintaining soil moisture at optimum levels will require more frequent irrigation. Monitor the rate if ripening to determine the timing of final irrigation.	Irrigate only when the crop is slow to ripen or crop stress threatens yield and soil moisture is depleted.

Scheduling relies on irrigation systems delivering precise and punctual irrigation. Scheduling should therefore be incorporated into an overall irrigation management strategy that factors in maintenance and monitoring (NSW Agriculture 2001: 9).

- **Opportunistic or Continuous Cropping**

Opportunistic cropping involves planting when soil moisture is available due to rainfall events rather than creating the conditions artificially with irrigation. Studies with broadacre cereal crops indicate this can substantially reduce irrigation and decrease groundwater recharge to nominal amounts (Bell et all 2000; 151). No horticultural trials of this technique were identified in this study but this may provide water efficiency benefits if demonstrated to be viable.

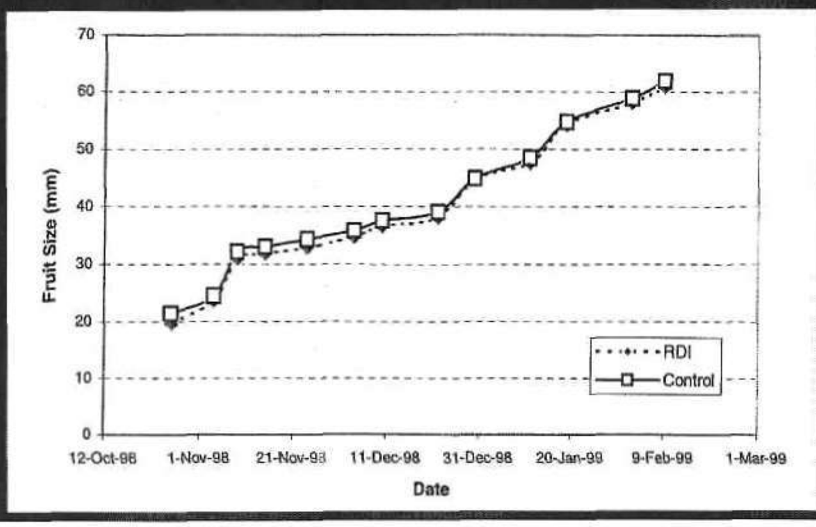
- **Regulated Deficit Irrigation (RDI)**

RDI is an irrigation strategy that involves less irrigation early in the season to reduce excessive vegetative growth and thus increase water efficiency (Boland et al :582). Trials for fruit production in the Goulburn and Murray Valleys indicate significant increases in water-use efficiency and decreases in tree growth can be achieved with no effect on fruit size or yield, as shown for the use of RDI in peaches. (Corrie and Boland 2000). The effectiveness of RDI on other horticulture crops requires further research but this strategy could potentially deliver increased water-use efficiency benefits to the industry as a whole.

Trials of RDI on Peach

The trial involved the irrigation of several types of stone and pome fruit with RDI and traditional irrigation strategies (control group). As shown for Golden Queen Peaches (below) no difference was observed in the growth rates between the RDI and control groups.

Growth of Golden Queen peach fruit (mm) in 1998/99 (Corrie and Boland 2000)



- **Benchmarking Water-use**

Benchmarking is the process by which past and present performance is measured and compared to provide a basis for comparison and continued improvement (Hickey et al 2001: 4). Benchmarking studies have been identified as one of the key factors in optimising water management (LWRRDC 1997: 33).

Benchmarking can operate at a variety of levels including industry, catchment and farm. The process of benchmarking commences with growers gathering data about their current water-use efficiency. This level can then form a basis for improvement or be compared to an industry average, catchment average or a target figure.

Useful measures of water use-efficiency include (but are not limited to):

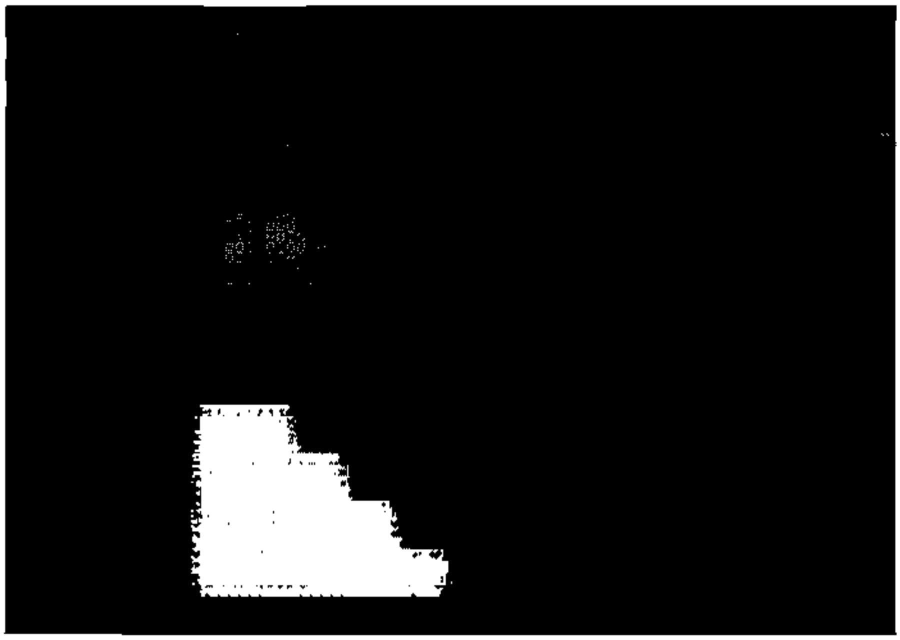
- On-farm irrigation efficiency;
- Application efficiency;
- Yield per hectare;
- Gross return per megalitre; and
- Tonnes per megalitre (this measure is sometimes referred to as water use-efficiency or (WUE) (Hickey et al 2001: 5).

Good environmental management (GEM) benchmarking should incorporate the principles of *foresighting*. Foresighting is:

> *'a way of thinking about the longer term future and how it could differ from the present, a means of our current views and policy settings, and one way of overcoming the difficulties of a static or backward looking analysis'.*
>
> *(Johnston and Chudleigh 1999: 1)*

By anticipating future scenarios in water policy (such as allocations and rising water costs), potential impacts be incorporated into the benchmark target figures. In this way, irrigators will be able to change management practices in a strategic way rather than as a short-term tactical response to regulatory change.

Grower collaboration within a catchment to determine target figures is an example of an exceptional management practice. One useful way to generate grower collaboration, stimulate discussion and reward irrigation excellence is through irrigation competitions. One competition is the 'Irrigated Farm Competition' run annually by the Irrigation Research and Extension Committee and NSW Agriculture. The competition is profiled below.



- **Run-Off and Drainage Management**

This includes a range of measures from systems that collect drainage from the soil profile to earthworks, which allow run-off to be collected in dams. The collection and re-use of run-off has advantages as it allows sediments, nutrients and any agricultural chemicals to be trapped prior to entering local watercourses and affecting aquatic ecosystems. It can have nutrient recycling benefits through reapplying the nutrients that were lost to drainage through leaching (Briercliffe (ed) 2000: 10, James et al 1996: 21). However, it is critical to be aware of the various state policies governing the use of drainage and run-off and to ensure on-farm systems are consistent with local catchment management plans.

Drainage management should take into account:

- farm topography and artificial wetland design;
- retention of natural wetlands, watercourses and riparian vegetation;
- identification and management of preferential flow paths;
- the augmentation rather than modification of natural drainage systems; and
- run-off and drainage re-use systems (Queensland Fruit and Vegetable Growers 1998: 38).

Another area, which is currently being researched, is the use of recycled effluent water. Research with potato growers in the Torquay area is focussing on the effect of the nutrient levels in effluent and potential pathogens (Bates 1999: 33). The Dissolved Air Flotation and Filtration plant at Bolivar on the North Adelaide Plains is already operational (Kelly 2000: 36). This strategy for the re-use of water may be a potential GEM practice if research demonstrates its safety on horticultural crops, however, it may prove better suited to orchard and perennial crops than vegetables.

- **Maintenance of Vegetation Cover**

Controlling the amount of irrigation input into a horticultural enterprise is only part of a management strategy for areas prone to salinity, waterlogging and high water tables (Martin and Metcalfe 1998: 68). Aside from ensuring water-use efficiency GEM practices involve establishing a permanent cover of vegetation to extract excess water from the soil profile (Lefroy and Stirzaker 1999: 277). The appropriate type of vegetation cover will vary according to the type of horticultural crop. Cover-cropping has been demonstrated to be of value in some circumstances (Lefroy and Stirzaker 1999: 278), however appropriate species will vary based on the crop being produced. Cover-cropping and agroforestry also have soil and land management benefits by preventing erosion and increasing organic matter content.

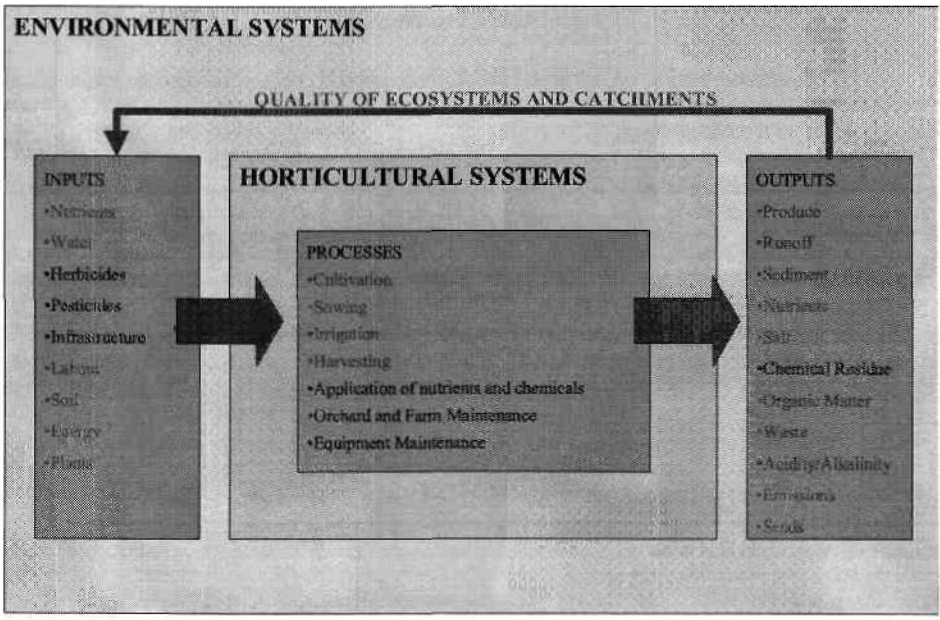
The conservation and maintenance of riparian vegetation (vegetation associated with waterways such as streambank trees and wetlands) is particularly critical to catchment health (Wasson et al 1996: 7-45). Riparian vegetation maintains bank stability and protects against gully erosion (Queensland Fruit and Vegetable Growers 1998: 31). Wetlands filter nutrients and trap sediments, improving water quality and decreasing the likelihood of algal blooms. GEM for horticulture involves actively preserving, and in some cases repairing, riparian vegetation and wetlands at a farm level. Horticulturalists should also participate in the maintenance of vegetation cover at a catchment level through program such as Landcare and Rivercare.

B.4. Soil and Land Management

B.4.1. Overview

The management of soil and land resources under horticultural production can significantly decrease the quantity of fertiliser and labour inputs required. Outputs of salt, nutrients and sediments can be reduced through appropriate management and the quality of water outputs improved. (Figure B.4). Through good management of cultivation, orchard and farm maintenance and nutrient application, run-off, sediment, nutrient, acidity/alkalinity and salt outputs can be reduced (Figure 4). Organic matter content of the soil can also be improved.

Figure B.4: Schematic diagram of the horticultural system elements impacted by soil and land management



Good soil and land management practices involve a range of measures to address:

Good soil and land management practices involve a range of measures to address:

- Soil acidity;
- Soil structure decline;
- Erosion;
- Low organic matter;
- Nutrient levels; and
- Biodiversity loss.

The effective management of these impacts has demonstrated benefits in terms of lower input costs and in some cases, improved yields. These benefits may be realised in both the short and long-term but will ultimately result in greater sustainability of environmental and horticultural systems.

B.4.2. Good Environmental Management

The most fundamental aspect of effective soil and land management is information and planning (Hamlet 2001: 3). Good environmental management of land and soil resources hinges on a thorough understanding of soil types, slope, climate, endemic native vegetation species and species requirements, crop nutritional requirements and current soil status. As such, catchment and property knowledge is essential to the development of a system-based plan for soil and land resource management.

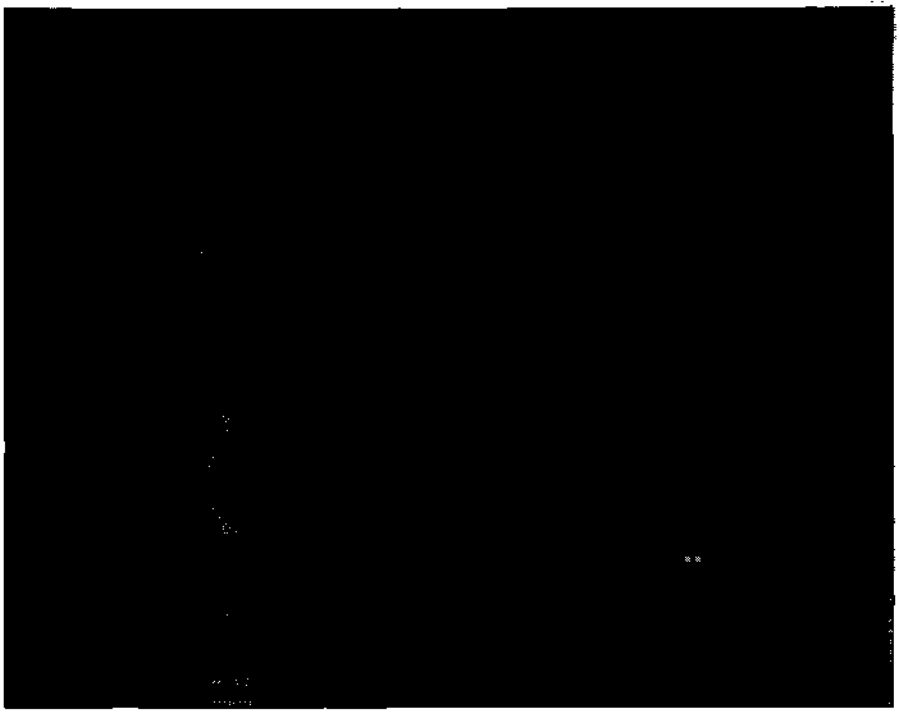
- **Low Impact Tillage Systems**

Poor tillage practices can lead to soil compaction, erosion and structure decline (Queensland Fruit and Vegetable Growers 1998: 20). Poor soil structure causes soils to have low infiltration rates, breakdown quickly under heavy rainfall and form surface crusts (Queensland Fruit and Vegetable Growers 1998: 20). Minimum tillage is now widely adopted in the USA with 37% of land under cropping (total including both horticulture and agriculture) is sown using minium tillage practices (Reeder 2000: 41). In Australia, minimum tillage has been widely adopted by the grains sector. Minimum tillage has been particularly well researched in the context of broadacre agricultural cropping and some lessons are transferable to horticulture.

Research suggests that minimum tillage is suitable for some types of horticultural production (Stirzaker 1999: 199). In vegetable crops, trials in minimum tillage returned the lowest erosion rates when compared to conventional and other tillage regimes (Wells 2000: 24). However, minimum tillage may also be associated with soil hardness leading to limited root growth and lower yields in vegetables (Wells 2000: 24). Soils with high organic matter content were shown to display low erosion rates even under rotary hoeing (Wells 2000: 24). Thus, high organic matter levels should be nurtured and cultivation minimised as this destroys organic matter (Panagiotopoulis 1990: 21).

It is desirable to decrease tillage frequency through such strategies as the moderate use of herbicides, integrated weed management and maintaining semi-permanent beds (NSW Agriculture 1997: 14). Using tined hoes and non-inverting implements is more desirable than rotary hoes or disc ploughs (NSW Agriculture 1997: 14). Growers should attempt to determine the minimum levels of tillage feasible without allowing soils to harden. Problems of pest and disease associated with stubble retention can be reduced through ensuring the highest possible diversity in crop rotations (Wallwork 2000: 5).

Potato farmers in the Robertson district of New South Wales have been undertaking trials of minimum tillage in comparison to conventional tillage methods (Lanz 1996: 39). Their experience is profiled below.



- **Erosion Control Measures**

The purpose of using erosion control measures is to prevent the loss of sediment and nutrients in run-off or as dust. Erosion control measures function by shortening slope length, binding sediments in-situ, trapping mobile nutrients and sediments and/or directing run-off into stable drainage lines. These measures may include:

- Contour banks;
- V-shaped drains;
- Bench terraces;
- In-fall access tracks or roads;
- Low profile mounds;
- Grassed waterways with suitable species cover; and
- Strip cropping, cross drains and contour planting (Queensland Fruit and Vegetable Growers 1998: 11).

Another erosion control measure is windbreaks. Windbreaks reduce wind speeds by 25-75% (Queensland Fruit and Vegetable Growers 1998: 13). Windbreaks are a useful tool in a whole farm planning approach as they provide the additional benefits of reducing the incidence of spray drift, may conserve endemic species and provide wildlife habitat if appropriate vegetation is selected. Windbreaks should be planted 10m away from crops, as maximum protection is 15m from the break. This also allows for vehicle access and prevents shading and competition (Queensland Fruit and Vegetable Growers 1998: 13).

Where feasible, areas affected by erosion should be rehabilitated, especially areas where gully and rill erosion are occurring. Run-off water should be diverted away and this area revegetated with endemic trees and also grasses to provide groundcover, especially while the trees are establishing.

What measures or suite of measures that are appropriate in each individual case will vary based on soil type, type of production, slope, rainfall patterns, soil condition and vegetation cover.

The importance to horticulturalists of extracting accurate, expert information and advice is highlighted by the special conditions experienced in the tropical zone. The suite of conditions experienced by tropical growers are very different to all other types of horticulture. Outlined below are examples of erosion control measures for tropical orchards (including macadamias and mangoes).

- **Fertiliser Management**

The incorrect application and management of fertiliser adversely impact on environmental quality by contributing to soil acidity, soil contamination, groundwater contamination and the quality of aquatic systems (Queensland Fruit and Vegetable Growers 1998: 14). Fertiliser application represents a significant proportion of the cost of horticultural production. For example, it is estimated that fertilisers are as much as 15-20% of the cost of potato production (McPharlin and Jeffrey 1997: 2). Thus, the systematic reduction of fertiliser inputs makes sound economic and environmental sense. Indeed, estimates suggest that savings of $400 per hectare of potatoes could be made simply by not over fertilising with phosphorus (McPharlin and Jeffrey 1997: 2). Conversely, inadequate application can adversely impact on grower yield. Good fertiliser management involves the thorough understanding of crop and soil requirements in regard to application rates, scheduling and application methods.

Fertiliser Type and Application Rates

A survey of apple and pear growers in the Murray-Goulburn Valley, found that more than 20% were applying excessive amounts of nitrate (Schneider 1996: 6). Excessive or prolonged application of nitrogen fertiliser can lead to problems of soil acidity (Schneider 1996: 6). Soil acidity directly impacts the ability of crops to absorb nutrients. A soil pH of 6.0-6.2 will allow maximum availability of most nutrients to plants (James et al 1997: 32). Soil pH outside this range will impact on the ability of plants to absorb some nutrients.

Localised soil acidity may be a particular problem under fertigation systems where nitrogen applications are concentrated in a very small area (Schneider 1996: 6). The use of ammonium based nitrogenous fertilisers should be phased out as these are more likely to lead to acidity problems (Goldspink 1999: 22). Growers should substitute calcium or potassium nitrates are more benign (Goldspink 1999: 22). Lime can be applied to ameliorate the effects of soil acidity (Hollier et al 1993: 25), however, appropriate fertiliser application is preferable.

Growers should, through consultation with local authorities and soil testing, ensure that they are applying appropriate levels of fertiliser for both soil and crop type. Soil should be tested prior to planting to determine the nutrient status of the soil to assist in the development of an appropriate fertiliser program. This is particularly important when using 'blended' fertiliser as an incorrect blend may cause nutrient deficiencies or excessive levels in the soil (Queensland Fruit and Vegetable Growers 1998: 15).

Scheduling

It is also important that growers schedule the application of nitrogen fertilisers appropriately to avoid unnecessary application (Goldspink 1999: 23). Fertiliser should be placed and timed to coincide with the peak growing periods of the crop (Queensland Fruit and Vegetable Growers 1998: 17). Good scheduling practice also involves the use of leaf, sap and/or soil testing at various growth stages of the crop to determine nutrient usage and requirements.

Caution should be used (particularly in tropical areas) to ensure that fertiliser application is timed to avoid heavy rainfall events and thus fertiliser run-off. This may not always be possible, but weather reports should always be consulted prior to application. Nutrient levels in run-off concentration tests may not be indicative of total nutrient loss during such events because even if large amounts of fertiliser are being removed, the volume of run-off will dilute samples (Khese et al 1997:8).

Application Methods

Essentially three types of fertiliser application are commonly used; broadcasting, incorporation into the soil prior to planting, and through irrigation lines (fertigation). The broadcasting and cultivation of fertiliser into the soil are often effective prior to planting (Queensland Fruit and Vegetable Growers 1998: 19). However, fertigation offers a more precise method of delivering nutrients after crops are established. Automatic dosing systems may be used that further increase precision (James et al 1997: 33). Fertigation also has a short delay between application and uptake and is thus useful as a rapid response fertiliser to diseased crops (Queensland Fruits and Vegetable Growers 1998: 19). Soluble fertilisers tend to be more expensive, however, this should be weighed against the benefits of decreased fertiliser loss, lower inputs and reduced use of machinery (thus associated fuel and maintenance savings as well as reduced impact upon soil structure).

Other Aspects of Good Fertiliser Management

- Avoid using fertilisers close to dams and waterways. High levels of nutrients in waterbodies may lead to algal blooms and encourage waterweeds (NSW Agriculture 1997: 34).
- Filter drainage through artificial wetlands (see case study below of the use of artificial wetlands to trap nutrients in nursery run-off).
- Establish grassed areas and windbreaks and maintain remnant vegetation as a means of trapping nutrients in run-off (NSW Agriculture 1997: 34).
- Use composted animal manures as a natural source of phosphorus and nitrogen (caution should be exercised with the use of animal manures to avoid excessive accumulation of nitrogen and phosphorus in the soil (NSW Agriculture 1997: 34) and outbreaks of pests and diseases (such as the current problems in Western Australia where the use of poultry manure on vegetable farms may have contributed to problems with escalating stable fly populations (Cook et al 2000)).
- Care should be taken to ensure that plant diseases are not confused for nutrient deficiencies and excessive fertiliser applied (NSW Agriculture 1997: 34).
- Groundwater testing should be conducted to monitor nutrient leaching (NSW Agriculture 1997: 34).
- Soil testing is growing significantly in Australian agriculture and plant testing is also developing in horticultural industries. Testing is becoming increasingly viable as there are well researched benefits related to managing soils with soil test data. However, uptake of testing in Australia is not as rapid as it is in the US (Peverill 1993).

- **Mulching**

Mulching can improve yield and tree health (Firth 2000: 3). It adds organic matter to the soil, impedes the growth of weeds alleviating the need for herbicides and aids in soil water retention. In orchards, the slashing of grass or groundcover in the interrows and directing slashed material onto tree rows has been effective (Firth 2000: 3). Also the mulching of pruned limbs and leaf litter has demonstrated value (Firth 2000: 3). In annual crops, mulching of organic waste products from the crops (eg turning unharvested plant materials into the soil) may provide benefits.

The use of compost provides similar benefits to mulching but the material is processed prior to application (Beattie 2001: 1). This process (if performed properly using guidelines such as those set-out in the Australian Standard for Composts, Soil Conditioners and Mulches) should assist in managing crop contamination risks (Beattie 2001: 1) and pest outbreaks.

- **Maintenance of Vegetation Cover**

Vegetation binds soil together to prevent erosion, adds organic matter and helps to regulate soil nutrient levels. The type of vegetation cover that is appropriate will vary according to the type of horticultural crop under production. These may be broadly grouped into three strategies for maintaining vegetation cover:

Agroforestry

Tree plantations may be placed to intercept groundwater or grown in areas to mine excessive groundwater in areas previously under horticultural production (Lefroy and Stirzaker 1999: 293). The use of productive tree species with relatively low water requirements, such as chestnuts, may be a viable option for areas which have a high probability of erosion. The integration of trees and crops may also be viable however, yields may be reduced due to competition with the trees. If a tree-crop yielding high economic returns is used, such as olives, then integration may be feasible. Ultimately, growers should seek out local research or conduct small scale trials.

Alley Cropping

High biomass crop rotations have environmental as well as economic benefits for growers. Cover crops, which produce large amounts of biomass (such as sweet corn), have been shown to contribute organic matter to the soil, decrease leaching, protect vegetable crops from rainfall, reduce dust, improve machinery access and run-off and bind soil together (Wells 2000: 23, Queensland Horticulture Institute 1999:1). If sown densely, cover crops can also suppress weeds, reducing inputs of herbicides (Queensland Horticulture Institute 1999:1). Rotations with low-growing legumes have the additional advantage of adding nitrogen to the soil. Cover crops are grown with very low irrigation and fertiliser inputs thus they absorb excess inputs and provide economic returns to growers (Wells 2000: 23).

Crop Rotations

The use of well managed crop rotations has displayed significant success in broadacre cropping, particularly where legumes are used (Lefroy and Stirzaker 1999: 297). Rotations of legumes, such as lucerne, not only bind the soil but add nitrogen and organic matter (Lefroy and Stirzaker 1999: 297). A rotation of a green manure crop has been shown to particularly benefit leafy green vegetables, reduce disease perpetuation and assist in breaking the nematode cycle (in the case of grasses only, nematode populations may increase in susceptible vegetables with legume cover crops) (Queensland Horticulture Institute 1999:1). The selection of green manure crops will vary based on season and available time. Green manure crops should be slashed after sufficient growth has occurred and allowed to regrow (Queensland Horticulture Institute 1999:1).

- **Conservation and Maintenance of Remnant Native Vegetation**

The conservation of remnant vegetation includes riparian vegetation, wetlands and remnant vegetation which may include forest, scrub and/or native grasses. Native vegetation may trap nutrients and sediments, filter run-off, add organic matter, reduce groundwater discharge, bind soils and act as windbreaks while providing habitat for native animals and plants.

While horticulturists may not deem biodiversity conservation as a high priority issue (MacArthur Agribusiness and Sinclair Knight Merz 2001: 92), growers can may a significant contribution to biodiversity outcomes. Small areas of remnant vegetation exist throughout horticultural areas of Australia and growers can actively impact on these directly, via clearing, or indirectly through poor management practices. Regions with high numbers of endemic species, such as south western Western Australia and Far North Queensland are known as biodiversity 'hot spots' and require an extra effort by growers.

The clearance of native vegetation should be avoided. When clearing is necessary, interconnected remnants of reasonable size should be conserved such that ecosystems remain viable (Queensland Fruit and Vegetable Growers 1998: 44). The size will vary based on the type of vegetation and/or ecosystem in the remnant.

Some remnant vegetation is aging and regeneration is not occurring due to poor seedling survival rates (Noble et al 1996: 6-13). Remnant vegetation should be fenced, the invasion of weeds managed and fertiliser drift minimised (Noble et al 1996: 6-13). Environmental weeds are particularly devastating as they out compete and choke native vegetation. It is estimated that environmental weeds cost Australia $3.3 billion per year (Queensland Fruit and Vegetable Growers 1998: 44).

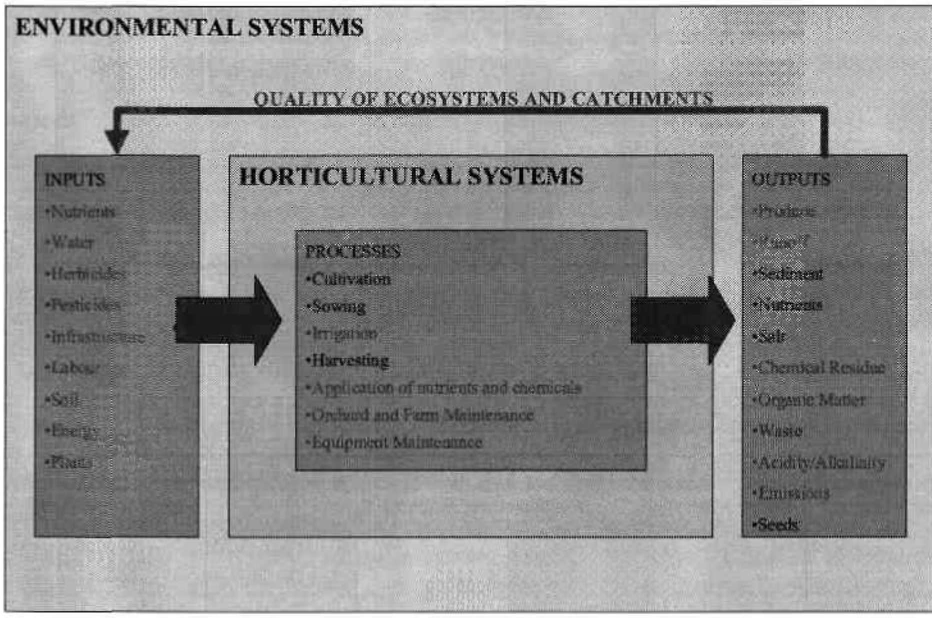
Legislation regarding the clearance of native vegetation is continually tightening and local and state information should always be sought prior to land clearance. Consultation with departments of primary industry/agriculture and natural resources/environment should occur to ensure adequate cover is maintained in strategic locations to avoid erosion and trap sediments and nutrients. Horticulturists should actively participate in Bushcare, Landcare and Rivercare groups to gain local expert opinions and contribute to biodiversity conservation at a catchment level (LWRRDC 1992: 132).

B.5. Pest, Insect, Weed and Disease Management

B.5.1. Overview

Within horticultural systems, management of agricultural chemicals is important from both an environmental and economic perspective. Agriculture chemicals are a costly input into horticultural production and minimising their use will reduce outlays by growers as well as saving on fuel, labour and machinery costs if the number of applications are reduced (Figure B.5). If chemical residues are an output from farms (in run-off, in produce or as drift) they may have implications for human health, quality assurance of produce, and the produce of neighbouring stock or organic enterprises as well as impacting upon ecosystems and water quality (Figure B.5).

Figure B.5: Schematic diagram of the horticultural system elements impacted by agricultural chemicals



Being an island continent, Australia is in the fortunate position of being naturally isolated from many pests and diseases which afflict horticultural crops in other nations. However, Australia is at greater risk from insect pests than nations that experience winters cold enough to kill insect pests (Noble et al 1997: 6-20). Furthermore, export prospects could be jeopardised by the impacts of pests and diseases such as the Queensland Fruit Fly (Noble et al 1997: 6-20). As such, the management of pests, diseases, weeds and insects is a critical part of whole farm planning.

Legislation is in place in the states and territories to ensure agricultural chemicals are applied in a manner which causes no harm to consumers, the general public, livestock and some natural systems (James et al 1997: 22). The application of chemicals to crops should be thoroughly researched to ensure compliance with regulations and that the chemicals are appropriate to both the local area and crop. Stockpiling of chemicals poses an unnecessary risk and should be avoided. Monitoring usage provides information for better demand management so chemicals can be ordered as required. Each time chemicals are purchased the choice should be reviewed to ensure an appropriate selection. Directions on the labels should always be read to avoid excessive or inappropriate application.

Table B.3 (below) reports on the chemical residues found in fruits and vegetables at Flemington Markets. Some of the chemicals detected (BHC and Dieldrin) were banned some years previously (Rowland et al 1997: 14) indicating persistence of these residues in the soil. As this type of scrutiny is increasing in the marketplace, minimisation of chemical use is advisable. Through the implementation of GEMs such as integrated pest management and farm hygiene (and other practical measures) horticulturalists can reduce usage without impacting yields.

Table B.3: Flemington Markets residue survey

Crop	Number of Samples Exceeding MRL	Pesticide Residue	Residue mg/kg	MRL mg/kg
Carrot	1	Chlorpyrifos	0.02	0.01
Chinese Cabbage	2	Endosulfan	2.27-3.10	2.00
Lettuce	5	Endosulfan	2.05-7.18	2.00
Lettuce	2	Fenvalerate	0.17-0.48	0.00
Lettuce (Hydroponic)	1	Fenvalerate	0.3	0.00
Lettuce (Hydroponic)	1	Furalaxyl	0.13	0.00
Onion	1	BHC	0.13	0.00
Onion	1	Endosulfan	0.25	0.20
Pear	1	Chlorpyrifos	0.26	0.20
Silverbeet	1	Permethrin	0.15	0.00
Zucchini	9	Dieldrin	0.01-0.12	0.00

Source: Rowland et al 1997: 14)

Note: Survey shows the number of samples with a residue exceeding Maximum Residue Limit (MRL). The total sample number is 25,000. In total, 25 of 25,000 samples exceeded the MRL.

B.5.2. Good Environmental Management

- **Storage, Transport and Disposal of Chemicals**

In their survey of horticultural producers and government agencies across Australia, MacArthur Agribusiness and Sinclair Knight Merz (2001: 56) identified chemical/container disposal and options for storing farm chemicals as two of the top environmental priorities.

Chemicals should always be stored in a manner consistent with that on the label. Several guidelines exist for the storage of chemicals. From these the key points are:

- Storage areas should be locked to exclude children, unauthorised pets and livestock.
- They should be located above flood levels.
- Warning signs should be placed on the door or gate.
- Floor should be impermeable and leakages should be collected in a sump.
- If no underground sump is in place, doors and walls can be bunded.
- Use metal shelves as timber absorb leaks.
- Keep records of chemical use to plan purchases so that chemicals aren't stockpiled for unnecessarily long periods of time.
- Keep chemicals separate from seeds, fertilisers, protective clothing and stock feed.
- Always keep chemicals in their original container.
- Store in cool conditions away from direct sunlight (James et al 1997: 23, DNRE 1999: 14).

Disposal should follow instructions on the label. Generally, heavily diluted excess chemicals can be used applied to crops, but should not be allowed to reach ground water or storm drains and concentrated chemicals should never be disposed on farm (DNRE 1999a: 16). All care should be taken to dilute the correct quantities of chemicals with variation skewed towards mixing less than required rather than more.

Containers should be triple rinsed, punctured or crushed, and disposed to an approved agent. The NSW and Commonwealth joint scheme called ChemCollect has been implemented to collect and safely dispose of unwanted and non-registered farm chemicals without cost. Similar schemes operate in other states and territories.

- **Integrated Pest and Weed Management**

Integrated Pest Management and Integrated Weed Management (often referred to jointly as IPM) are defined as a control strategies in which a combination of biological, chemical, mechanical and cultural methods are used to ensure long term sustainable management of weeds and pests. IPM is a widely recommended strategy to suppress weed and pest problems by shifting the focus from 'quick fix' chemical strategies to a more holistic long-term approach.

This approach is based on the fact that pests and weeds will never be fully controlled and eliminated. Therefore, pests need to be managed in a sustainable manner. The emphasis is of IPM on anticipating and preventing problems before they occur whenever this is possible and only used chemicals when truly required. Furthermore, IPM is essential as over-reliance on chemicals can result in the development of resistance problems, build-up of secondary pests and diminishing returns (James et al 1997:25). It provides a safeguard to natural resources by minimising environmental impact.

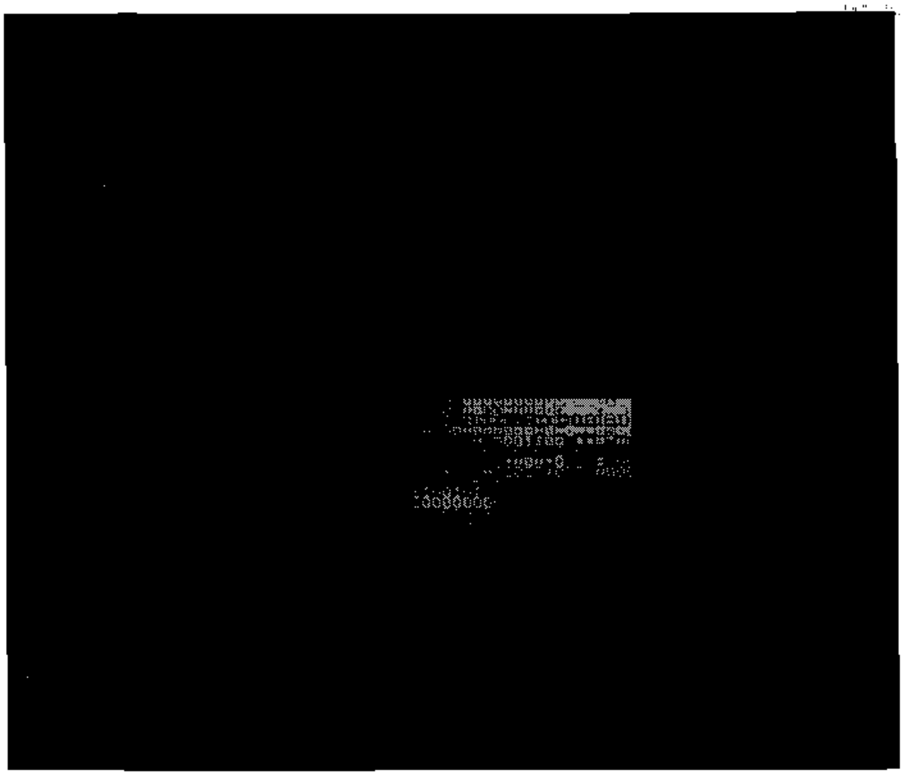
It is usually not possible to adopt IPM strategies from overseas as the pests are often very different, and the climate and production methodologies are significantly different (Horne 1998). However, IPM is particularly successful in Australia because strict quarantine regulations have ensured that many of the particularly destructive pests are not present in Australia. Adoption of IPM by Australian potato growers has much faster than in the USA. This was also due to active grower groups and dedicated advisers (Horne 1998).

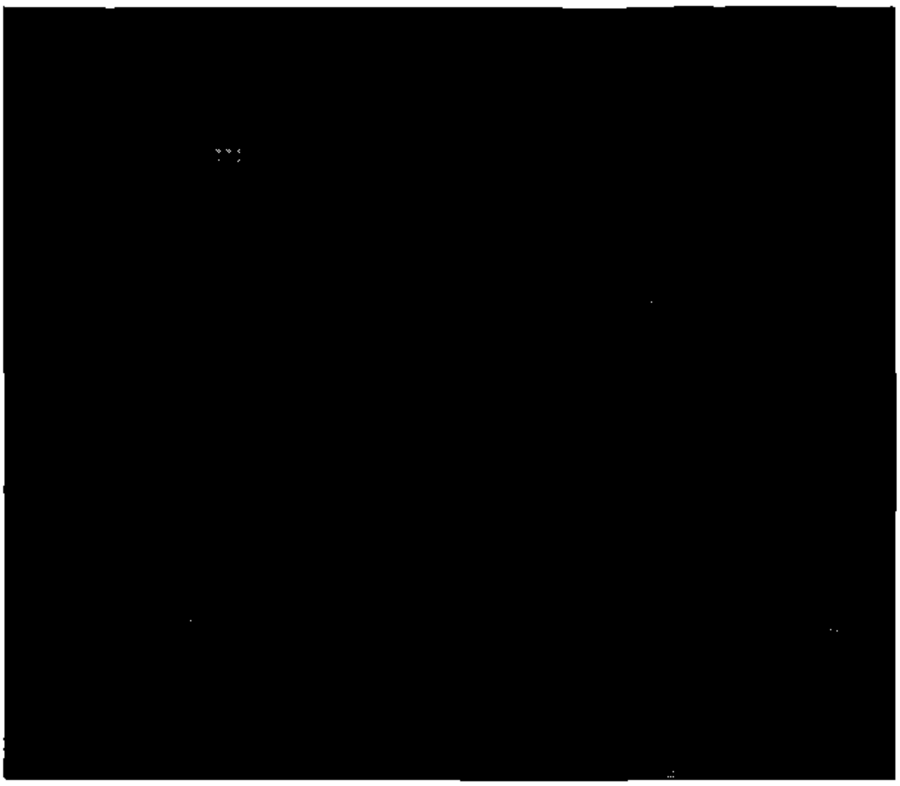
IPM and Potatoes

It has taken about 10 years to develop the understanding needed to produce a workable potato IPM strategy that can be applied in most areas of Australia. Research began in 1987 after the withdrawal of DDT and other organochlorin insecticides. An IPM strategy for potato crops mainly utilises biological controls (predators and parasites) and cultural controls (irrigation, weed control) (Horne and Spooner-Hart 1998). Research suggests that rotation of harvestable brassicas in potato crops is an effective form of biofumigation. (Matthiessen 1997)

IPM and Tomatoes

A lot of work has been completed on IPM in tomatoes. Bacillus thuringiensis (Bt) is recommended in the early life of the plant to control leaf miners, loopers and cluster caterpillars. It is considered a softer option because it does not kill beneficial insects. However, it is not recommended for areas where heliothis is present. (Queensland Fruit and Vegetable Growers (1998: 74)





IPM is a multi-faceted approach to management that relies heavily on a common-sense attitude embodied in whole farm planning principles. For example production areas should be organised to minimise the spread of pests. In a nursery it is as simple as keeping all spider mite susceptible plants together and away from hot, dry areas, fans and walkways (Steiner 1997).

Some of the main strategies for good chemical management include: crop rotation, good farm hygiene, break in production, protecting beneficial organisms, monitoring pests and developing thresholds for chemical use.

Crop Rotation

Management of cropping regimes is an integral part of IPM. It involves ensuring breaks in production and rotation of crops. Continuous production encourages the accumulation of pest problems. So, fallows should be practiced to allow soils to rejuvenate and pest and disease problems to decline (Queensland Fruit and Vegetable Growers 1998: 71).

Crop rotations are beneficial in controlling pests, for example rotating a legume after a leafy vegetable crop can reduce the impact of nematodes and also add nitrogen to the soil (Queensland Horticultural Institute 1991: 1). Various crop rotations have been trialed as an alternative to nematicides, which are extremely toxic and have adverse environmental impacts. The trial monitored the presence of nematodes on different vegetable crops and their tolerance to nematodes. It was found that it was unnecessary to use chemicals in the cooler months of the season and that tomato and eggplant were by far the worst hit crops by nematodes. Tomato crops were then treated with molasses that was found to inhibit both egg hatching and juvenile nematode motility (Vawdrey and Stirling 1998),

Mulches

Mulches in the form of plastic, organic, and living are very effective in reducing weeds. Plastic mulches are used in high-income, wide row vegetables such as tomatoes, capsicums, and melons. They have the added advantages of conserving water, warming the soil, and deterring aphids but they are expensive and disposal is a problem (Grundy and Henderson 2001: 3).

Organic mulches such as straw and sawdust can also be used but they are less suitable to mechanical application and some weeds can grow through them (Grundy and Henderson 2001: 3). However, organic mulches increase organic matter content of the soil and reduce water loss through evaporation (refer to soil and land management section for a more in-depth discussion).

Monitor Pests and Develop thresholds for chemical usage

In the USA adoption, of IPM has been shown to give tangible benefits, both economic and environmental to a range of horticultural crops. In some cases the usage of insecticide has reduced by 75% due to effective crop monitoring (Horne 1998). An IPM system should have an action threshold for the application of insecticides. This threshold should be the point at which pest numbers are likely to inflict economic yield and quality losses unless a spray is used. This is based on the concept that plants can withstand a certain level of pest before serious damage occurs.

Crops should be monitored on a weekly basis using a magnifying glass and pests should be identified by type and quantity. This can be done by the farmer but it is important that they are confident that they can identify the pest and beneficial species, and have the time to do the monitoring. An aspect of good environmental practice is to also provide monitoring support by a crop scout that assists in identification and planning in a particular region (Horne 1998).

Managers should understand the lifecycle of insects as it is possible to reduce insecticide use by only spraying when it will give the greatest effect. One such time is during mating cycles. Growers in the Shepparton and Cobram districts have had particular success with this strategy (outlined below).

IPM in Stone and Pome Fruit

Pheromones and cultural techniques are being used in a HRDC funded project to control the Oriental Fruit Moth and Carpaphilus beetles. "Mating disruption is the cornerstone of IPM in the Shepparton and Cobram Districts" and the decreased damage results of this program have been better than those of an insecticide-only program of pest management. The stone and pome fruit industries are looking to develop further mating disruption and other alternative IPM strategies in anticipation that azinphosmethyl and parathion, could be banned for use on Oriental Fruit Moth by the NRA (HRDC 2000).

Other methods of IPM include insect zappers that provide early warning signals of pest occurrence and quantity and allow the grower to measure the success of control measures. Crops can also be strategically planted to trap pests (Steiner 1997: 3). Cultivation, moving and chipping of weeds is relatively cheap and easy and it leaves no residues. It is most effective against annual weeds or seedlings. Heat treatments may also be effective as a knockdown option for organic farmers but it is an expensive option.

Alternatives to pesticides include oils, soaps and bacillus formulations, pheromone traps, steam and bus zappers for moths. Spot applications should be considered as an alternative to blanket application (Steiner 1997: 5).

When moving to IPM it is important to monitor the volumes and types of chemicals used and measure the savings. One monitoring method is "Pestdecide" developed by NSW Agriculture.

"Pestdecide"

A rating index called Pestdecide has been developed by NSW Agriculture that uses information on site of application, activity, timing of application, persistence, efficacy, cost, environmental effects, mammalian toxicity, availability of alternatives and compatibility with IPM to measure the Total Pesticide Index for a particular crop over a season. It is planned that this program will be incorporated into QA accreditation (Penrose 1997).

Protecting beneficial organisms

Insecticide applications destroy both beneficial and harmful insects. It has been estimated that in US potato crops alone, the loss of these beneficial insects is worth $8 million per year (Horne 1998). This is important in maintaining ecosystem function and can be achieved by targeted chemical spray or the removal of surrounding weed populations that can harbour pests.

An IPM strategy would investigate the potential for utilising mating disruption, predatory and parasitic insects or pathogenic fungi. These would be used in conjunction with sprays and not as a total replacement especially as they do not work as quickly (Horne 1998). Release predators in sufficient numbers for the crop area, plant size or when a serious infestation is already possible (Horne 1998). Do not use pesticides that can harm predators just prior to or following predator release. Two successful examples of the introduction of predator species are the LAPDOG and TOPCAT programs outlined below.

LAPDOG and TOPCAT

These programs have been developed in North Queensland by potato grower groups and the Queensland Department of Primary Industries to determine the major insect pest concerns and the appropriate IPM strategies to deal with the pests. The program has selected a biological approach to pest management introducing shield bugs and wasps to deal with heliothis, cluster caterpillar, green peach aphid and potato tuber moth. One farmer is even building nests to attract owls that prey on rodents on the farm (Hughes 1998: 28).

- **Application Management**

The GEM practices of rate management focus on minimising chemical application. Central to this process is ensuring that detailed records of the timing, volumes and types of chemicals applied are kept (Queensland Fruit and Vegetable Growers 1998: 72). This data provides information for benchmarking performance and is evidence of quality assurance and environmental compliance.

Effective rate management relies on two things: practices and equipment.

Practices

Chemical application regimes should ensure that a range of products are used, which control pests in different ways (that is they have different 'mode of action'). This strategy can avoid resistance to a class of chemicals and keep costs lower (James et al 1997: 24). Another strategy to achieve these outcomes is to ensure chemicals are only applied when weed and pest numbers rise above the threshold where they are likely to cause economic damage in line with the principles of IPM (Queensland Fruit and Vegetable Growers 1998: 72). Forecasting can assist in this by predicting when applications may be needed and allowing the monitoring process to be refined (Queensland Fruit and Vegetable Growers 1998: 73).

Equipment

To ensure good results as well as minimising pesticide usage, and cost efficiency, it is important to select the best delivery mechanism and to maintain the mechanism to ensure that it operates at its optimum capacity. Sprayers require regular adjustment and care is essential for good spray coverage and results. To reduce drift, It is important to use the appropriate nozzle, at the correct boom spacing and correct boom pattern to ensure that the correct spray pattern is formed and the correct spray dose per area is applied.

Equipment that reduces the amount of fine droplets minimises drift. Equipment which meets this criteria include:

- Soluble pesticides applied via micro irrigation systems (pestigation);
- low drift nozzles;
- direct soil injection systems;
- air-assisted sprayers;
- electrostatic sprayers;
- twin fluid systems; and
- shielded boom sprayers (DNRE 1999a: 19-20).

Spray nozzles require regular replacement. Sometimes they last as little as 15 hours of spraying time (James et al 1997: 24). Use a soft brush to clear blocked nozzles and rather than a wire or coarser brush (James et al 1997: 24). Always flush out the sprayer with soapy water after use and rinse with fresh water and spray the clean water rinsate over fallow land. Ensure that wastewater cannot enter ground or surface water (James et al 1997: 24). Use hollow cone nozzles for insecticides and fungicides and flat fan nozzles for herbicides (James et al 1997: 24).

- **Containment**

Containment of agricultural chemicals is required to prevent the movement of chemicals offsite as agricultural chemicals can have serious environmental effects when they build up in human water supplies, reach aquatic ecosystems or impact upon native species.. Spray drift is the most common cause of off-site contamination and occurs when chemical droplets and vapour are carried by air movement away from the site of application (Bibo 1999: 1). Several strategies exist to control the movement of chemical offsite. These include:

Selecting Appropriate Application Conditions

Chemicals should not be applied under adverse weather conditions. Table B.4 provides an indication of which conditions could represent a high risk of drift. If multiple factors are present then application should be ceased or delayed (DNRE 1999a: 24-25).

Table B.4: Risk of drift

Factor	Potential Drift Hazard Scale		Comment
	High	Low	
Wind Speed	Still air or greater than 15 km/hr.	Steady wind (1-10 km/hr).	
Wind Direction	Unpredictable or towards sensitive areas.	Predictable and away from sensitive areas.	
Humidity	Relative humidity < 40%.	Relative humidity > 80%.	Vapour formed and drop size reduction.
Atmospheric Stability	Inversion layer present within 100 m of spray release height.	No inversion layer.	Farm chemical application should not be undertaken when inversion layers present.
Temperature	High (> 30°C).	Low (< 15°C).	
Sensitive Area	Close (< 100 m).	Far (> 1 km).	
Buffer Zone	None	Distance > 100 m.	
Vegetable Barrier	No vegetation.	Live shelter, > 2x release height, permeability 50%.	*Casuarina* spp make excellent barriers.
Toxicity	S7 chemicals or LD 50 dose < 200 mg/kg.	Chemicals with LD 50 dose > 5000 mg/kg.	
Volatility of Chemical	High (vapour pressure > 10 mPa).	Low (vapour pressure < 0.1 mPa).	Eg many ester formulations.
Maximum Release Height of Spray	> 1.5 m above target.	< 0.35 m above target.	
Targeting of Spray	Directed above target.	Directed at target.	Frequently a problem in orchards.
Drop Size	VMD < 50 um.	VMD > 200 um.	
Travel Sped	> 20 km/h.	< 10 km/h.	

Source: DNRE 1999a: 24-25

Note: A single high-risk category should not necessarily prevent a chemical application particularly when offset by low risk factors (except if the high risk situation is an inversion layer). When several high risk conditions apply, application should be delayed or an alternative sought.

To avoid contamination due to run-off of chemicals several practices are useful including:

- location of mixing and wash down sites away from drains and waterways;
- avoid spillagewhen storing or pouring;
- take all precautions to avoid overspraying; and
- ensure appropriate irrigation levels, especially after spraying to prevent leaching (DNRE 1999a: 25).

It is important to note that containment is not a substitute for good chemical management, rather a component of it.

- **Farm Hygiene**

Farm hygiene is the protection of a farm through the prevention of the introduction and/or spread of pests and diseases (Loughrey 1999: 1). The general aim is to prevent the inadvertent transferral of weeds, diseases, insects and nematodes through machinery, boots, vehicles and mulches (Loughrey 1999: 1).

Farm hygiene involves aspects of whole farm planning. For example, correct new orientation can maximise leaf drying and allow air movement through the crop (Queensland Fruit and Vegetable Growers 1998: 76).

Other methods of improving farm hygiene include:

- Restrict movement of machinery;
- Organise a standard delivery point for all deliveries;
- Place a sign at front gate for all visitors to visit your office first;
- Keep machinery, vehicles and clothing/footwear clean;
- Check any plant material used;
- Remove crop residues that are known to harbour pests or diseases;
- Learn to correctly identify pests and diseases (Loughrey 1999: 2);
- Remove and destroy weeks and volunteer plants;
- Immediately remove and destroy diseased or infested plants; and
- Compost or mulch plant material (James et al 1997: 27).

Several horticultural industries have developed guidelines and/or information packages to assist growers in improvement of farm hygiene. The nursery and vegetable industries have developed guidelines to assist growers ('NIASA Best Practice Guidelines', 'Best Practice Guidelines for Growing Vegetables'). A good example is provided below for stonefruits. The appropriate hygiene measures to control major stone fruit diseases are outlined over the page (Table B.5).

Table B.5: Farm hygiene practices to manage fungal disease in stone fruit

Fungal Disease	Cultural Practice and Timing
Brown Rot	• Monitor weather conditions for infection (eg wind, moisture, warmth). • Monitor insects to reduce tissue damage (eg carpophilus beetle, oriental fruit moth, light brown apple moth). • Prune and remove diseased twigs during winter. • Shape trees to ensure thorough spraying and better air flow. • Remove winter mummified fruit from trees and orchard floor. • During season remove infected and rotten fruit to reduce spore load. • Clean packing shed equipment regularly with disinfectant during harvest. • During harvest remove waste fruit daily from packing sheds. • Rapid cool fruit to 2-5°C for transit so fungus grows slowly.
Blossom Blight (Laxa)	• As for brown rot.
Shot Hole	• In winter, prune out infected fruit stalks, buds and twigs.
Freckle	• Prune out twigs bearing freckle lesions where spores over-winter. • Ensure tree is defoliated over winter.
Rust	• Prune out twigs bearing rust infections where spores over-winter.
Leaf Curl	• Monitor weather conditions for infection (cool, moist, spring weather). • Spray with good coverage in early season.
Transit Rot (Rhizopus Rot)	• Rapid cool fruit to 2-5°C for transit so fungus grows slowly. • Reduce fruit damage in tree by thinning, pruning and insect pest control. • Remove rotting fruit from trees where spores over-winter. • Handle fruit carefully to minimise damage during harvest and packing.

Source: Pocock et al 2000: 11

Use Buffer Zones

Buffer zones are a designated area around a crop in which agricultural chemicals are not applied. The function of buffers is to allow spray particles to fall out of moving air. Buffers have increased effectiveness when vegetation is used to trap chemical droplets (DNRE 1999: 1).

Vegetation buffers are most effective when:

- The vegetation is at least twice the height of orchard trees or crop;
- Vegetation is taller than the spray unit used;
- The porosity of buffer is 20-50%; and
- The buffer is located directly next to sensitive sites such as waterways, residential areas, other crops and on property boundaries.

(Walker 2000: 2)

It is important to use fine foliage, porous buffers to act as filters. Denser trees or solid objects (such as buildings) will only divert air and not trap chemicals (DNRE 1999b: 2). The most suitable type of plant will vary based on the height of the crop, however some suitable plants are:

- casuarina or sheoak;
- hybrid willows;
- rye corn;
- sorghum;
- bottlebrush; and
- tea trees (DNRE 1999: 1).

B.6. <u>Maximising Adoption of Environmentally Sustainable Management Practices by Horticulturalists</u>

The ability of key stakeholders to manage change will be critical to the long-term success of any systems based approach to environmental sustainability. This process will determine the success of the transition, implementation and ongoing application of good environmental management practices. This section of the literature review examines the current thinking in the area of change management within the horticultural sector and identifies key issues and barriers that have an impact the rate at which change occurs.

B.6.1. Rate of Adoption

The rate of adoption of a new technique is influenced by a number of factors. These include:

- "the extent to which the farmer finds the new technology complex and difficult to comprehend;
- how readily observable the outcomes of an adoption are;
- the financial costs;
- the farmers beliefs and opinion towards the technology;
- the farmer's level of motivation;
- the farmers perception of the relevance of the new technology; and
- the farmer's attitude to risk and change" (Guerin and Guerin 1994: 549).

Undoubtedly other factors also have the potential to impact on the rate of adoption such as social factors, cultural factors, political factors, market forces, grower sophistication, and industry life cycle.

[redacted]

Early work into the rate of adoption of new and innovative ideas, techniques and processes categorised people as falling into one of five areas:

- Innovators
- Early adopters
- Early majority
- Late majority
- Laggards

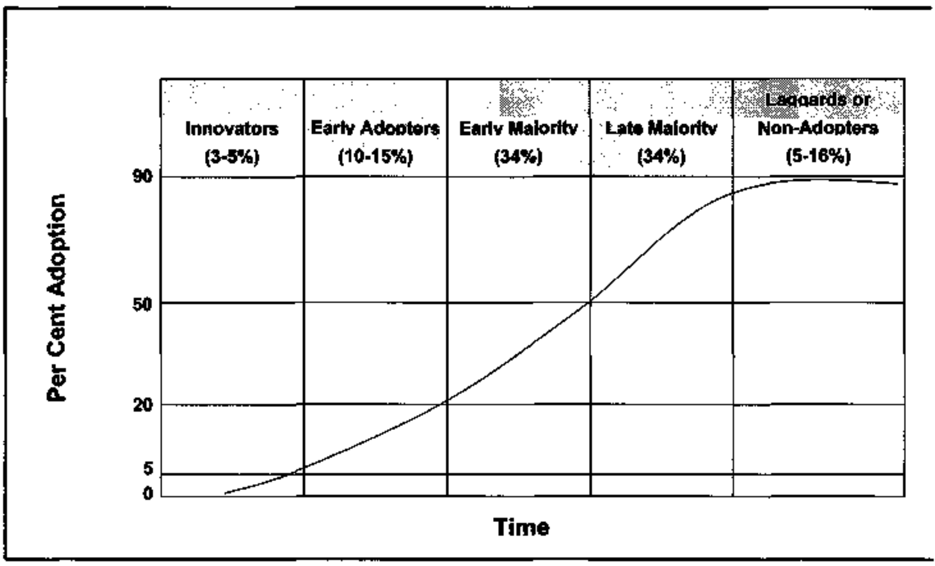
As Figure B.6 illustrates (over page), growers are distributed along a gradient of adoption with 72% of growers falling into the early and late majority categories. The horticultural industry will undoubtedly have growers in each category in the context of environmental management. Innovators are the change agents and will play a critical role in the rate of adoption of good environmental management practices by horticulture.

The Birchip Cropping Group (BCG), located in Northern Victoria have shown that innovators as change agents do not necessarily have to be individuals. Established in 1992, the BCG has increased significantly both the rate and level of adoption by broadacre farmers of new grain types and varieties. The key to the success of BCG has been its ability to move individual farmers through the adoption stages and in some cases allowed farmers to move from the laggard and late majority category into early majority (Kelly and McCracken 1999).

The rate of adoption of environmental management practices appears to be intrinsically linked to profitability. Research has consistently shown that the perceived financial advantages of environmental innovations are the best indicator of their subsequent adoption. However, the degree of receptiveness to messages about profit maximisation strategies varies (Barr and Cary: 1992: 9-10). Non-economic motivations become more important when they interact with economic factors and assume increasing importance in explaining conservation behaviour when the profitability of the practice is low (Ajzen and Fishbein 1980). Community pressure or social norms may also influence such psychological motivations (Ajzen and Fishbein 1980).

Figure B.6: Rate of adoption curve

Source: Kelly and McCracken 1999: 50



There appear to be five general factors that contribute to the conservation behaviour by growers:

1. Recognition of an environmental problem;
2. A perception that an available solution is technically feasible;
3. The technical solution is deemed to be economically profitable (i.e. net returns greater than for current farming practices);
4. The presence of psychological motivation to act (for conservation behaviours these are usually related to concern for the environment, but they may also include concern for profit; and
5. Scale of the farm business. (Cary and Wilkinson 1998) (Sinden and King 1990).

B.6.2. Process of Adoption

When considering any model of adoption, the level of motivation must also be taken into account, as there is a strong correlation between the level of motivation and the rate of adoption (Sinden and King 1990).

Four aspects of innovation may be described:

- Relative advantage;
- Complexity;
- Trialability; and
- Observability.

Relative advantage

For adoption to occur (whether of a new technique, system, variety or process) a relative competitive advantage must be present. Where relative advantage is absent, the likelihood of adoption declines (Barr and Cary: 1992: 9-10).

Environmental innovations that are believed to be profitable are usually readily adopted, whilst innovations with a clear (net) financial cost were rarely adopted (Barr and Cary: 1992: 9-10). In effect economic factors were identified as the strongest predictors of adoption (Carboni and Napier 1993). Some decisions (to change) are made for immediate economic survival, while others are made in view of anticipated long-term benefits (Chamala 1987).

Complexity

Sometimes innovations, which appear simple to the uninitiated, may in fact imply significant and complex changes to the horticultural production systems. Such innovations are less likely to be adopted. Complexity increases the risk of failure and it introduces increased costs in gaining knowledge (Vanclay and Lawrence: 1994). If a new innovation is complex, its cost and expected returns are difficult to identify. Thus, the adoption challenges the grower's beliefs, then the communication from researcher to extension officer to grower is problematic. As such, these initiatives are less likely to lead to adoption. (Rogers 1983) (Guerin and Guerin 1994).

An example of a high complexity innovative good environmental management practice, is IPM. The complexity of this practice has reduced the rate of adoption. Growers often explain non-adoption as being based upon concerns about its ease of use, speed and reliability (Bodnaruk and Frank 1997).

The level of grower sophistication also has an impact on the rate of adoption and the perception of complexity is exacerbated by the method of delivery (Kelly and McCracken 2000). A study of farmers in the Loddon Murray region of Victoria found that farmers were limited in their ability to adopt elements of specific skills training if the training was offered in such a way as to fall outside the level at which the farmers preferred to learn. As such, the level of grower sophistication is intrinsically linked to the complexity of an innovation and directly impacts upon the rate of adoption.

Trialability and Observability

Innovations, which have advantages that are observable, are more likely to be adopted (Barr and Cary 2000: 12). This is supported by observations of members of the Birchip Cropping Group, whose adoption behaviour has been directly influenced by trials conducted on a variety of sites to ensure the relevance of results (Kelly and McCracken 1999). The role of research organisations and their ability to influence the rate of adoption is best examined in the context of their ability to influence research undertaken and extension to ensure grower awareness of R&D outcomes.

Importantly, for nearly all rural research organisations biophysical sustainability is now treated as a core issue (Griffin NRM 2000: 24-25). However, there is a general perception that R&D findings generated by these organisations are being under-utilised or poorly disseminated (Griffin NRM 2000: 24-25).

Many good environmental management practices have characteristics, which can be expected to lead to slow and low rates of adoption. Many offer limited relative advantage to the farmer, are associated with complex farm system changes, or are difficult to trial or observe.

B.6.3. Understanding the Decision Making Process

In order to effectively manage change it is necessary to understand the decision processes of horticultural managers when it is recommended that they change their farm management systems (Barr and Cary 2000: 12). The decision making process illustrates clearly that there are growers who make strategic decisions rather than tactical responses relating to change to good environmental management practices.

Anticipation of degradation

In adopting new farming techniques, growers are anticipating both the future and an opportunity to gain advantage. Some find this anticipation easier than others. Landholders often do not anticipate land degradation and hence do not adopt better environmental management practices (Barr and Cary 2000: 14).

Anticipating loss is psychologically more difficult than anticipating gain. When a loss is possible, rather than inevitable, it is easy and sometimes sensible to forget about it or wait for further evidence. (Barr and Cary 2000: 14). Therefore, it is natural to resist a proposition that one is contributing to the degradation of soil and water beyond the farm boundary. However, blame for damaging another's farm or property can act as a strong stimulus for change (Barr and Cary 2000: 14).

Seeing degradation

In many land degradation situations "seeing" land degradation means observing the actual changes in the soil or vegetation and construing these changes as a management problem (Sinden and King 1990). Some forms of environmental damage is easy to see (e.g. gully erosion and severe salinity), while others are often less obvious (e.g. rising water table, early stage salinity, acidity, nutrient run-off and chemical build-up) (Barr and Cary 2000: 15). Anticipation of a land degradation problem will heighten a grower's perception of symptoms of deteriorating land condition. (Cary and Wilkinson 1997). When anticipation is combined with actually seeing degradation there is two-way causation prompting change that results in increased adoption (Abelson and Betts 1985).

Observers will be sensitised if they know they are looking for a problem (anticipation) and if they know what they are looking for then there is a higher likelihood of early detection of environmental problems (Barr and Cary 2000: 15). This will increase the likelihood of adoption of good environmental management practices. If on the other hand growers are desensitised to environmental problems there is a strong likelihood that there will need to be external factors providing impetus to change. For example, in Tasmania potato farmers interpreted the erosion on their farms as being something that "goes with the land", rather than recognising it as a degradation problem (Ewers et al 1989).

Change in circumstances such as this may come as a direct result of external pressures, whether from local, state or federal government, green lobby groups, local communities, regulatory bodies, industry self regulation or local/neighbouring farmers (amongst others). However, recognising land degradation as a serious farm problem does not guarantee the use of conservation practices: it is not a sufficient condition for environmental technology adoption (Cary and Wilkinson 1998).

Seeking Information

The ability of growers to access relevant information is likely to have an impact on the rate and level of change. Industry, government and the private agribusiness sector influence the rate of change by increasing the level of knowledge and understanding of important environmental issues.

Growers fall into skill categories that relate to the level at which they seek or take in information. In some instances growers may possess high-level skills in specific area but require basic level information in other areas (e.g. environmental management). Broadly the categories that define the level at which growers prefer to learn fall into five areas; low basic, basic, intermediate, advanced and worlds best practice (Kelly and McCracken 1999).

These categories fit well with the adoption characteristics (Illustrated in Figure B.7 over the page):

- Low basic ~ laggard
- Basic ~ late majority
- Intermediate ~ early majority
- Advanced ~ early adopters
- Worlds best practice ~ innovators

Better motivated and educated farmers made the greatest financial progress on their properties (Singh and Ray 1980).

Weighing the alternatives and the risks

Expectations of financial return play a major role in a grower's decision-making process (Barr and Cary 2000: 15). If a grower is under continuous financial pressure, long-term farm priorities will be continually deferred to satisfy immediate financial need. The future will be created from a string of short-term decisions (Barr and Cary 2000: 15).

Risk will be a significant factor in most decisions, and individual growers will have different tolerances to risk (Dwyer 1974; Ralph 1972).

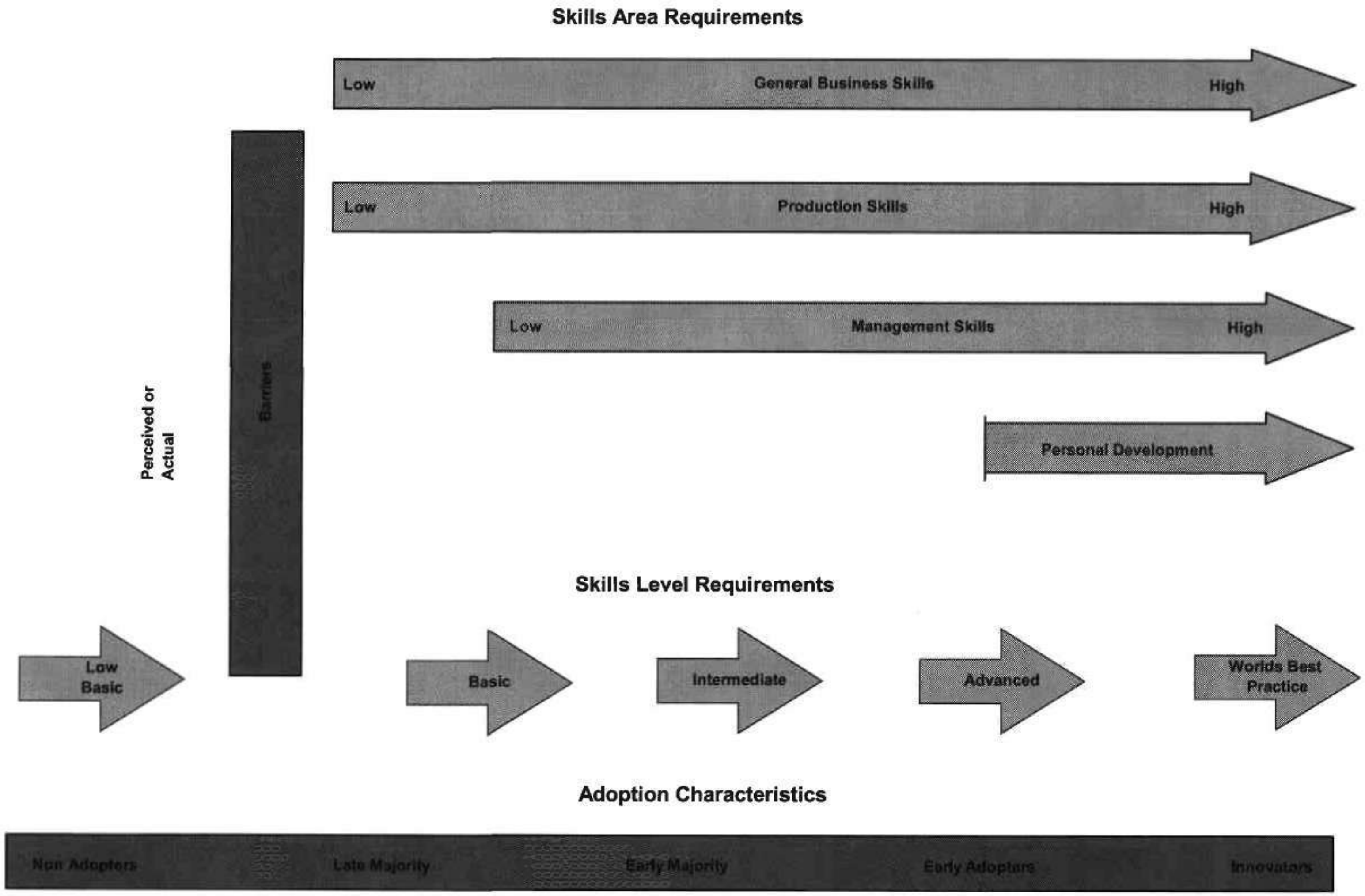
Making a decision

Decision-making does not end when the selection of the best alternative has been made. It is then time to secure support for the final commitment. This support is likely to be sought through social, cultural, industry, government and market avenues.

Undertaking a trial

A successful trial is more likely to lead to increased levels, and higher rate of adoption. Trialing ensures that there is less cost to the industry as a result of failure and allows trialing under differing conditions. Researchers also believe that both the public and private sector have an ongoing role to play in the development of new environmentally responsible management practices.

Figure B.7: Skill categories for the level of uptake of knowledge



Source: adapted from (Kelly and Cracken 1999)

Making a change

In some circumstances the adoption decision may be constrained by outside influences (e.g. a finance provider's approach to lending to fund improved environmental practices) (Barr and Cary 2000: 18). Making a change applies equally as strongly to industry and catchment managers as it does to individual growers. As outlined earlier there are numerous factors influencing change, some of which the grower, catchment manager or industry have control over, while others are external and beyond influence. A grower's propensity for change and the perceived need for change is an important factor, which may strongly influence the outcome of a change to more environmentally sustainable management practices.

Reaffirming the decision

Once a grower has taken on a new style of farm management, continued commitment will be guaranteed if the new techniques meet the farmer's expectations. If the new methods exceed expectations, as was the case with much early laser grading, then the rate of adoption will accelerate (Ewers 1988). Peer expectation of continued commitment or personal support and encouragement will reinforce commitment (Barr and Cary 2000: 18).

B.6.4. Barriers to Change

It is important to recognise that change is a difficult process to initiate and manage. The decision-making process is open to influence from internal and external factors, with most being categorised as either real or perceived. Barriers which may have relevance to any change to good environmental management practices include:

- Economic factors (e.g. cost of change, current profitability, access to finance, likelihood of an increase in profitability) (Barr and Cary 2000);
- Farm Scale (e.g. conservation practices requiring expensive machinery and equipment may be precluded on smaller scale properties) (Cary and Wilkinson 1998);
- Lack of access to relevant training (Kelly and McCracken 1999);
- Lack of technical knowledge or perception of technology (Guerin and Guerin 1994: 549) ;
- Adoption life cycle stage (e.g. late majority and laggards make up approximately 40% to 50% of any population) (Kelly and McCracken 1999);
- Community pressure and social norms (Ajzen and Fishbein 1980);
- Psychological constraints (e.g. there may be predisposing aspects of personality as a key factor in resistance to adoption) (Ajzen and Fishbein 1980) (Guerin and Guerin 1994) (Itharat 1980) (Lobel 1987) ;
- Dis-adoption - Previous experience with conservation practices (e.g. for every two farmers in northeast Victoria who adopted conservation tillage practices, there was one farmer who abandoned it) (Cary *et al* 1989);
- Perceived risk of changing practices relative to economic outcomes (benefits) (If a person or group of people do not understand the nature of the risk involved with a new venture they may be considering, it is more likely that they will be resistant to change) (Jedlicka 1979);
- Grower beliefs (if a farmers beliefs are challenged by a new environmental practice the likelihood of adoption declines) (Rogers 1983);
- Access to, and quality of extension (e.g. personal contact versus the use of other communication tools);

- Literacy and language skills (e.g. The inability of farmers in horticultural areas near Sydney to read chemical labels has led to concerns over the level of chemical being applied to crops) (Kelly and McCracken 1999);
- Perceived lack of relevance or applicability (Frank and Chamala 1992);
- Time required to learn about new practices (Mortiss 1988);
- Grower isolation from field days and on-site demonstrations (e.g. Birchip Cropping Group) (Guerin and Guerin 1994) (Kelly and McCracken 1999);
- Age of grower (Guerin and Guerin 1994) ;
- Level of education (Kelly and McCracken1999); and,
- Absence of leaders/innovators (Kelly and McCracken 1999).

B.7. Conclusion

Overcoming barriers to good environmental management is critical in improving the sustainability of Australian horticulture. Economic considerations are the major barrier to the adoption of new practices, however, environmental and economic objectives need not be mutually exclusive. The key to good environmental management is to integrate a systems approach into a whole farm-planning scheme. In this way both environmental and economic objectives can be identified and progressed.

From this literature review it is evident that a great deal of information is available. However access to this information was often problematic due to the wide range of organisations within Australia conducting research on environmental best practice. There is minimal cross-sector integration of research, which means that our investigation will provide a good opportunity for integrated research to occur so that information can be disseminated to growers around Australia in various industries. Both the domestic and international literature is highly specialised and is not readily applied to other industries or other regions. Identifying generic principles of good environmental management, particularly in the international literature, was also difficult due to language barriers and access problems.

'Knowledge Gaps', or areas where further research is required, were constantly being identified by the project team during the course of this literature review. As this project proceeds, further gaps will be identified. As the literature continues to be assessed and further international research is accessed, a more thorough understanding of these gaps will emerge. The final report will include a detailed assessment of these knowledge gaps.

Most of the research into good environmental management, identified in this literature review, was quite specific. However, in Australia, there is a movement towards more general guidelines. The challenge remains as how to best manage the change to better environmental practices and overcome the barriers in this process. The use of a systems-based approach to identify barriers and develop strategies to overcome these has identified in this report as both a comprehensive and adaptable method for the horticultural sector. This approach will form the basis for the following phases of this project.

Appendix C: Project Results

C.1. Overview

The purpose of the Best Practice Study was to assist the Australian horticultural sector to understand the:

- Elements of GEM;
- Process by which the horticulture sector adopts new practices;
- Tools to assist this change; and
- Drivers that encourage adoption.

These areas are complex and highly interrelated. The national industry consultation used workshops, discussion forums and the survey to gather qualitative and quantitative data on each of these areas. This was done by exploring key issues in change management in the horticultural sector including:

- Environmental issues;
- Reasons why projects succeed and fail to increase on-farm adoption of environmental measures;
- Influences on change;
- Incentives and pressures to change;
- Environmental measures which the industry is willing to keep, change and try;
- Drivers for adoption; and
- Barriers to adoption.

The following appendix reports the quantitative data gathered during the national industry consultation on each of these areas. Qualitative information from workshop discussion, specific to each of the topic areas is also reported where appropriate.

C.2. Environmental Issues

During the national industry consultation, data was collected on the main environmental issues facing the horticulture sector. While this information was outside the scope of the Best Practice Study, this topic was used in the survey, workshops and discussion forums to focus participants on the area of GEM practices.

Survey respondents were asked to rank the three most important environmental issues facing the horticulture sector in their region. As Figure C.1 indicates, water featured strongly with four of the top five issues being water efficiency, water quality, run-off water and drainage and salinity. This was also reflected at the workshops (Table C.2) with the three most frequently raised environmental issues being: water access, water quality and run-off and drainage. Water also dominated responses in the 'other issues' category of the survey, comprised of respondents offering alternative issues to those provided in the survey. Issues such as environmental flows, water access and groundwater management were raised. Salinity, groundwater, water use efficiency and environmental flow issues were also prominent in workshop discussions.

This result is likely to be a function of a number of factors including:

- The majority of horticulture in Australia is irrigated;
- The predominantly dry conditions being experienced in many horticultural zones during the period of consultation;
- Water usage is being increasingly regulated under changes being introduced into most states as part of the COAG Water Reform Agreement; and
- Recently, many environmental programs by state agriculture departments have been directed at on-farm water management (for example, 'Waterwise on the Farm' was mentioned in both New South Wales and Queensland meetings).

Feedback on environmental issues from the survey were sorted into responses from growers and stakeholders, in order to identify any differences in the priorities of these groups (Table C.1). Figure C.2 shows that both groups have rated water issues as important. However, in general the environmental issues regarded as important by growers have tended to focus on those issues with highly visible effects and which impact significantly upon their operations (water quality, salinity, run-off water and drainage). Stakeholders also rated these issues highly, however, they tended to focus more on technical aspects rather than on-farm physical impacts. This trend is indicative of growers focussing on tangible aspects of environmental problems with industry professionals, in line with their expertise and training, focussing on more technical elements. For example, soil structure decline was strongly recognised as an environmental problem by stakeholders but growers did not prioritise this issue as highly. Growers were also more likely to nominate issues directly relating to production such as managing feral pests, weed management, chemical container disposal and fertiliser application, than were stakeholders.

The regional workshops highlighted that water issues, chemical use, biodiversity and soil erosion (shown in red in Table C.2) were of concern across Australia and should be regarded as high priority for Horticulture Australia. However, other environmental issues raised demonstrated that these concerns are often regional or commodity based. For example urban encroachment often dominated discussion at meetings held on the outskirts of major cities (Windsor, Nambour, and Perth), GMOs were topical in Tasmania due to state government policies and waste disposal was of higher concern in rural production zones. While this trend may be related to awareness raised by existing environmental programs, it highlights the importance of local knowledge and information in the development of environmental programs.

Figure C.1: Most important environmental issues (survey respondents)

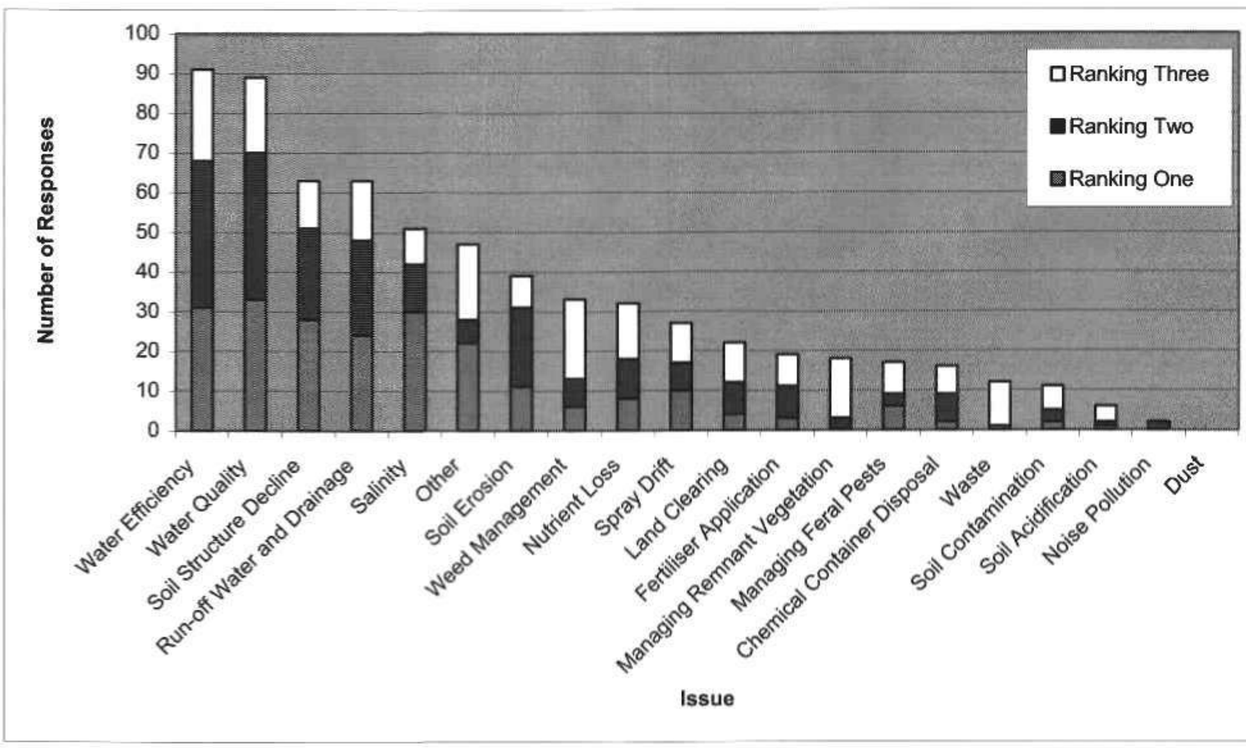


Table C.1: Most important environmental issues (survey respondents)

	Number 1 issue			Number 2 issue			Number 3 issue			
Issue	Growers	Stakeholders	Total	Growers	Stakeholders	Total	Growers	Stakeholders	Total	**Total**
Salinity	16	14	30	5	7	12	3	6	9	**51**
Soil structure decline	6	22	28	8	15	23	6	6	12	**63**
Soil acidification	1	0	1	0	1	1	1	3	4	**6**
Soil erosion	4	7	11	4	16	20	3	5	8	**39**
Nutrient loss	2	6	8	5	5	10	2	12	14	**32**
Fertiliser application	2	1	3	3	5	8	2	6	8	**19**
Spray drift	3	7	10	6	1	7	3	7	10	**27**
Water quality	17	16	33	18	19	37	14	5	19	**89**
Water efficiency	7	24	31	12	25	37	13	10	23	**91**
Run-off water and drainage	13	11	24	12	12	24	3	12	15	**63**
Land clearing	0	4	4	1	7	8	4	6	10	**22**
Managing remnant vegetation	0	0	0	1	2	3	3	12	15	**18**
Dust	0	0	0	2	0	2	0	0	0	**2**
Noise pollution	0	0	0	0	0	0	0	0	0	**0**
Chemical container disposal	2	0	2	4	3	7	5	2	7	**16**
Waste	1	0	1	1	2	3	4	7	11	**15**
Soil contamination	2	0	2	0	0	0	1	5	6	**8**
Weed management	5	1	6	4	3	7	11	9	20	**33**
Managing feral pests	5	1	6	1	2	3	3	5	8	**17**
Other	8	14	22	5	1	6	11	8	19	**47**
Total	**94**	**128**	**222**	**92**	**126**	**218**	**92**	**126**	**218**	

Figure C.2: Number one environmental issue (by respondent)

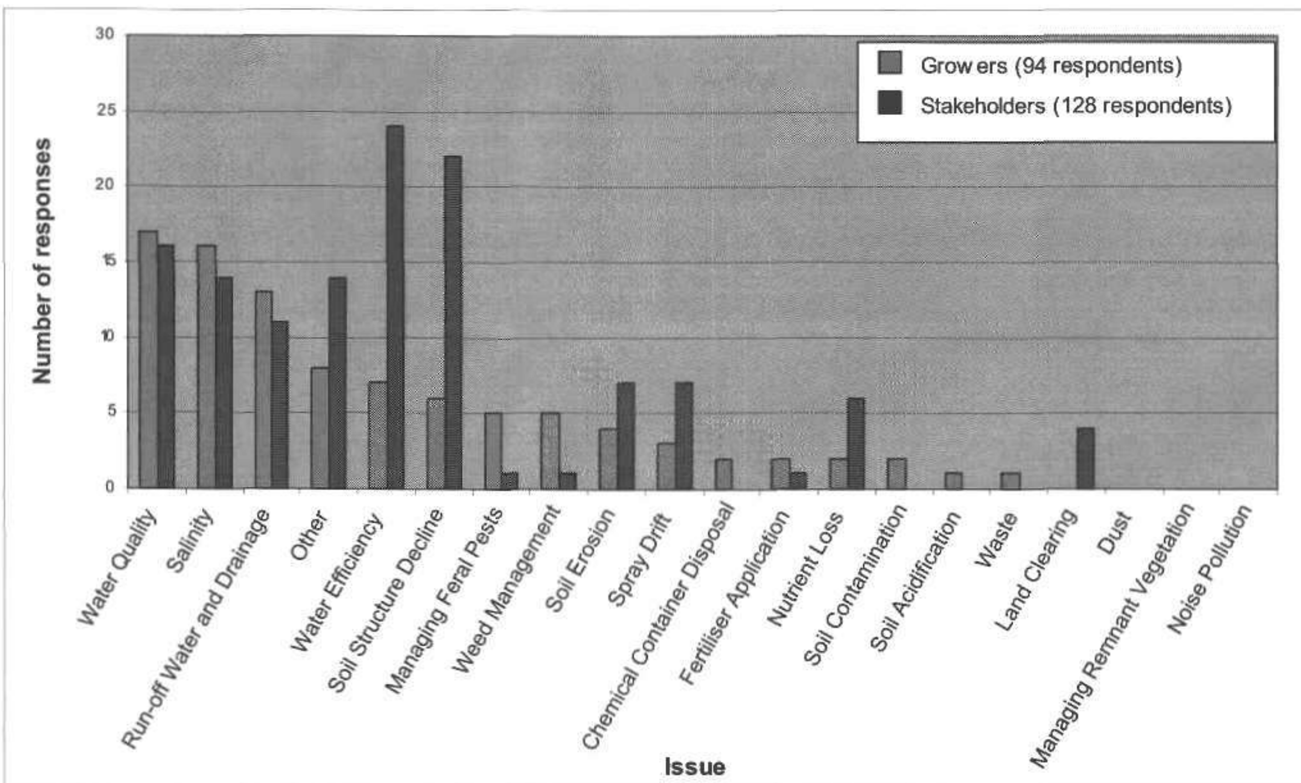


Table C.2: Environmental issues across Australia[1]

Regional Workshops	Water access	Water Quality	Run-off and drainage	Chemical Use	Biodiversity	Soil Erosion	Salinity	"Right to farm"	Urban Encroachment	Watertable or groundwater	Other Soil Issues	Other	Soil Fertility	Water use efficiency	Food safety	Odour	Soil Organic Matter	Spray Drift	Climate Change	Environmental flows	Land clearing	Noise	Soil borne diseases	Soil Structure	Waste	Weeds	Soil Acidification	Declining Rural Populations	Dust	GMOs	Pests and Diseases
Nambour Growers (QLD)	High	High	High	High	High	High	Low	Medium	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Windsor Stakeholders (NSW)	High	High	High	High	High	Low	High	Medium	Medium	Low	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Griffith Growers (NSW)	High	High	High	High	High	Low	Low	Medium	Medium	Medium	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Devonport Growers (TAS)	Low	High	High	High	High	High	High	Medium	Low	Low	Medium	Low	Low	Low	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Shepparton Combined (VIC)	High	High	High	High	Low	Low	High	Low	Low	Medium	Low	Medium	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Bundaberg Growers (QLD)	High	High	High	Low	High	High	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Nambour Stakeholders (QLD)	High	High	Low	High	High	High	Low	Low	Medium	Low	Low	Medium	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
South Johnstone Combined (QLD)	High	High	Low	High	Low	High	Low	Low	Low	Low	Medium	Low	Medium	Low	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Windsor Growers (NSW)	High	High	Low	High	Low	High	High	Medium	Low	Low	Medium	Medium	Low	Low	Low	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Griffith Stakeholders (NSW)	High	Low	High	Low	High	Low	High	Low	Low	Medium	Medium	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Darwin Combined (NT)	Low	Low	High	High	High	Low	High	Low	Low	Medium	Low	Low	Low	Medium	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Kununurra Combined (WA)	High	High	Low	Low	Low	Low	High	Low	Low	Medium	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Hobart Stakeholders (TAS)	High	Low	High	Low	Low	High	Low	Low	Medium	Low	Low	Low	Medium	Medium	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Launceston Stakeholders (TAS)	High	High	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Perth Stakeholders (WA)	High	Low	High	Low	Low	High	Low	Medium	Medium	Medium	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

High Priority

Medium Priority

Low Priority

[1] Note: Regional workshops were separated into stakeholder and grower meetings. In some circumstances meetings were comprised of combined participants.

C.3. Reasons why projects succeed and fail to increase the on-farm adoption of environmental measures.

C.3.1. Reasons why projects succeed in increasing on-farm adoption

Examining the reasons why projects are successful in increasing the adoption of GEM practices identifies the elements that achieve behaviour change. Financial gains dominated responses (Figure C.3) indicating that financial incentives may be a prerequisite for projects gaining widespread adoption. Both direct and indirect financial gains were nominated by the respondents including: cost-savings, tax incentives, subsidies and cost rebates.

The survey datum also strongly emphasised the need for projects to demonstrate other benefits that may stem from the adoption of environmental measures. The demonstration of visible and tangible benefits was the second most nominated reason why projects succeed. The related responses of technical assistance and support and better farm management also support this result. This outcome from the survey supports discussion during the regional meetings that emphasised the need for the use of awareness tools in extension, such as field days, technical videos and demonstration sites.

The survey results (Figure C.4) also indicate that growers are responsive to projects which draw on community spirit as a reason for adopting GEM practices. Sustainability, citizenship and the generation of ownership all rated strongly as reasons why environmental projects succeed. These issues demonstrate the willingness of farmers to undertake projects for conservation reasons. These results indicate that environmental projects may be more successful where the demonstration of financial and farm planning benefits is combined with environmental citizenship. Growers who nominated sustainability as a reason for project success tended to emphasise long-term resource productivity and generational farming concerns in their responses. This focus was also reflected at meetings with both growers and stakeholders expressing concern for the long-term viability of current production systems and the desire to ensure resource productivity to allow generational continuity of farming operations.

C.3.2. Reasons why projects fail to increase on-farm adoption

Both growers and stakeholders identified the main reason that projects fail is the cost of implementing GEM practices (Figure C.4). This result underscores the importance of financial drivers in motivating change and suggests that without this single element, projects are likely to fail. As such, the use of cost-benefit analysis may be regarded as an essential component of environmental extension.

Both groups nominated apathy and change resistance as the second major reasons why projects fail. This result emphasises the need to understand the change management characteristics of growers and utilise drivers to motivate change. Complexity and lack of support and infrastructure also feature highly in the responses of growers. These factors suggest that a high degree of technical and demonstrative assistance is required to overcome apathy and facilitate behavioural change among growers.

The number of growers nominating complexity, as a reason was significantly more than the stakeholder responses (Figure C.4). Both groups also nominated a lack understanding of growers as a major reason for project failure. These results indicate that there may be a low level of understanding of the change management needs of growers among those delivering environmental programs.

Figure C.3: Reasons why projects succeed in increasing on-farm adoption of GEM practices

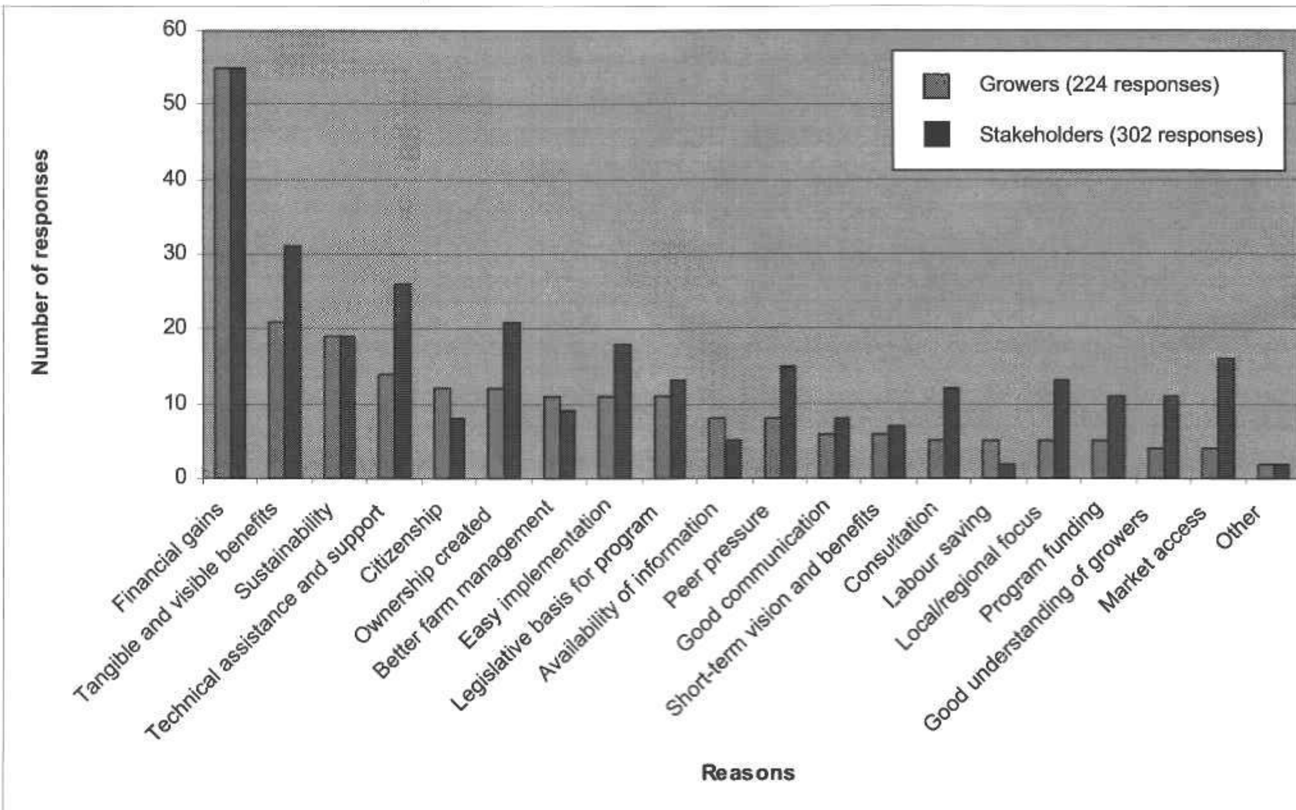
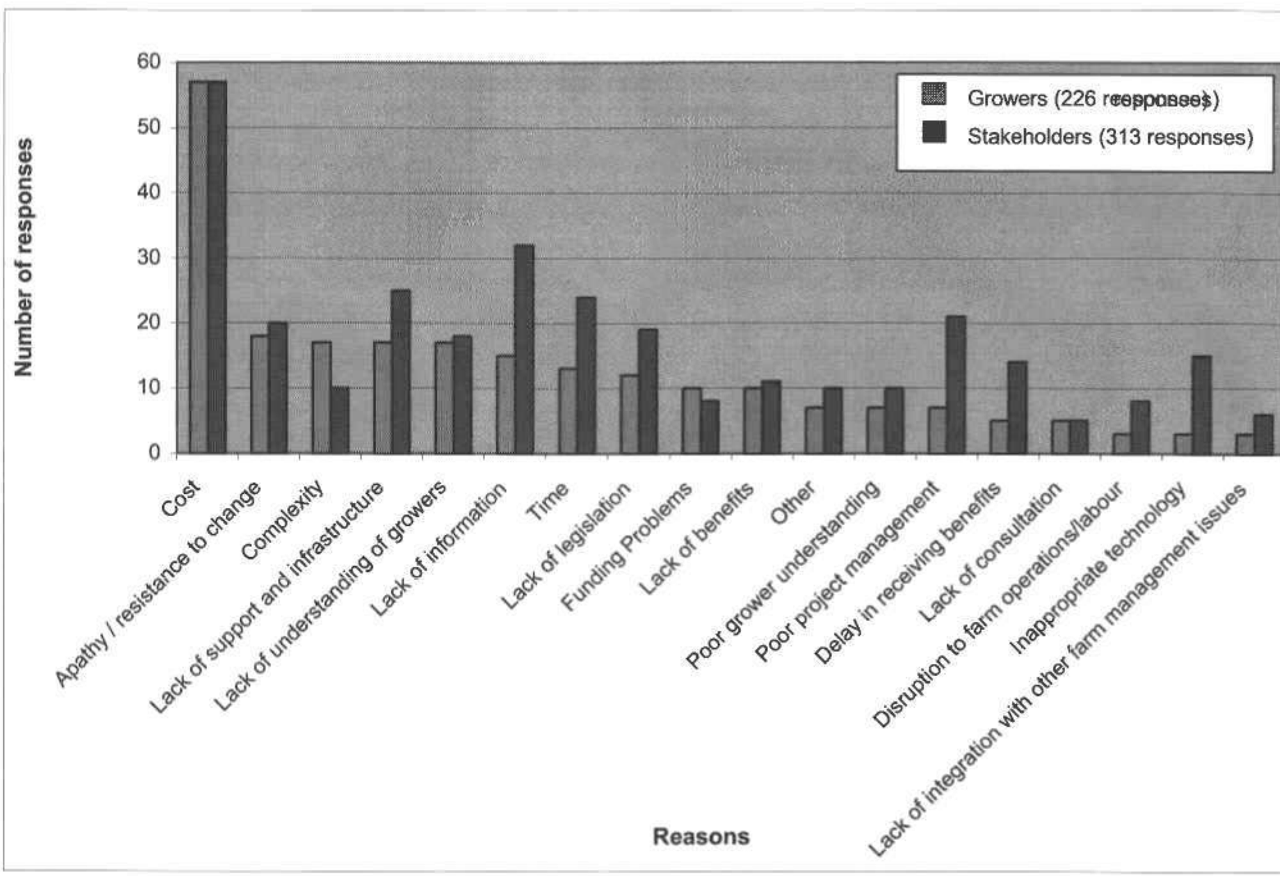


Figure C.4: Reasons why projects fail to increase on-farm adoption of GEM practices



C.4. Influences on change

The national industry sought to identify those organisations or factors that are most likely to exert influence the decisions of growers. Overall, legislation received the most number of responses consistent with the findings of the regional workshops and other survey results (Figure C.5 and Table C.3). Supermarkets, wholesalers and consumers were found to be the second strongest influence. The level of influence of supermarkets and wholesalers is due to their role in controlling market access in Australia.

Responses of growers and stakeholders varied markedly in terms of the influence of other organisations. Figure C.6 indicates that IDOs have a greater influence on growers than is recognised by stakeholders. Conversely, industry associations are not as influential as stakeholders believe. This result suggests that those delivering horticultural projects may not be adequately utilising the influence of IDOs to increase adoption. In addition, IDOs may require further training on GEM practices to enable their influence on growers to be utilised more effectively.

Figure C.5: Influences on change

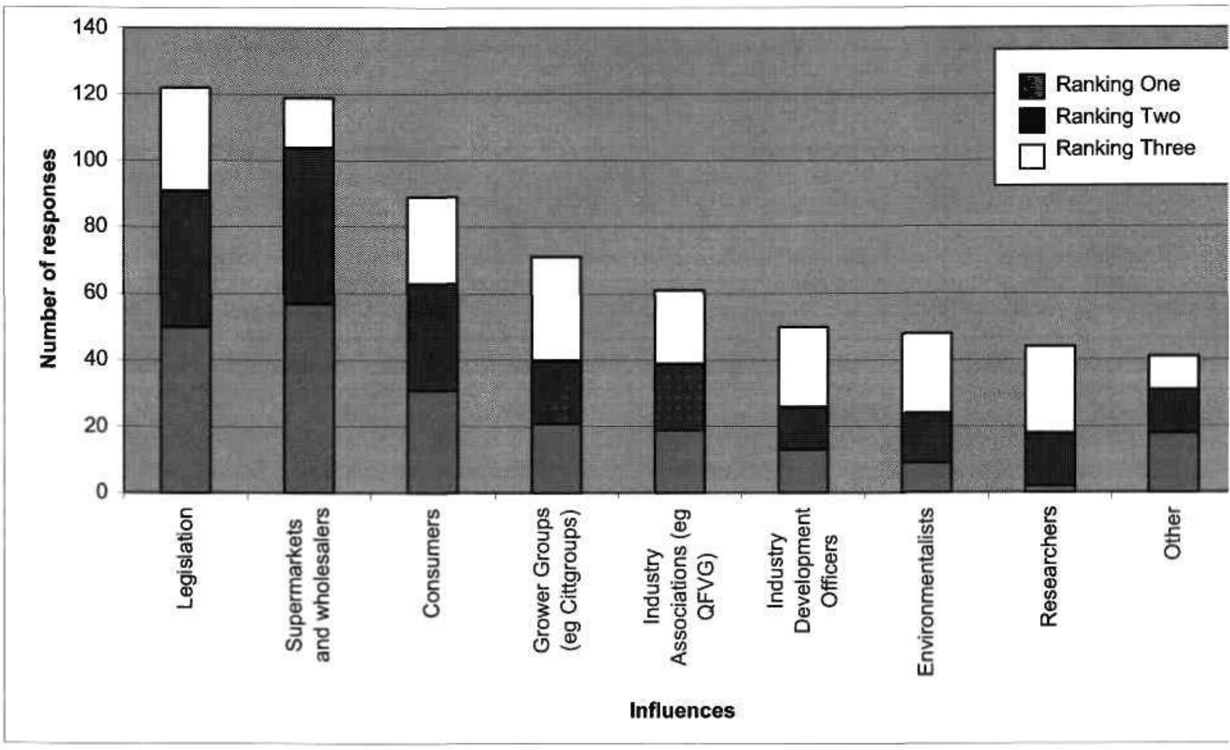
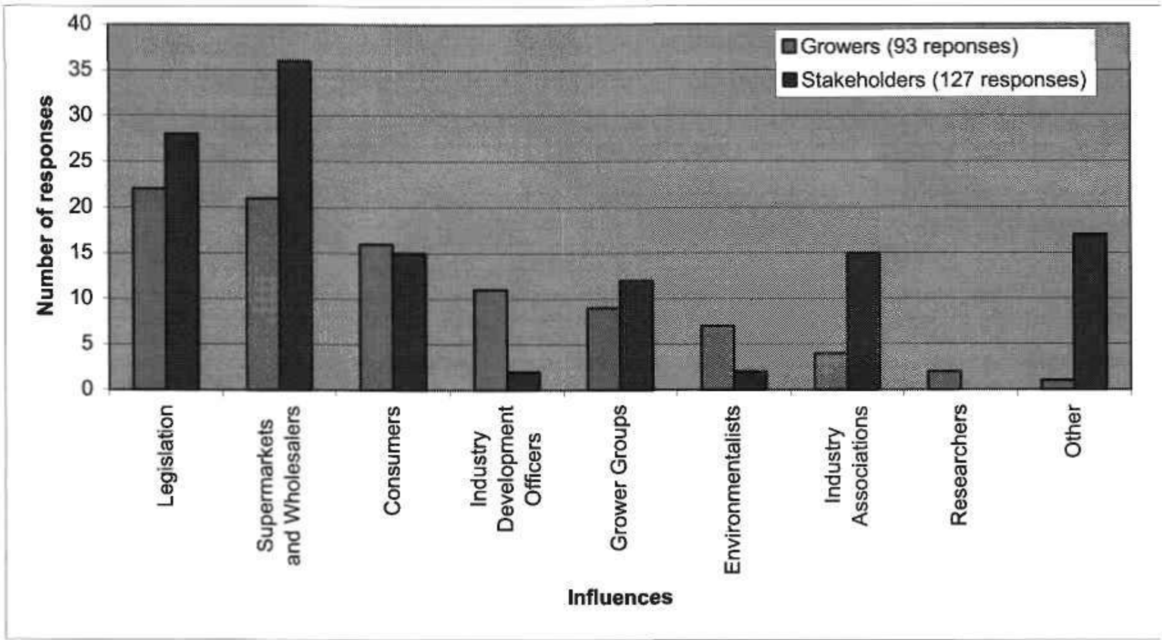


Table C.3: Influences on change by rank

	Number 1 influence			Number 2 influence			Number 3 influence			Total
Influence	**Growers**	**Stakeholders**	**Total**	**Growers**	**Stakeholders**	**Total**	**Growers**	**Stakeholders**	**Total**	
Industry Development Officers	11	2	13	4	9	13	11	13	24	**50**
Legislation	22	28	50	15	26	41	11	20	31	**122**
Environmentalists	7	2	9	7	8	15	11	13	24	**48**
Industry Associations	4	15	19	12	8	20	8	14	22	**61**
Supermarkets and Wholesalers	21	36	57	18	29	47	7	8	15	**119**
Consumers	16	15	31	13	19	32	8	18	26	**89**
Researchers	2	0	2	8	8	16	17	9	26	**44**
Grower Groups	9	12	21	10	9	19	10	21	31	**71**
Other	1	17	18	5	8	13	3	7	10	**41**
Total	**93**	**127**	**220**	**92**	**124**	**216**	**86**	**123**	**209**	

Figure C.6: Number one influence on change (by respondent)



C.5. Incentives and pressures to change

Through the "Carrots and Sticks" tasks at regional workshops the incentives and pressures for change were assessed (Table C.4 and Table C.5). Incentives for change are those factors that encourage voluntary change by offering rewards for adoption. Pressures are those motivations for change that stem from penalties for non-compliance. These motivations may be actual or perceived but result in higher level of adoption.

Financial incentives, cost-savings and increased market access were the three incentives that were raised at most workshops. This mirrors the survey result that financial gains were the major reason why projects succeed (Figure C.3). Information and support again featured strongly as did incentives centred on community spirit.

The pressure for change raised at the workshops (Table C.5) reflected aspects of the results to both the reasons for project failure and the influences on change. Legislation was the pressure most often raised at the regional workshops in accordance with the responses to the major influences on change. Decreased market access and consumer pressure were also frequently raised, mirroring the strong level of influence of supermarkets, wholesalers and consumers discussed in section C.4. Domestic and export market QA systems were also raised at a number of meetings as a strong pressure to change. This is related to market access and is also indicative of the level of influence of supermarkets and wholesalers.

Community pressure was the third most frequently raised factor to change. At the majority of regional meetings, community perceptions of horticulture were raised in the context of at least one of the workshop tasks. The industry seems to perceive a growing negative environmental sentiment against horticultural production in Australia. This appears to be particularly the case in areas of urban encroachment upon horticultural production zones. This pressure may the reason that citizenship was nominated as a major reason for project success in section C.3.1

Table C.4: Incentives for change[2]

	Incentives for change																						
	HIGH								MEDIUM									LOW					
Regional workshops	Financial incentives	Cost-savings	Increased market access	Long-term resource sustainability	Recognition	Community pressure	Lifestyle benefits	Support and information	Personal pride	Consumer pays principle	Demonstrated success	Education	OH&S concerns	Peer pressure	Competition	Product quality	Simplicity	Debt as a driver of innovation	Environmental catastrophe	Ease of compliance	Generational change	Innovation incentives	Self-regulation
Darwin Combined (NT)	High	High	High	High	Low	Low	Low	High	Low	Low	Low	Medium	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Bundaberg Growers (QLD)	High	Low	High	High	High	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Nambour Growers (QLD)	High	High	High	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Windsor Growers (NSW)	High	High	High	High	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Griffith Growers (NSW)	High	High	Low	High	Low	Low	High	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Launceston Stakeholders (TAS)	High	Low	Low	High	High	High	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Windsor Stakeholders (NSW)	High	High	Low	Low	High	High	Low	High	Low	Medium	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Devonport Growers (TAS)	High	Low	Low	Low	High	Low	High	High	Medium	Low	Low	Medium	Low	Medium	Low	Low	Medium	Low	Low	Low	Low	Low	Low
Shepparton Combined (VIC)	High	Low	High	Low	Low	Low	High	Low	Low	Medium	Medium	Low	Medium	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low
Griffith Stakeholders (NSW)	High	High	Low	Low	Low	Low	High	Low	Low	Low	Low	Low	Low	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low	Low
Nambour Stakeholders (QLD)	High	High	Low	Low	Low	Low	Low	High	Low	Low	Medium	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low
Perth Stakeholders (WA)	Low	Low	Low	Low	Low	High	High	High	Medium	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
South Johnstone (QLD)	Low	Low	High	Low	High	High	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Hobart Stakeholders (TAS)	High	Low	Low	Low	High	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low

High Priority

Medium Priority

Low Priority

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[2] This task was not undertaken at the Kununurra combined workshop due to time constraints

Table C.5: Pressures to change[3]

Regional workshops	HIGH: Legislation	HIGH: Decreased market access	HIGH: Community pressure	HIGH: QA (domestic and / or export)	HIGH: Consumer pressure	MEDIUM: Financial penalties (taxes / rates)	MEDIUM: Traceability	MEDIUM: Environmental catastrophe	MEDIUM: Farmer conscious	MEDIUM: Lifestyle impacts	MEDIUM: Litigation	MEDIUM: Long-term resource sustainability	LOW: Climate change	LOW: Economic viability of current practices	LOW: Increased cost of natural resources	LOW: Labour demand and availability	LOW: Peer pressure	LOW: Urban encroachment
Nambour Stakeholders (QLD)	High	High	High	High	High													
Windsor Stakeholders (NSW)	High	High	High		High	Medium	Medium											
Hobart Stakeholders (TAS)	High	High		High	High													
Bundaberg Growers (QLD)	High	High		High	High													
Shepparton Combined (VIC)	High	High		High	High							Medium						
South Johnstone (QLD)	High	High	High			Medium												
Devonport Growers (TAS)	High	High	High			Medium				Medium								
Launceston Stakeholders (TAS)	High	High	High					Medium	Medium									
Windsor Growers (NSW)	High	High					Medium											
Griffith Stakeholders (NSW)	High	High									Medium							
Darwin Combined (NT)	High			High		Medium		Medium			Medium	Medium						
Griffith Growers (NSW)	High			High														
Nambour Growers (QLD)		High	High							Medium								
Perth Stakeholders (WA)	High	High					Medium		Medium									

High Priority

Medium Priority

Low Priority

3 This task was not undertaken at the Kununurra combined workshop due to time constraints

C.6. Environmental measures the industry is willing to keep, change and try

At the regional workshops the project team sought to examine the specific practices that the industry was willing to keep, change or try. This was undertaken to examine the characteristics of practices that are either readily adopted or to which there is resistance.

C.6.1. Priorities to keep

Table C.6 identifies those GEM practices which were nominated at the workshops as those which are currently working well or are in need of only minor reform.

The highest priority environmental measure to keep was a range of chemical disposal and certification programs i.e. *ChemCollect*, *ChemCert* and *Drum Muster*. This result is consistent with Stage 1 of this study (Sinclair Knight Merz 2001), which found the disposal of chemical containers was the highest priority environmental indicator among state agencies and horticultural producers. However, while chemical use was of high concern at the regional workshops (Table C.2), chemical container disposal and waste did not rank highly among environmental issues. This contradictory result perhaps indicates a lack of clarity within the industry on this issue and the need for better defined and more consistent protocols for chemical handling and disposal across the industry.

Government funding for programs was the second most frequently discussed element of GEM practice to be kept. This result is likely to be a function of the high proportion of stakeholders present at the meetings (58%). Indeed, 5% of meeting participants were government employees and some of the other industry professionals may also receive government funding. Despite this potential skew in the results, support for government funding was also related to the provision of extension services. Concern was expressed at many meetings about the scaling down of the rural extension services available to growers. During this task, meeting participants expressed the desire to ensure these services are not further reduced.

At various stages through the regional workshops, IPM was discussed as an example of a GEM practice that had been widely adopted by growers. Indeed, IPM was also nominated as a high priority to be tried. This is likely to be due to:

- Cost-saving associated with decreased use of chemicals;
- Use of IPM as an alternative where resistance to chemicals had occurred;
- Concerns regarding chemical residues and food safety; and
- The high degree of private sector support for IPM through 'Pest Scouts' and similar initiatives.

C.6.2. Priorities to change

Table C.7 identifies those environmental practices which the meeting participants nominated as being non-functional or in need of radical modification. The primary focus of the high priorities for change was extension and communication within the industry. Improved communication between stakeholders was the highest priority nominated at the regional workshops. Better perceptions of horticulture and communication methods for extension were also of high priority. These results are indicative of issues in the delivery of environmental programs and scientific research to growers. This is consistent with the reasons why projects fail to increase adoption (Figure C.4) where complexity, lack of understanding of growers and lack of support and infrastructure were nominated as major reasons for project failure.

QA was nominated second as a priority for change. Across the regional workshops, participants were generally critical of the way in which some QA programs had been implemented. The major change recommended was that QA systems should be industry driven, as *Freshcare* has, rather than being "imposed from the top down". Meeting discussion also focussed on the need to incorporate environmental considerations into existing QA systems rather than developing separate systems. This alignment of systems reflects the desire for more effective communication between industry stakeholders.

Chemical use within the industry was also identified as an area in need of reform. This is in line with retaining chemical certification and collection programs and a high industry adoption of IPM. The prioritisation of changes to the industries chemical use practice is consistent with a lack of clarity and need for consistent chemical handling and disposal protocols across the industry (section C.6.1).

C.6.3. Priorities to try

Table C.8 identifies those environmental practices that the meeting participants would be willing to try. EMS were nominated at the most meetings as a high priority to be tried within the industry. This may be due to a high degree of public discussion surrounding the development and adoption of EMS in horticulture. The use of EMSs as decision-making frameworks for agriculture has been topical recently in Australia. Initiatives, such as the development of a 'National Framework for the Development of Environmental Management Systems in Agriculture' by AFFA, have led to a heightened awareness of EMS among rural producers. The interest expressed regarding EMS at the workshops is likely to have stemmed from this increase in awareness.

Risk assessment and management was also among the practices in which interest was expressed. This may be related to heightened awareness of decision-making frameworks such as EMS. Risk assessment and management is an important component of QA systems and increasing industry emphasis upon the traceability of produce may explain this result.

Financial considerations also featured strongly in those measures meeting participants would like to see tried. Financial incentives for conservation and increased market access through environmentally friendly production methods were also prioritised. These results are consistent with the strong emphasis placed on economic and market drivers for change throughout the national industry consultation.

IPM was nominated as a high priority to be tried within the industry in line with the high level of interest in chemical use in horticulture. In this context workshop participants focussed on improving elements of IPM and the general approaches taken. For example, at a number of meetings interest was expressed in trialling catchment or regional approaches to IPM to ensure consistent efforts to reduce pest number and raise predator numbers. In regions or industries where the adoption of IPM was not strong, interest was expressed in adoption.

Table C.6: Priorities to keep

	Priorities to keep: HIGH					MEDIUM						LOW								
Regional workshops	ChemCert, ChemCollect and / or Drum Muster	Government funding for programs	IPM	Knowledge of traditional farming systems	Water use efficiency	ICM	Diversity of enterprises	Processing industry	Profitable enterprises / practices	QA	Quarantine status	Basic infrastructure	Best practice principles	Clean and green image	Family farming	Local innovation	Right to farm	Soil moisture monitoring	Tools to increase soil OM	Water security
Griffith Stakeholders (NSW)	High	High																		
Windsor Growers (NSW)	High	High																		
Nambour Growers (QLD)		High	High	High																
Darwin Combined (NT)		High	High																	
South Johnstone (QLD)	High		High							Medium										
Griffith Growers (NSW)	High			High																
Windsor Stakeholders (NSW)	High				High		Medium													
Nambour Stakeholders (NSW)	High			High		Medium														
Shepparton Combined (VIC)			High		High	Medium														
Bundaberg Growers (QLD)			High		High	Medium														
Launceston Stakeholders (TAS)		High					Medium		Medium		Medium									
Perth Stakeholders (WA)				High				Medium		Medium										
Hobart Stakeholders (TAS)					High															
Devonport Growers (TAS)								Medium	Medium											
Kununurra Combined (WA)											Medium									

High Priority

Medium Priority

Low Priority

Table C.7: Priorities to change

	Priorities to change: HIGH								MEDIUM				LOW										
Regional workshops	Improved communication b/w stakeholders	QA	Better perceptions of horticulture	Acceptance of EMS	Chemical use	Communication methods for extension	Soil management practices	Water access	Increased adoption of high-tech irrigation	More customer focus	Performance assessment methods	Rate of adoption of EBP	Chemical management practices	Grower profitability	ICM	Incentives for conservation measures	Increased adoption of IPM	Increased farmer pride	Increased local research	Increased sustainability	Increasing age of farmers	Poor water management practices	Waste disposal
Nambour Growers (QLD)	High	High	High									Medium											
Hobart Stakeholders (TAS)	High	High			High	High																	
Windsor Growers (NSW)	High	High																					
Bundaberg Growers (QLD)	High		High			High		High															
Perth Stakeholders (WA)	High		High			High																	
Darwin Combined (NT)		High		High			High																
Griffith Growers (NSW)		High						High	Medium	Medium													
Nambour Stakeholders (QLD)	High			High							Medium												
Launceston Stakeholders (TAS)	High						High			Medium													
Windsor Stakeholders (NSW)					High			High			Medium												
Griffith Stakeholders (NSW)							High		Medium			Medium											
Shepparton Combined (VIC)			High																				
Devonport Growers (TAS)				High																			
Kununurra Combined (WA)	High																						
South Johnstone (QLD)					High																		

High Priority

Medium Priority

Low Priority

Table C.8: Priorities to try

	Priorities to try																					
	HIGH						MEDIUM						LOW									
Regional workshops	EMS	Conservation incentives	Greater govt - grower communication	IPM	Market access	Risk assessment and management	Consumer perceptions	Decreased chemical use	Extension delivery and availability	New production techniques / varieties	New research structures	Systems approach to soil health	Accreditation for irrigation designers	Better management of water resources	Codes of practice	Cost-benefit analyses	Companion planting	Increased sustainability	Partial root zone drying	Redefined paddock boundaries	Refund system for chemical containers	Run-off control regulations
Windsor Stakeholders (NSW)	High	High	High		High																	
Shepparton Combined (VIC)	High	High										Medium										
Launceston Stakeholders (TAS)	High				High	High																
Perth Stakeholders (WA)		High	High						Medium													
South Johnstone (QLD)	High			High				Medium				Medium										
Kununurra Combined (WA)	High			High							Medium											
Nambour Growers (QLD)		High			High		Medium															
Hobart Stakeholders (TAS)				High		High			Medium													
Griffith Stakeholders (NSW)					High	High																
Bundaberg Growers (QLD)		High		High																		
Nambour Stakeholders (QLD))	High										Medium											
Windsor Growers (NSW)			High				Medium															
Griffith Growers (NSW)			High							Medium												
Darwin Combined (NT)								Medium														
Devonport Growers (TAS)										Medium												

High Priority

Medium Priority

Low Priority

C.7. Drivers for adoption

An understanding of the factors that actively lead to the on-farm adoption of new practices and technology is fundamental to encouraging this process. Consistent with the results outlined above financial drivers dominated (Figure C.7). Seventy percent of respondents nominated financial considerations as the leading driver for change. In the context of drivers, economic sustainability in Figure C.7 refers to the long-term viability of resources and thus has been considered a financial driver. Analysis of the number one driver (Figure C.8) indicates that both growers and stakeholders both recognise the importance of financial drivers. This result stipulates that the presence of financial driver may be a prerequisite for the voluntary adoption of environmental measures.

Environmental considerations and citizenship again featured among the results for this section. Combined, environmental conservation, environmental programs and citizenship represented 20% of the total responses to this survey question. However, the general absence of these among the number one responses indicates that these factors are of secondary concern. This indicates that these drivers may be most useful as a compliment to economic or market drivers in environmental programs.

Technological change accounted for 10% of the total responses. However, at regional workshops the historical drivers for change were examined through the development of local horticulture timelines (Table C.9). This analysis suggested that technological change has been the dominant driver for industry change over the past forty years. Technological development was the driver behind seventy-three of the major industry changes reported at the workshops. This result is likely to be a function of the rapid technological changes that have effectively revolutionised horticultural production over the previous decades. Technological innovation is also likely to be a contributing factor to the introduction of new commodities that also rated as a strong driver for change. Technological development is likely to be a strong motivator for change based on the perception that new technologies often lead to productivity or efficiency gains for growers.

The role of legislative drivers was also evident in the timelines, with both policy changes and natural resource legislation appearing as strong drivers for change. The types of policy changes reported tended to relate to activities of various departments of agriculture. Initiatives that encouraged the removal of orchard varieties (for example apple trees in Tasmania and stonefruit trees in Griffith) featured among the responses. Changes to the regulation of natural resources, in particular water allocations, were also frequently mentioned.

Market forces have also been historically strong drivers for change. The activities of processing and agribusiness companies were frequently referred to as an explanation for changing horticultural production patterns. The activities of supermarkets rated as only a moderate historical driver for change. This is likely to be due to the relatively recent growth in their influence (mid to late 1980s).

Events in other agricultural industries were reported as having a strong influence on horticultural production. For example, in Devonport, cattle prices were closely linked to the level of horticultural production, events in the sugar cane industry in Queensland and the level of rice production in Kununurra and Griffith were also reported as being of significant influence. Broader economic factors were also reported as being a strong driver for change. Interest rates, labour availability and cost and exchange rates were all reported as influencing patterns of production.

Figure C.7: Drivers for adoption (as proportion of total)

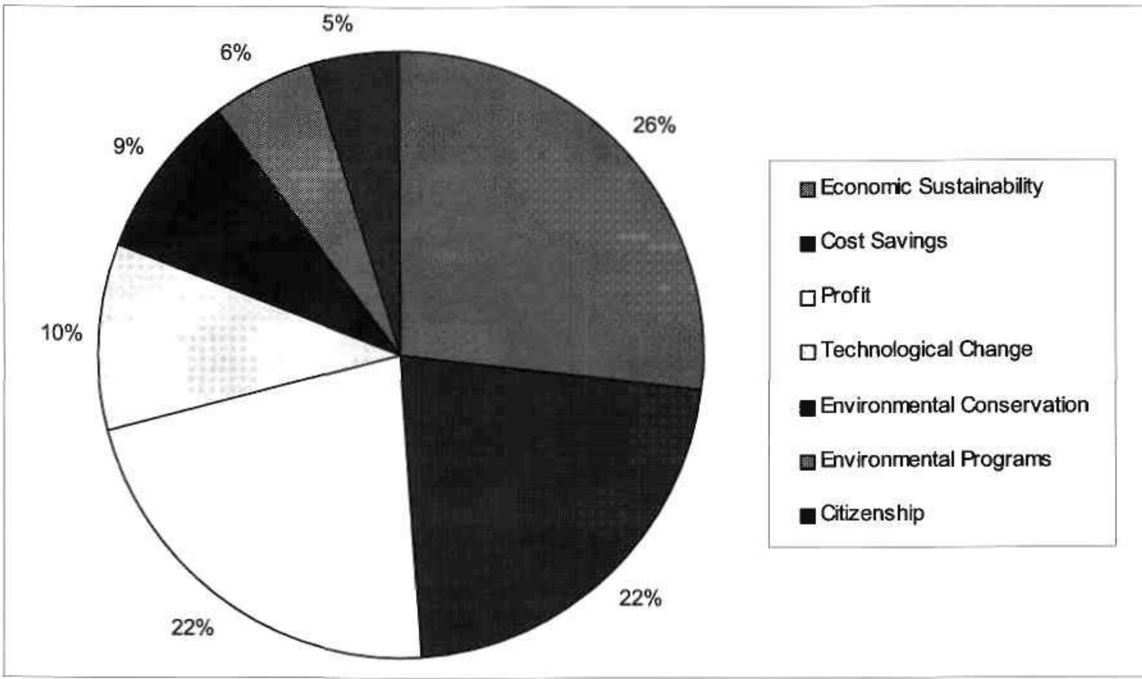


Figure C.8: Number one driver for adoption (by respondent)

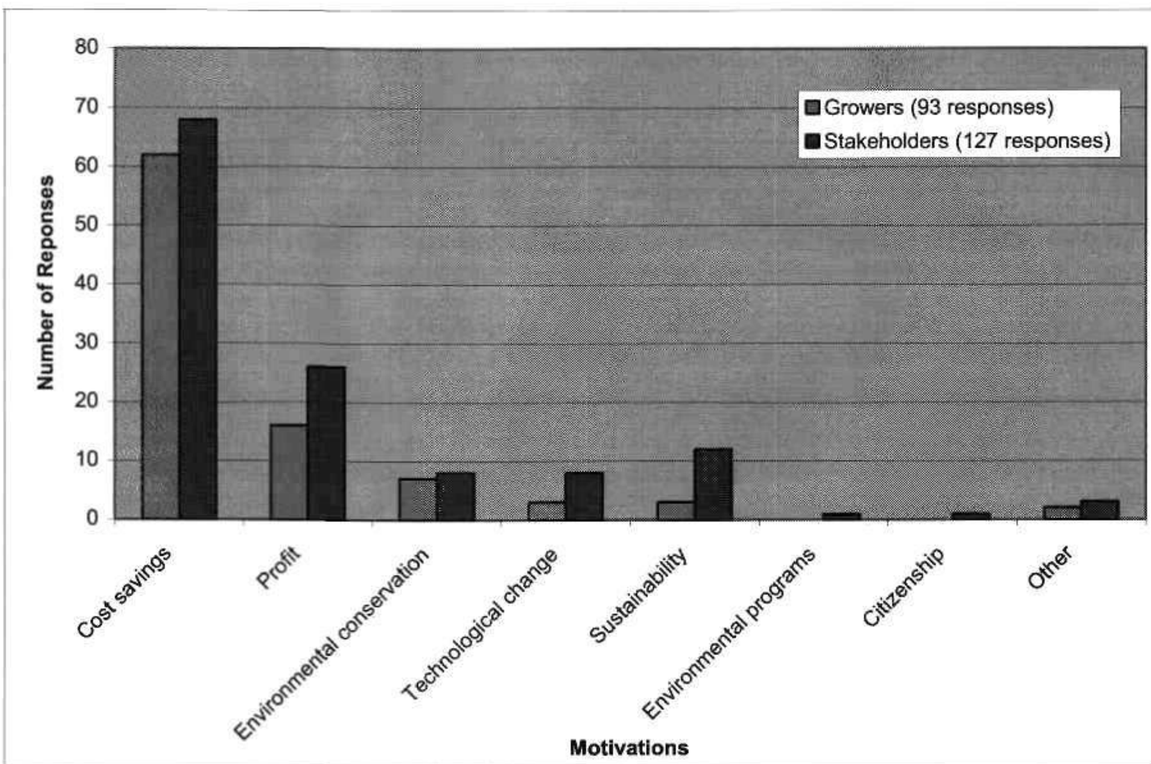


Table C.9: Historical drivers for change

Regional workshops	Change Driver: STRONG							MODERATE							WEAK						
	Technological development (73)*	Policy changes (52)	Processing company activities (48)	Events in other industries (44)	Introduction of commodities (38)	Broader economic events (34)	Legislation (natural resource) (32)	Supermarket activities (20)	Pest and disease incursions (19)	Environmental catastrophe (17)	Imports of produce (17)	Introduction of new varieties (17)	Land availability / prices (14)	Commodity price changes (13)	Infrastructure development (10)	New markets opened (10)	Geographic movement (9)	Public pressure (9)	Demographics of growers (6)	Legislation (other eg Native title) (4)	Quarantine (4)
Launceston Stakeholders (TAS)	High	High	High	High	High	High	High	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Nambour Stakeholders (QLD)	High	High	High	High	High	High	High	Medium	Low	Low	Medium	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low
Hobart Stakeholders (TAS)	High	High	High	High	High	High	Low	Medium	Medium	Low	Medium	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low
Bundaberg Growers (QLD)	High	High	High	High	High	Low	High	Medium	Low	Medium	Medium	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low
Griffith Growers (NSW)	High	High	High	High	Low	High	High	Low	Low	Medium	Medium	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low
Griffith Stakeholders (NSW)	High	High	High	High	Low	High	High	Low	Medium	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low
Shepparton Combined (VIC)	High	High	High	High	Low	High	High	Medium	Low	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low
Devonport Growers (TAS)	High	Low	High	High	High	High	High	Low	Low	Low	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Nambour Growers (QLD)	High	High	High	High	Low	High	Low	Medium	Medium	Low	Medium	Low	Low	Medium	Low	Low	Low	Low	Low	Low	Low
Perth Stakeholders (WA)	High	High	High	Low	High	High	High	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Kununurra Combined (WA)	High	High	Low	High	High	Low	High	Low	Medium	Medium	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
South Johnstone (QLD)	High	High	Low	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low	Low
Windsor Stakeholders (NSW)	High	High	Low	Low	High	Low	High	Medium	Medium	Medium	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low
Darwin Combined (NT)	Low	High	High	High	High	Low	Low	Low	Medium	Medium	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Windsor Growers (NSW)	High	Low	Low	High	Low	High	High	Medium	Low	Medium	Medium	Medium	Low	Medium	Low	Low	Low	Low	Low	Low	Low

High Priority

Medium Priority

Low Priority

*Denotes the total number events recorded on workshop industry timelines in which the change was driven by this factor.

C.8. Barriers to adoption

The barriers to adoption nominated by the survey respondents again indicate that financial considerations dominant the adoption decision-making process (Figure C.9). Cost and lack of financial benefits accounted for 43% of responses. However, Figure C.10 indicates that growers and stakeholders have different perceptions of which is the major barrier to the on-farm adoption of environmental measures. Seventy-eight percent of growers nominated cost as the major impediment to adoption. All other responses represent minor percentages.

Alternatively, 51% of stakeholders nominated cost as the major barrier to adoption. The complexity of environmental initiatives was rated highly at (16%) by stakeholders, however only (3%) by growers. This discrepancy of opinion is also shown by the overstating by stakeholders of the importance time and lack of financial benefits. This result indicates that simply stated cost-benefit analyses should be included in environmental programs seeking to encourage the voluntary adoption of GEM practices. This also supports the suggestion that a more detailed knowledge of the change management characteristics of growers would benefit those delivering environmental programs.

Figure C.9: Barriers to adoption (as proportion of total)

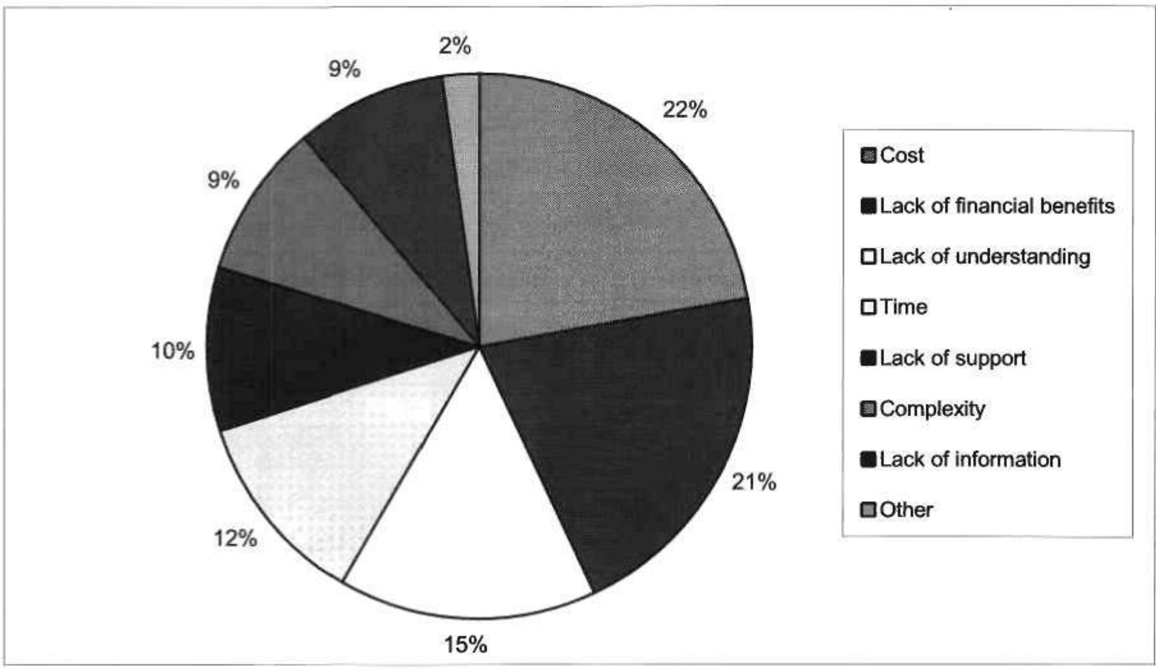
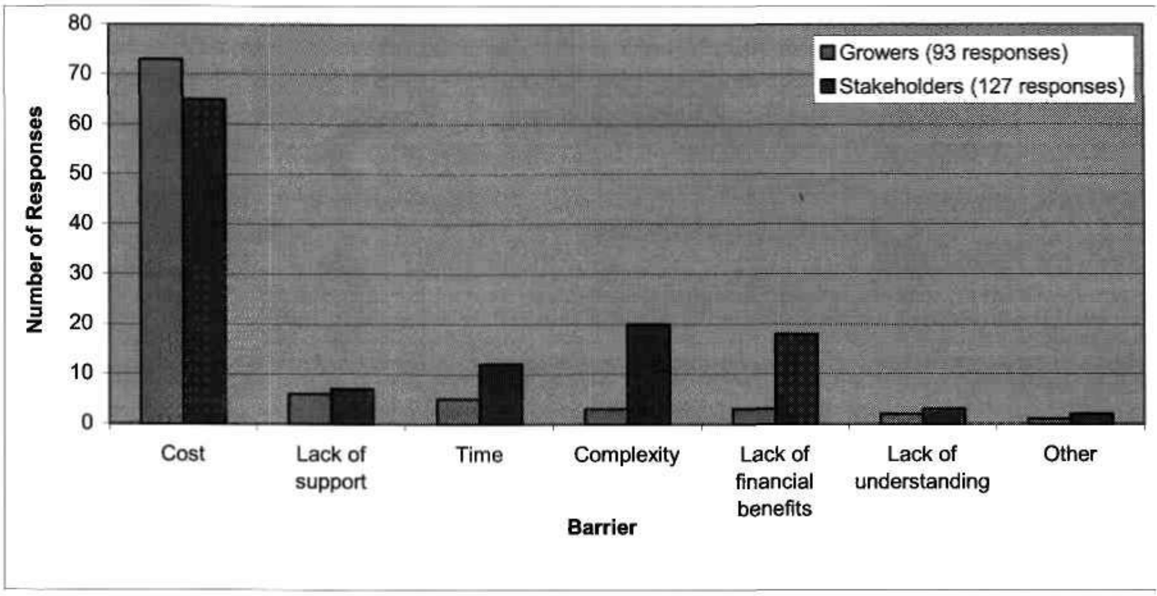


Figure C.10: Number one barrier to adoption (by respondent)



C.9. Summary

The results from the Best Practice Study overwhelmingly emphasise the importance of financial drivers in the on-farm adoption of environmental measures. Each of the results outlined above indicates that financial considerations are the critical element in the decisions by growers to adopt environmental measures. These financial considerations manifest as positive drivers in the form of financial incentives and barriers to adoption such as the cost of implementing environmental measures. This emphasises the need for the use of cost-benefit analyses in environmental programs.

Legislation as a driver for adoption was clearly shown through the role of policy changes and environmental legislation as a historical driver for change. In the context of increasing environmental regulation and urban encroachment upon horticultural production zones, community pride and grower citizenship were also found to be strong motivators for change.

Analysis of the responses of both stakeholders and growers has demonstrated that there was often pronounced differences in the perceptions of these groups. This suggests that the process of voluntary adoption in the horticultural sector may be a poorly understood process. A strong understanding of the specific change management needs of the target audience of any environmental programs should be developed by those responsible for developing and delivering the program in order to ensure success.

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Appendix E: Sources of information on GEM

Table E.1: Sources of information of good water management practices

Practice	Description	Useful publications
Targeted irrigation systems	Drip, trickle, micro-spray and spitter irrigation systems	• Cresswell, H.C. and Huett, D.O. (1996). 'Managing Nursery Runoff: techniques to reduce nutrient leaching from pots'. HDRC and NSW Agriculture Wollomgbar, NSW. • Hickey, M.J, Hoogers, R. & Hulme, J.M., (2000). 'Onion irrigation: to furrow,drip or spray?' In: *Onions Australia*. AOIA, Adelaide, South Australia. • Hickey, M.J, Hoogers, R., Hulme, J.M., Muldoon, D., Aleemullah, M., Ashcroft, B. and Qassim, A. (2001), 'Best Management Guidelines for Irrigation of Processing Tomatoes'. NSW Agriculture, Yanco NSW. • Hickey MJ & Hulme JM (2000) 'Irrigation best practice-A snap shot of the Hay District' In *Australian Lettuce Industry Conference*, NSW Agriculture pp 32 -36. • Land and Water Resources Research and Development Corporation (1997). 'Optimising On- and Off- Farm Water Management Supply Systems'. Report on the Finding and Proceedings of the Workshop held at The University of New England, 10-11 December 1996. Land and Water Resources Research and Development Corporation, Canberra, ACT. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Slack, J. (2000). 'Best Practice – Irrigating Stone Fruit'. In: *Fruitwise* Number 40, pp3-5.
Soil moisture monitoring	Tensiometers, Gopher, EnviroSCAN and Neutron probe	• Hickey, M.J, Hoogers, R., Hulme, J.M., Muldoon, D., Aleemullah, M., Ashcroft, B. and Qassim, A. (2001), 'Best Management Guidelines for Irrigation of Processing Tomatoes'. NSW Agriculture, Yanco NSW. • Muldoon, D., Hickey, M.J, & Hoogers, R (2001) 'Irrigation and Rockmelons Rooting Depth on Clay Soils'. In Austalian Melon Runner. Ed: Kelly, G. and Beech, A pp 10-12. • NSW Agriculture (2001). 'Waterwise on the Farm: Update 6'. Orange NSW. • Panagiotopoulos, K. and Gardner, W.K. (1990). 'Principles of Sustainable Agriculture: Managing Soil Structure. Department of Agriculture and Rural Affairs, Horsham, Victoria.
Regulated deficit irrigation	Less irrigation early in the season to reduce excessive vegetative growth	• Boland, A.M., Corrie, J., Bewsell and Jerie, P. (2000). ' Best management practice and benchmarking for irrigation, salinity and nutrients in Stone and Pome Fruit'. In: *Proceedings of the Irrigation Association of Australia Conference*, Melbourne 2000. • Corrie, J. and Boland, A.M. (2000). 'Water Use Efficiency for Horticulture to Ensure Profitability and Sustainability". Unpublished research paper. Department of Natural Resources and the Environment, Knoxfield and Tatura, Victoria.
Scheduling	A plan of when and how much water is required to generate maximum yields without water wastage	• Hickey, M.J, Hoogers, R., Hulme, J.M., Muldoon, D., Aleemullah, M., Ashcroft, B. and Qassim, A. (2001), 'Best Management Guidelines for Irrigation of Processing Tomatoes'. NSW Agriculture, Yanco NSW. • NSW Agriculture (2001). 'Waterwise on the Farm: Update 6'. Orange NSW. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Slack, J. (2000). 'Best Practice – Irrigating Stone Fruit'. In: *Fruitwise* Number 40, 3-5.
Opportunistic or continuous cropping	Planting when soil moisture is available due to rainfall events	• Bell, R., Mues, C. and Beare, S. (2000). 'Salinity Management: some public policy issues in the Murray Darling Basin'. In: *Outlook 2000*, Commonwealth of Australia (ABARE), pp151-163.

Practice	Description	Useful publications
Benchmarking water use	Process by which performance is measured and used as a basis for comparison	• Hickey, M.J, Hoogers, R., Hulme, J.M., Muldoon, D., Aleemullah, M., Ashcroft, B. and Qassim, A. (2001), 'Best Management Guidelines for Irrigation of Processing Tomatoes'. NSW Agriculture, Yanco NSW. • Johnston, R. and Chudleigh, P. (1999). 'Foresighting Sustainable Irrigation and River Health'. Land and Water Resources Research and Development Corporation, Canberra, ACT. • Land and Water Resources Research and Development Corporation (1997). 'Optimising On- and Off- Farm Water Management Supply Systems'. Report on the Finding and Proceedings of the Workshop held at The University of New England, 10-11 December 1996. Land and Water Resources Research and Development Corporation, Canberra, ACT.
Run-off and drainage management	A range of measures which collect drainage and allow it to be reused	• Bates, J. (1999). 'Potato Growers look to reclaimed water during dry spell'. In: *Potato Australia*, Vol 10, September 1999, 33.Bodnaruk and Frank (1997) • Briercliffe, T. (ed) (2000). 'Environmental Best Practice in the Production of Ornamentals'. ADAS Consulting Ltd and Ministry of Agriculture Fisheries and Food (Horticulture and Potatoes Division), Kent UK. • James, E., Mebalds, M., Beardsell, D., Van der Linden, A. and Tregea, W. (1996). 'Development of recycled water systems for Australian nurseries'. HRDC and the Nursery Industry Association of Australia, Gordon, NSW. • Kelly, J. (2000). 'Sustainable use of reclaimed water in irrigation – Northern Adelaide – SA'. In: *Potato Australia* Vol 11; 36. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Maintenance of vegetation cover	Establishment of a permanent vegetation cover and managing remnant vegetation	• Lefroy, E.C. and Stirzaker, R.J. (1999). 'Agroforestry for water management in the cropping zone of southern Australia'. In: *Agroforestry Systems* **45**: 277-302. • Martin. L. and Metcalfe, J. (1998). 'Assessing the causes, impacts, costs and management of dryland salinity'. Land and Water Resources Research and Development Corporation, Canberra, ACT. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Wasson, B., Banens, B., Davies, P., Maher, W., Robinson, S., Volkler, R., Tait, D., and Watson-Brown, S. (1996). 'Inland Waters'. In: *State of the Environment Australia 1996.* Commonwealth of Australia (Environment Australia), 7-1 – 7-55.

Table E.2: Sources of information of good soil and land management practices

Practice	Description	Useful publications
Low impact tillage systems	Minimum and reduced tillage	• Lanz, Sandra (1996). 'Sustainable potato production in highland Australia'. In: *Potato Australia* Vol 7 pp39-40. • Panagiotopoulos, K. and Gardner, W.K. (1990). 'Principles of Sustainable Agriculture: Managing Soil Structure. Department of Agriculture and Rural Affairs, Horsham, Victoria. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Reeder, R. (2000). 'United States Proves Minimum Tillage Benefits'. In: *Min Till Drill; A guide to minimum tillage cropping systems*, Kondinin Group, Cloverdale, WA, pp41-43. • Stirzaker, R.J. (1999). "The problem of irrigated horticulture: matching the biophysical efficiency with the economic efficiency". In: *Agroforestry Systems* 45:187-202, 1999. • Wallwork, S. (2000). 'Systems approach secures minimum till success'. In: *Min Till Drill; A guide to minimum tillage cropping systems*, Kondinin Group, Cloverdale, WA, pp4-9. • Wells, A.T. (2000). 'Final Report: Sustainable vegetable farming systems: 1998-2000'. HRDC and NSW Agriculture, Gosford NSW.
Erosion control measures	Measures designed to reduce the loss of sediment in run-off or as dust	• Firth, Daryl (2000). 'Reducing erosion and other soil degradation in macadamia orchards'. Agnote-DPI-331, first edition, July 2000. Alstonville, NSW. • Khese. Y., Pove, B., McShane, T., Moody, P. and Reghenzani, J. (1997). 'Nutrient loss study in the Johnstone River Catchment'. Department of Primary Industries, Queensland. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Fertiliser management	Includes appropriate scheduling, type and application rates and application methods and other aspects of good fertiliser management.	• James, L., Murchison, J., Yiasomi, B. and Senn, A. (1997). 'Best Practice Guidelines for Growing Vegetables'. NSW Agriculture. Orange, NSW. • Stephens, R. (2001). 'Using wetlands to remove nutrients from nursery run-off – Eastwood Nurseries Wholesale, Mangrove Mountain, NSW.' In: *The Nursery Papers* Issue 4, 2001. • Peverill, Kl.. (1993) 'Soil testing and plant analysis in Australia' in Australian Journal of Experimental Agriculture, 1993, 33, 963-71. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Mulching	Application of vegetative matter to the topsoil	• Australian Standard for Composts, Soil Conditioners and Mulches • Beattie, B (2001). 'Compost in horticulture – its safe use'. Agnote DPI-374, 1st edition, January 2001, Gosford NSW. • Firth, Daryl (2000). 'Reducing erosion and other soil degradation in macadamia orchards'. Agnote-DPI-331, first edition, July 2000. Alstonville, NSW.
Maintenance of vegetation cover	Includes such practices as agroforestry, alley cropping and crop rotations.	• Lefroy, E.C. and Stirzaker, R.J. (1999). 'Agroforestry for water management in the cropping zone of southern Australia'. In: *Agroforestry Systems* **45**: 277-302. • Queensland Horticultural Institute (1999). 'Horticultural Crops: cover and green manure cropping'. DPI-note, Department of Primary Industries, Queensland. • Wells, A.T. (2000). 'Final Report: Sustainable vegetable farming systems: 1998-2000'. HRDC and NSW Agriculture, Gosford NSW.

Practice	Description	Useful publications
Conservation and maintenance of native vegetation	Including riparian vegetation, wetlands, forest, scrub and /or native grasses.	• Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Noble, I., Barson, M., Dumsday R., Friedel, M., Hacker. R., McKenzie. N., Smith, G., Young, M., Maliel, M. and Zammit. C. (1996). 'Land Resources'. In: *State of the Environment Australia 1996.* Commonwealth of Australia (Environment Australia), 6-1 – 7-55. • Land and Water Resources Research and Development Corporation (1993). 'Remnant Vegetation in the Rural Landscape: A Consultancy Report'. Occasional Paper No 04/93, Land and Water Resources Research and Development Corporation, Canberra, ACT.

Table E.3: Sources of information on good pest, insect, weed and disease management practices

Practice	Description	Useful publications
Chemical handling	Storage, transport and disposal of chemicals	• Department of Natural Resources and Environment (VIC) (1999). 'Code of Practice for Farm Chemical Spray Application'. Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria. • James, L., Murchison, J., Yiasomi, B. and Senn, A. (1997). 'Best Practice Guidelines for Growing Vegetables'. NSW Agriculture. Orange, NSW. • ChemCollect websites in each state www.chemcollect.vic.gov.au , www.chemcollect.nsw.gov.au, www.environment.sa.gov.au/epa/chemcollect.html
Integrated Pest Management	Control strategies in which a combination of biological, chemical, mechanical and cultural tools are used.	• Agriculture Research Service 2001 Website. http://www.ars.usda.gov/is/qtr/q499/ipm499.htm • Grundy, T. and Henderson, C. (2000). 'Integrated Weed Management Components in Vegetable Crops'. DPI note, Department of Primary Industries, Gatton Research Station, Queensland. • Horne (1998) 'National IPM program for potato pests.' HRDC, Gordon. • Horne and Spooner-Hart (1998) 'Review of IPM in Potatoes in Australia'. In *Potato Australia* 9: 49 • HRDC (2000) 'IPM strategy for Oriental Fruit Moth and Carpophilus beetles'. In Stone Fruit Industry Report 1999/2000: 7. • Hughes, M (1998: 28) 'IPM in North Queensland'. In *Potato Australia* 9: 28 • Matthiessen, J. (1997) 'Assessing the biofumigation potential of brassicas' In *Potato Australia*, 8. • Penrose (1997) 'A rating index as a basis for decision making on pesticide use reduction and IPM accreditation.' HRDC, Gordon. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future. Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Steiner, M. (1997) 'A step-wise programme for practising IPM.' The Nursery Papers: Essential Information for Australian Professional Nursery Operations No. 5. 97. • Vawdrey and Stirling (1998) 'Alternatives to Nematicides in Fruit and Vegetable Crops'. QDPI Note. Queensland Horticulture Institute.
Application management	The minimisation of chemical application through appropriate practices and equipment	• Department of Natural Resources and Environment (VIC) (1999). 'Code of Practice for Farm Chemical Spray Application'. Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria. • James, L., Murchison, J., Yiasomi, B. and Senn, A. (1997). 'Best Practice Guidelines for Growing Vegetables'. NSW Agriculture. Orange, NSW. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future. Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.

Practice	Description	Useful publications
Containment	Prevention of the movement of chemicals offsite	• Bibo, J. (1999). 'Agricultural and veterinary chemicals - Spray Drift Issues'. Animal and Plant Health Service (www2.dpi.qld.gov.au). • Department of Natural Resources and Environment (VIC) (1999). 'Code of Practice for Farm Chemical Spray Application'. Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria.
Farm hygiene	The prevention of the introduction of pest, weeds and diseases	• Department of Natural Resources and Environment (VIC) (1999). 'Code of Practice for Farm Chemical Spray Application'. Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria. • Department of Natural Resources and Environment (VIC) (1999). ' Using Vegetation as a barrier to reduce spray drift'. *Agricultural Notes* AGO860 Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria. • James, L., Murchison, J., Yiasomi, B. and Senn, A. (1997). 'Best Practice Guidelines for Growing Vegetables'. NSW Agriculture. Orange, NSW. • Loughrey, T. (1999). 'Farm Hygiene for Vegetable Crops'. DPI Note, Department of Primary Industries, Queensland • Pocock, D.R., Magarey, P.A. and Sylvia, S.A. (2000). 'Managing Fungicides for Stone Fruit Diseases'. In: *Australian Fresh Stone Fruit Quarterly*. Vol 2, Number 4, Summer. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Walker, R. (2000). 'Ecological Risk Assessment of chlorpyrifos in Mountain River'. Unpublished PhD thesis, School of Agricultural Science, University of Tasmania.
Conservation and maintenance of native vegetation	Including riparian vegatation, wetalnds, forest, scrub and /or native grasses.	• Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Noble, I., Barson, M., Dumsday R., Friedel, M., Hacker. R., McKenzie. N., Smith, G., Young, M., Maliel, M. and Zammit. C. (1996). 'Land Resources'. In: *State of the Environment Australia 1996*. Commonwealth of Australia (Environment Australia), 6-1 – 7-55. • Land and Water Resources Research and Development Corporation (1993). 'Remnant Vegetation in the Rural Landscape: A Consultancy Report'. Occasional Paper No 04/93, Canberra, ACT.

Table E.4: Sources of information on good air management practices

Practice	Description	Useful publications
Managing spray drift	Minimisation of drift through buffer zones, timing of spraying and appropriate equipment	• Bibo, J. (1999). 'Agricultural and veterinary chemicals - Spray Drift Issues'. Animal and Plant Health Service (www2.dpi.qld.gov.au). • Department of Natural Resources and Environment (VIC) (1999). 'Code of Practice for Farm Chemical Spray Application'. Department of Natural Resources and the Environment (Chemical Standards Branch), Victoria. • Department of Natural Resources and Environment (VIC) (1999). ' Using Vegetation as a barrier to reduce spray drift'. *Agricultural Notes* AGO860 Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Managing dust	Use of conservation tillage practices and other techniques to reduce farm traffic	• Lanz, Sandra (1996). 'Sustainable potato production in highland Australia'. In: *Potato Australia* Vol 7 39-40. • Panagiotopoulos, K. and Gardner, W.K. (1990). 'Principles of Sustainable Agriculture: Managing Soil Structure. Department of Agriculture and Rural Affairs, Horsham, Victoria. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Reeder, R. (2000). 'United States Proves Minimum Tillage Benefits' . In: *Min Till Drill; A guide to minimum tillage cropping systems*, Kondinin Group, Cloverdale, WA, pp41-43. • Stirzaker, R.J. (1999). "The problem of irrigated horticulture: matching the biophysical efficiency with the economic efficiency". In: *Agroforestry Systems* 45:187-202, 1999. • Wallwork, S. (2000). 'Systems approach secures minimum till success'. In: *Min Till Drill; A guide to minimum tillage cropping systems*, Kondinin Group, Cloverdale, WA, pp4-9. • Wells, A.T. (2000). 'Final Report: Sustainable vegetable farming systems: 1998-2000'. HRDC and NSW Agriculture, Gosford NSW.
Managing burning	If burning is necessary, a high intensity burning is most likely to reduce impact	• Various state EPA regulations • Local council regulations • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Managing odour	Practices which reduce the movement of chemicals offsite or odours from manure	• Bibo, J. (1999). 'Agricultural and veterinary chemicals - Spray Drift Issues'. Animal and Plant Health Service (www2.dpi.qld.gov.au). • Department of Natural Resources and Environment (VIC) (1999). 'Code of Practice for Farm Chemical Spray Application'. Department of Natural Resources and the Environment (Chemical Standards Branch), Victoria. • Department of Natural Resources and Environment (VIC) (1999). ' Using Vegetation as a barrier to reduce spray drift'. *Agricultural Notes* AGO860 Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.

Practice	Description	Useful publications
Managing greenhouse gas emissions	Reducing land clearance, burning activities and the use of fossil fuels	• The Australian Greenhouse Office (www.greenhouse.gov.au) • Sustainable Energy Authority Victoria agribusiness program. (www.seav.vic.gov.au/business/agri/index.html)

Table E.5: Sources of Information on good waste management practices

Practice	Description	Useful publications
Disposing of chemicals	Mixing only appropriate amounts or disposal of dilute chemicals onto land	• Department of Natural Resources and Environment (VIC) (1999). 'Code of Practice for Farm Chemical Spray Application'. Department of Natural Resources and the Environment (Chemical Standards Branch), East Melbourne, Victoria. • James, L., Murchison, J., Yiasomi, B. and Senn, A. (1997). 'Best Practice Guidelines for Growing Vegetables'. NSW Agriculture. Orange, NSW. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Disposing of chemical containers	Use of an appropriate collection program such as *Drum Muster* and *Chem Collect*	• Various state environment authorities • Departments of Agriculture or Primary Industries in each state • Local councils • ChemCollect websites in each state www.chemcollect.vic.gov.au , www.chemcollect.nsw.gov.au, www.environment.sa.gov.au/epa/chemcollect.html • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Disposing of plastics	Reuse of plastics or disposal to avoid burning where possible	• Various state EPA regulations • Local council regulations • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC.
Disposing of organic matter	Use of mulching and composting	• Australian Standard for Composts, Soil Conditioners and Mulches • Beattie, B (2001). 'Compost in horticulture – its safe use'. Agnote DPI-374, 1st edition, January 2001, Gosford NSW. • Firth, Daryl (2000). 'Reducing erosion and other soil degradation in macadamia orchards'. Agnote-DPI-331, first edition, July 2000. Alstonville, NSW.

Table E.6: Sources of information on the management of biodiversity

Practice	Description	Useful publications
Conservation and maintenance of native vegetation	Including riparian vegetation, wetlands, forest, scrub and /or native grasses	• Local catchment management groups • Land and Water Resources Research and Development Corporation (1993). 'Remnant Vegetation in the Rural Landscape: A Consultancy Report'. Occasional Paper No 04/93, Land and Water Resources Research and Development Corporation, Canberra, ACT. • Landcare Groups in local areas • Noble, I., Barson, M., Dumsday R., Friedel, M., Hacker. R., McKenzie. N., Smith, G., Young, M., Maliel, M. and Zammit. C. (1996). 'Land Resources'. In: *State of the Environment Australia 1996.* Commonwealth of Australia (Environment Australia), 6-1 – 7-55. • Queensland Fruit and Vegetable Growers (1998). 'Farmcare: Cultivating a Better Future, Code of Practice for Sustainable Fruit and Vegetable Production in Queensland'. Queensland Fruit and Vegetable Growers and HRDC. • Various state government departments of National Parks and Wildlife.
Managing native animals	The conservation and management of native animals present on a property	• Various State government departments of National Parks and Wildlife. • WIRES in each State • Various State government environmental departments
Managing endangered and threatened species	Species which are listed in Federal or State Act	• Environment Australia • Various State government departments of National Parks and Wildlife. • Various State government environmental departments
Managing feral pests	Controlling the populations of, or removing feral pests from a property	• Departments of Agriculture or Primary Industries in each State