



Hydroponics

as an Agricultural Production System

**A report for the Rural Industries Research
and Development Corporation**

by

Hassall & Associates Pty Ltd

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Foreword

The purpose of this study was to increase the understanding of hydroponics role as an alternative to conventional soil based agricultural production systems.

Hydroponics is the production of crops in isolation from the soil, either with or without a medium, with their total water and nutrient requirements supplied by the system. Production takes place either in a greenhouse or outdoors and systems can recirculate or allow nutrients to 'run-to-waste'.

Hydroponics has emerged as a commercial alternative to soil based production. Significant crops include 'fancy' lettuce, cut flowers such as roses, gerberas, carnations and lisianthus, tomatoes and cucumbers. Industry farm gate value is thought to be in the order of \$300-\$400 million per annum.

While not all crops are suitable for growing hydroponically and the technology is unlikely to displace soil production for bulk commodity items in the foreseeable future, the industry will continue to grow, especially if identified opportunities are brought to fruition.

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This report, a new addition to RIRDC's diverse range of over 700 research publications, forms part of our Resilient Agricultural Systems R&D program, which aims to foster agri-industry systems that have sufficient diversity, flexibility and robustness to be resilient and respond to challenges and opportunities.

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Abbreviations

AHA	Australian Hydroponics Association (now AHGA)
AHGA	Australian Hydroponic and Greenhouse Association
BCA	Benefit Cost Analysis
CEA	Controlled Environment Agriculture – another name for greenhouse food production in the USA
CEO	Chief Executive Officer
DFT	Deep Flow Technique
EC	Electrical Conductivity
GFT	Gravel Flow Technique
GM	Gross Margin
HACCP	Hazard Analysis Critical Control Point
HAL	Horticulture Australia Limited
HRDC	Horticultural Research & Development Corporation
HFF	Hydroponic Farmers Federation of Victoria
IPM	Integrated Pest Management
IRR	Internal Rate of Return
ML	Megalitre (10,000 litres)
NDEFRA	Netherlands Department of Environment, Food and Rural Affairs, website
NFT	Nutrient Film Technique, a hydroponic production technique utilising a constant flow of solution usually without a growing media
NPV	Net Present Value
NRA	National Registration Authority for Agriculture and Veterinary Chemicals
RIRDC	Rural Industries Research and Development Corporation
SWOT	Strengths Weaknesses Opportunities and Threats
UV	Ultra Violet light
USDA	United States Department of Agriculture

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Executive Summary

The purpose of this study was to increase the understanding of hydroponics role as an alternative to conventional soil based agricultural production systems. Hydroponics is the production of crops in isolation from the soil, either with or without a medium, with their total water and nutrient requirements supplied by the system. Production takes place either in a greenhouse or outdoors and systems can recirculate or allow nutrients to ‘run-to-waste’.

The Rural Industries Research and Development Corporation (RIRDC) funded the study under its Resilient Agricultural Systems Sub Program. The research addressed international and domestic industries, requirements for commercial production, the economics of commercial production and constraints to further expansion.

The key messages to emerge from the review of the global commercial hydroponics industry are:

- The commercial hydroponics industry has grown four to five fold in the last 10 years and is currently estimated at between 20,000 and 25,000 ha with a farm gate value of \$US6 to \$US8 billion;
- Production is focused in affluent countries with discerning consumers (The Netherlands, Spain, Canada, Japan, UK, USA, Italy, New Zealand and Australia) or countries which have access to these markets (Mexico and China);
- Worldwide, there are a limited number of crops grown hydroponically. Tomatoes, cucumbers, lettuce, capsicums and cut flowers are the most important. They are also the most important hydroponically produced crops in Australia;
- Hydroponics has embraced Integrated Pest Management and is moving away from ‘run-to-waste’ systems with their potential for environmental problems;
- Industry success in the short to medium term will come from a market focus not a break through in hydroponics technology;
- The Dutch provide an efficient industry model for Australia to emulate. Features of the Dutch model are contrasted to the Australian industry in the report;
- The adverse reaction of German consumers to an ‘unnatural’ production system needs to be noted and addressed by the Australian industry;
- North American expansion is currently ‘production push’ and is set for an expanded period of low returns if a Dutch style market focus is not brought to their production;
- Competition on the domestic Australian market can be expected from New Zealand, and possibly Holland, in the short to medium term; and
- International integration of production and marketing will ‘shut out’ producers who are not sufficiently large-scale or part of a cluster arrangement. This is equally true for Australian and overseas growers.

Review of the Australian commercial hydroponic industry reveals that:

- The area of commercial hydroponic production increased from 150 ha in 1990 to 500 ha by 1996 and it is feasible that the area of production could be double this in 2001. There are between 1,000 and 2,000 domestic commercial hydroponic growers. Industry value is estimated by industry leaders at approximately \$400 million gross at farm gate. If this is accurate, it is the equivalent to 20% of the value of total vegetable and cut flower production;
- Commercial production includes an array of techniques, and no one system is considered best. Rockwool and NFT are the backbones of the Australian industry and systems are moving towards recirculation. More than half of all Australian hydroponic production is grown outdoors reflecting the high proportion of lettuce grown. This is different to the worldwide scene where the majority of hydroponic crops are grown in greenhouses;
- Reluctance of growers and retailers to market product under a hydroponic label is one reason why the industry is perceived as being smaller than it actually is. Hydroponic produce is often marketed on qualities such as taste and freshness rather than method of production;
- Industry growth is being driven in part by new entrants and in part by conventional soil based growers converting to hydroponic production techniques. Industry growth, is expected to continue in this way over the next few years;
- Australia is ranked in the top 10 of world commercial hydroponic producers. This is not to say that that the industry is best practice in critical production and marketing issues. The industry is characterised by a large 'tail' of producers who are reluctant to invest and adopt innovation;
- Production takes place Australia wide but is concentrated in those states with larger population and therefore marketing bases, ie NSW, Queensland and Victoria;
- Australia has a large hydroponic lettuce industry, which dominates the market for 'fancy' lettuce. The industry is largest in NSW and has achieved export success;
- Cut flowers are grown in all the major hydroponic states, typically using techniques based around an inert 'potting mix' type medium. Popular commercial hydroponic flowers include roses, gerberas, carnations and lisianthus;
- There are a number of large hydroponic tomato growing and marketing clusters in Victoria which have achieved critical mass and supply the major supermarkets with premium product;
- Hydroponic cucumbers, especially the continental variety, hold a significant share of the total domestic market. Increasing Lebanese cucumber production in the Sydney Basin is also a significant contributor to the domestic market. Production has achieved appropriate commercial scale and a single Queensland grower has 5.7 ha of continental cucumbers under production;
- Industry strengths/opportunities include real comparative advantages and growth opportunities for the Australian industry, industry weaknesses/threats are not insurmountable; and

- The industry has an appropriate representative organisation but it is currently run by unpaid members of the industry and therefore suffers from a lack of continuity and does not have a professional image that would assist with leadership and planning. All three tiers of government have effectively supported the industry.

All things considered the industry has grown rapidly from a zero base over the last 25 years. False starts and setbacks associated with dubious means of promotion in the 1980s and early 1990s have been overcome and the industry is fast reaching critical mass.

Successful commercial production is undertaken by families producing for boutique markets, families as part of a larger growing and marketing cooperative and by corporates with investors who are not active in day-to-day management. The industry is capital intensive and capital costs are anywhere between \$100 and \$200 per square metre (m²), depending on the sophistication of the greenhouse being proposed and the level of equipment being included. Viable production units are a minimum of 1,500m². Commercial success is linked to:

- Establishment of the venture in a realistic economic framework;
- Attention to market requirements before production commences;
- Realistic expectation of price, yield and labour requirements; and
- Experience in horticultural production prior to entry into hydroponics.

Hydroponics is not a magical production system, it requires more skill to manage than conventional soil based systems and generates more technical problems. It is vital to recognise that the same level of skill is required to grow crops hydroponically as for soil growing (Rick Donnan, *pers. comm.*). Many newcomers have underestimated the horticultural skills required and their operations have consequently failed.

The results of the economic analysis show modest returns for entry-level investment. Results are consistent with agricultural production for a mature product, ie hydroponic products are mainstream and widely consumed, hydroponic produce does not attract the very high prices of a new or novel crop or product (although premiums are sometimes available). Returns are less than those achieved for highly speculative crops with limited or newly established markets. It needs to be remembered that the majority of commercial hydroponic growers are competing against conventional soil based producers with mainstream commodity style products (tomatoes, lettuce, cucumbers and so on). Improved industry profit is linked to larger scale production, exploitation of niches and on-farm value adding.

The Australian industry is successful as a commercial producer, to build on that success, the following constraints will need to be addressed:

- Grower cooperation to ensure production volumes, adequate grading and market interest in industry output;
- A retreat from the amateurism that characterises a new or emerging industry, ie use of substandard equipment and a reluctance to invest/embrace a commercial scale of production;
- Promotion to shift public opinion away from an image of backyard marijuana production and a high chemical input or unnatural systems;

- Information freely available to counter the dubious claims made by some industry promoters regarding industry yields and profits. This information together with industry promotion would assist to improve the industry's image with financial institutions;
- Attention to a constantly shifting and ever more sophisticated market, including one that is starting to demand the low chemical, sustainably produced product that is the industry's strength. Product branding may be one way of capturing this market;
- Industry education and training at a grass roots level of production is important. This might include education on climate control, crop environmental requirements and IPM programs within greenhouses;
- Industry data and standards including, potentially formal QA procedures or a suitable HACCP assessment; and
- Full time professional industry leadership to drive the industry from a strategic position, including formulation and resourcing of an industry strategic plan.

None of these industry constraints are intractable.

The study has shown that the commercial hydroponics industry is successful and rapidly expanding. It dominates the production of a limited number of crops and is probably the fastest growing Australian horticultural sector. The industry is larger than might commonly be perceived and this is because a lot of product is marketed on quality (eg vine ripened) rather than method of production (hydroponically grown).

Not all crops are suitable for growing hydroponically and the technology is unlikely to displace soil production for bulk commodity items in the foreseeable future. The industry will continue to grow over the next three to five years, especially if identified opportunities are brought to fruition.

It is the recommendation of this study's authors that the industry convene through the Australian Hydroponic and Greenhouse Association (AHGA) and form a working group to examine options to fund the creation of a full time industry CEO's position. It would be the responsibility of the hydroponic industry's CEO to formulate an industry plan and in cooperation with the industry, to address both the industry constraints and opportunities identified by stakeholders and reported in this study.

1. Introduction

1.1 Study Background

Hydroponics is the science of growing plants without soil. Nutrients and water are delivered straight to the roots of the plant, allowing plants to grow faster and harvesting to occur sooner. Hydroponics is capable of delivering consistent high quality produce from plants that out yield conventional production systems.

In Australia, which has a highly variable climate and a discerning customer base, the hydroponics industry provides an opportunity to overcome production variability. However, despite the benefits of consistent production that can be derived from hydroponic techniques, and the fact that hydroponic production has been used commercially since the 1970s, there is a *perception* that the industry has stalled in its evolution into a large-scale commercial alternative to traditional agricultural production.

As a result of this perception, this research sought to investigate and report:

- Characteristics and trends in the global and Australian hydroponics industries;
- Requirements for a commercial production system;
- The economics of commercial production;
- Constraints on further expansion of hydroponics as an agricultural production system; and
- Conclusions on the future of hydroponics as a large-scale production system.

1.2 Purpose of the Study

The purpose of this study was to increase the understanding of whether the hydroponics industry in Australia has emerged as a large-scale alternative to traditional agricultural enterprises and, if not, why not. To achieve this objective, the following was investigated and prepared:

- A detailed summary of currently available literature relating to the hydroponics industry, specifically literature focusing on describing hydroponics as an agricultural production system;
- An analysis of the key characteristics of the hydroponics industry, including:
 - The current structure of the Australian industry, a description of market size, main products produced, value of production and trends in these indicators;
 - The global environment and the implications of trends in the international market for the Australian hydroponics industry;
 - Description of positive (opportunities, strengths) and negative (risks, weaknesses) themes within the domestic industry; and
 - Demand for hydroponic produce, both within Australia and overseas.

- A review of production systems required for commercial-scale hydroponic production;
- An assessment of the economics of production for commercial scale-hydroponic production systems;
- A market assessment of the factors constraining broad-scale commercial production of hydroponics (risks/opportunities);
- A listing of key literature references suitable for consultation by current and prospective industry stakeholders;
- Establishment of a database of key industry contacts, including growers, suppliers and industry experts;
- An understanding of the reasons why the hydroponics industry has not emerged as a large-scale commercial alternative to traditional agricultural enterprises within Australia; and
- Conclusions on the financial viability of production and what products are best suited for this technology.

In addition recommendations were prepared dealing with suggestions for further strengthening the Australian hydroponic industry.

2. Hydroponics as a Commercial Production System

2.1 Definition of Hydroponics as an Agricultural Production System

Hydroponics or soilless culture is the production of crops isolated from the soil, either with or without a medium, with their total water and nutrient requirements supplied by the system (Jensen, 1999; Hanger, 1993).

For the purposes of this study hydroponics as an agricultural production system is concerned with commercial production of fruits, vegetables and cut flowers. The produce is grown for sale. The study excludes backyard and hobby style operations, the industry that supports this activity and research conducted at universities and other research centres. Hydroponics as an agricultural production system includes those activities, which have the potential to displace conventional soil based horticultural production.

2.2 History of Commercial Hydroponics

In a scientific sense, hydroponics has existed for over three centuries. The technology was first reported in scientific literature in the 1600's (Weir, 1991). In the 1940's the area of commercial hydroponics was estimated at 10 ha and use was dominated by the military, which employed gravel beds for vegetable production in remote and isolated areas (Carruthers, 1999).

In the 1950's and 1960's the introduction of plastics and a rapid development of their use in horticulture, together with research and development into greenhouses, led to additional interest in commercial hydroponic production. The first true commercial use of hydroponic systems is accredited to the Canadians in British Columbia at this time. Problematic soils in British Columbia led growers to experiment with sawdust based systems. From sawdust based systems hydroponics developed to include the use of peat, straw and sand based media finally leading to the development in the 1970's of the Nutrient Film Technique (NFT) and a proprietary medium similar to fiberglass insulation known as rockwool (Carruthers, 1999). Other developments in the 1970's included the use of fine mist sprays (Ein Gedi system) and various Japanese deep flowing nutrient recycling systems (Hanger, 1993).

In the 1980's and 1990's there was a rapid growth in the area of hydroponic production and the research and development to support it. Innovations included the modular perlite system developed in Scotland, three dimensional production of strawberries to better utilise greenhouse space, hybridisation of rockwool and NFT systems and research efforts to minimise the environmental impact of the industry including chemical minimisation and the use of Integrated Pest Management (IPM). Experimental and cutting edge commercial hydroponic systems have employed conveyor belt methods of planting/harvesting/packaging, waste heat use, total environment control and even robotics for planting, harvesting and packaging of produce.

Australian commercial hydroponic production commenced in the early 1970's with open air lettuce production on the Gold Coast and carnation production in Victoria. The industry received a major fillip in the late 1970's with the arrival of NFT and its adoption for small scale tomato production in Southern NSW and Victoria. Rockwool, under the Australian brand name of 'growool', was

launched in the early 1980's and rapidly gained favour for hydroponic production when married to European designed management systems (Hanger, 1993). In the 1990's increased promotion of hydroponic production systems resulted in many new operations being established across all Australia states (Murison et al., 1992). The downside of this rapid growth and promotion was the attraction to the industry of a number of 'turnkey' package operators and taxation driven corporate schemes who made unsupported and subsequently unachievable claims about industry yields, markets and profits. The presence in the industry of these operators has led to a somewhat 'saw-toothed' industry development path and a tarnished reputation amongst some external observers including the finance sector.

Major commercial hydroponic production technologies are outlined briefly in the section below.

2.3 Types of Commercial Growing Systems

Within an ideal hydroponics system, the root environment of the plant is supplied with all the oxygen, water and dissolved nutrients at the concentrations and temperature that the plant requires at each stage of growth. In effect, the hydroponic grower is providing optimum root zone conditions for the plants being grown. In addition, the leaves and stem of the plant require light of the correct spectrum, intensity and time period, as well as air quality and movement, temperature and humidity (Soladome, 2001).

Growing Environment

Successful commercial systems include both open air and greenhouse environments. In Australia the breakdown of greenhouse versus outdoor growing environments reflects both the type of crop under production and the climatic characteristics of the different states in which production takes place. Victoria and Tasmania have a relatively high proportion of hydroponic crops grown in greenhouses, while Queensland and Western Australia have more of their hydroponic crops growing outdoors. A survey commissioned in 1997 by the Horticultural Research & Development Corporation (HRDC), now known as Horticulture Australia Limited (HAL), showed nationally that slightly more than half of the total hydroponics growing area (55.6%) was outdoors and that the balance was produced in greenhouses, mostly made from plastic film (Bailey, 1999). See Table 1 below. The high proportion of outdoor growing reflects the crop involved, mainly lettuce and strawberries (Rick Donnan, *pers. comm.*).

Table 1. Areas of Growing Environments – Australia 1996

Growing Environment	Percentage of Total Hydroponic Production Area (%)
Outdoor Production	55.6
Plastic Film Greenhouses	36.7
Other Greenhouses	3.8
Shade Houses	3.8

(Bailey, 1999)

Open and Closed Systems

Seymour (1993) identifies two basic types of commercial hydroponic crop production systems. They are:

- Open or 'run to waste' systems; and
- Closed or 'recirculating' systems.

A brief overview of each is provided below.

Open Systems

In general terms an open system is one where nutrient solution is applied to the medium in which the plants grow and then drained off as waste. This solution is not recirculated to the feeder tank and reused within the hydroponic system. Fresh nutrient solution is applied to plants each time. In many cases the waste nutrient solution is collected and applied to either pastures or gardens (Olivieri *pers. comm.*). In urban areas this is not always possible due to land restrictions and in these cases the disposal of nutrient solution is an important environmental issue (James, 1993).

Closed Systems

Closed systems work in the same way as open systems with one important difference. Nutrient solution which runs-off after each application is collected and recirculated to be used in successive waterings. It is important that the pH and electrical conductivity (EC) of the nutrient solution is measured frequently to determine the acidity or alkalinity and total dissolved solids of the solution (Romer, 1993). This is relatively easy to automate. More difficult is to maintain the correct nutrient balance in the recirculating solution, this may require regular chemical analysis.

Historically the term 'closed system' was used synonymously with NFT (nutrient film technique) (Donnan, 1998). The NFT systems are no longer an accurate description of a closed system. Many other systems including media based hydroponics are currently operating as closed systems (Donnan, *pers. comm.*). In The Netherlands where the majority of hydroponic production is carried out using media based systems, legislation now states that "growers should grow their products in closed systems" (van Os, 1999).

In Summary

Capital and operating costs vary widely over the range of systems and crops. In closed systems the management of pH and EC is easier than in open systems. However, the management of nutrient balance is much more difficult. Good management of closed systems requires regular chemical analysis and adjustment of the recirculating solution. A common alternative is to periodically discard the used nutrient solution. Recirculating systems are also more vulnerable to the rapid spread of root disease throughout an entire crop.

Media and Water-based Systems

Hydroponic systems can be divided into two broad categories:

- Water-based systems; and
- Media systems.

All water-based systems are inherently closed systems. They are mainly used for short-term crops such as lettuce and herbs. There is also a small proportion of tomatoes grown using the water based system, NFT.

Longer term vegetable and flower crops are normally grown in media based systems. Until the 1990's virtually all media systems were operated as 'run-to-waste'. The main reasons for this were the easier nutrient management and the lower risk of disease spread.

Over the past decade environmental pressures have resulted in an increasing proportion of media systems being set up as, or converted to, closed systems. The general set up is to collect the run-off, treat it and return it. One reason for the predominance of media based systems is that the volume of recycled nutrient solution to be treated is only a tiny fraction of the volume from a continuous flow system such as NFT (Rick Donnan, *pers. comm.*).

Water-based systems account for only a small proportion of worldwide production while media systems account for around 90% of production (Donnan, 1998).

Table 2 below summarises the major hydroponic systems and the estimated portion of the worldwide hydroponic industry that use each system.

Table 2. Hydroponic systems

System Type	System	Proportion of Industry Using System
Water-based Systems	Nutrient Film Technique (NFT)	5%
	Water Culture (Gericke system)	3%
	Gravel Culture (GFT – gravel flow technique)	1%
	Aeroponics	0.2%
	<i>Sub-total</i>	<i>9%</i>
Media Systems	Rockwool (inorganic media)	57%
	Other inorganic media	22%
	Organic media	12%
	<i>Sub-total</i>	<i>91%</i>

(Donnan, 1998)

Water-based Systems

In general water-based systems refer to the nutrient film technique (NFT), water culture (based on the Gericke System) or aeroponics. The predominant type of water-based hydroponic system is NFT. Water-based hydroponics works on closed systems where nutrient solution is supplied to the system with the drainage collected and returned to the nutrient reservoir (as described in the section above 'Closed Systems') (Seymour, 1993).

Nutrient Film Technique

NFT consists of a flat-bottomed channel or gully in which a thin film of nutrient is re-circulated through the bare roots of the plant (Seymour, 1993). The nutrient solution is applied continuously as a shallow stream and recycled from the outflow back to the point of application (Mason, 1996). The channel is most often rigid PVC or 'lay flat' plastic film laid on a slope to allow nutrient solution to flow.

There are three difficulties that may arise from the use of NFT. Firstly, if the flow of nutrient solution is interrupted even for short periods of time the roots will dry out and quickly become stressed. A second problem can be the excessive heating of channels in newly planted systems and thirdly that the NFT channels can become blocked by roots of vigorous growing plants (Mason, 1996). Another important aspect of NFT is to ensure that sufficient oxygen is available to the plant. This may require either agitating of the nutrient within the tank or allowing air to reach the nutrient solution within the channels (Seymour, 1993).

A modified form of NFT known as gravel culture or gravel flow technique (GFT) involves NFT channels covered with a layer of gravel.

A typical NFT system is made up of the following:

- Gullies – along which nutrient solution flows and plant roots grow;
- Catchment pipe and tank – to collect discharge solution;
- Pump – to return water from catchment tank to the top of the system via a delivery pipe;
- Tanks – which contain the various concentrates required to run the system (eg nutrient solution or acidic solution which is injected into the dilute nutrient solution when required);
- Sensing devices – to measure pH and EC of solution (these devices regulate the release of the aforementioned concentrates, acidic solution etc); and
- Benching – to support gullies and maintain desired gradient (Mason, 1996).

Production advantages are achievable under NFT systems but require vigilant management along with high quality equipment and good system design (Seymour, 1993).

Water Culture

Historically water culture is a modified form of the Gericke system which involved a bed of litter suspended above a concrete tank. The litter excluded light and was used to support the plants. The major commercial water culture system is known as deep flow technique (DFT) and involves polystyrene boards (which support the plant and exclude light) being floated on recirculated nutrient solution (Donnan, 1998). It is important that the nutrient solution contains adequate oxygen for the plant and for this reason the solution is aerated (Donnan, 1998; Sutherland, 1999).

Aeroponics

Aeroponic systems, rarely used commercially, involve the suspension of bare rooted plants in a light excluded chamber, where they are intermittently misted with a nutrient solution (Seymour, 1993). The technique has been tried in various forms over the past 20 years (Donnan, 1998).

Media Systems

Media systems are broken down into two major categories organic and inorganic. The table below gives examples of the different types of organic and inorganic media.

Table 3. Types of Media

Media	Type
Inorganic Media	Rockwool, sand, scoria, perlite, pumice, expanded clay and vermiculite
Organic Media	Sawdust, peat, coconut fibre, bark, foam products, processed wood products, gel products and various mixes of organic and inorganic media

(Donnan, 1998 and Seymour, 1993)

The medium in a system may contain two or more materials, which together, are used to overcome the limitations of an individual material (Seymour, 1993).

Media systems generally require a container to hold the medium with the nutrient solution supplied to each container by a low pressure, low flow irrigation system. The nutrient is applied to the medium through micro-tube, micro-jet or drip emitter. Plastic bags and polystyrene boxes are the most commonly used media containers (Seymour, 1993).

Historically, Australian commercial production has been more than 90% reliant on run-to-waste systems. However, over the last decade or so the industry has converted to NFT style, closed systems (Carruthers, 1999). Recent data on systems used by the Australian industry (Bailey 1999) is presented in the table below. The table shows systems used and the percentage of survey respondents.

Table 4. Type of Production System Used by Australian Growers

System Type	System	Proportion of Commercial Producers using System
Closed (recirculating) Systems	Nutrient Film Technique (NFT)	38%
	Media based	16%
	Aeroponics	2%
	<i>Sub-total</i>	<i>56%</i>
Open (run-to-waste) Systems	Rockwool (inorganic media)	13%
	Other	30%
	<i>Sub-total</i>	<i>43%</i>

NOTE: Table is based on the growers who responded to the 1997 HRDC Survey (Bailey, 1999).

In terms of the main systems in use, NFT is the most prominent, followed by run-to-waste systems other than rockwool. Interestingly some 16% of respondents were using media-based systems where the nutrient was re-circulated. Carruthers (2001) speculates that perhaps this is indicative of the growing impact of wastewater controls and the use of sterilising techniques.

Further detail on hydroponic growing systems is available in Seymour (1993); Donnan (1998); Mason (1996) and SimplyHydro (2001). Information sources explicitly state that there is no universal best system and that it is important to assess systems using a range of parameters to determine which system best suits each particular circumstance.

3. Global Hydroponics Industry - Characteristics and Trends

In the 1940's, commercial hydroponic production accounted for around 10 ha globally. By the 1970's this had expanded to around 300 ha, and to 6,000 ha by the 1980s (Donnan, 1998). In the year 2001 it is estimated that commercial hydroponics accounts for somewhere between 20,000 and 25,000 ha of production worldwide and \$US6 to \$US8 billion in farm gate value (Hassall estimate based on Carruthers 1999 pro-rata for additional production data).

The world's major commercial producers of hydroponic product are Holland (10,000 ha), Spain (4,000 ha), Canada (2,000 ha), Japan (1,000 ha), New Zealand (550 ha), the United Kingdom (460 ha), the USA (400 ha) and Italy (400 ha). Current Australian production is estimated at over 500 ha.

An overview of world production area, systems used and crops produced, updated from Hanger (1993), is provided in Table 5 below and is followed by a brief discussion of the world situation for key indicator countries. Data limitations mean some figures were not available for either the historic or current period.

Table 5. World Hydroponic Production, Systems Used and Crops Grown (1980s through to 2001)

Country	Date	Area (ha)	Main Systems	Major Crops Grown	Reference
The Netherlands (Holland)	1987	3,500	Rockwool and other media based systems	Tomato, cucumber, capsicum, eggplant, cut flowers, beans, lettuce	Anon (1990) Agri-Holland, 2-1990,9-10*
	2001	10,000	Rockwool	Tomato, cucumber, capsicum, egg plant strawberry, lettuce, radish, roses, gerbera, chrysanthemum, freesia, carnation	Netherlands Department of Environment, Food and Rural Affairs
Spain	1996	1,000			Donnan (1998)
	2001	4,000	Perlite, sand, rockwool	Lettuce, cucumber, capsicum, tomatoes	Department of Agriculture, Food and Fisheries
Canada	1987	100	Rockwool, sawdust & NFT	Tomato, cucumber, lettuce	Donnan (1989) Commercial Hydroponics around the World*
	2001	2,000	Rockwool & perlite	Tomato, cucumber, capsicum	Various estimates
France	1996	1,000	Rockwool	Cucumber, capsicum, tomato, eggplant and cut flowers	Donnan (1998)
Japan	1984	293	Water, rockwool NFT	Honewort, tomato, leaf onion, lettuce, musk melon, cucumber	Kobayashi, et al (1998) Financial Results of Hydroponic Farming of Vegetables in the Central Japan*
	1999	1,000	DFT, NFT, gravel culture and rockwool	Tomato, mitsuba, welsh onion, strawberry, lettuce, cucumber, roses, carnation, chrysanthemum	Ito (1999) and Donnan (1998)

Country	Date	Area (ha)	Main Systems	Major Crops Grown	Reference
Israel	1996	650	Scoria, perlite, sand, aeroponics		Donnan (1998)
Belgium	1996	600	Rockwool		Donnan (1998)
Germany	1996	560	Rockwool		Donnan (1998)
New Zealand	1996	200			Donnan (1998)
	2001	550	NFT and pumice and sawdust media	Cut flowers, strawberry, tomato, capsicum, cucumber, lettuce, melon, chillies, Asian vegetables	Chris Winslade (<i>pers. comm.</i>) Horticulture News Magazine, NZ. Donnan (<i>pers. comm.</i>)
Australia	1996	500	NFT, sawdust, rockwool, sand, scoria & perlite		Donnan (1998)
United Kingdom	1988	392	Rockwool,	Tomato, cucumber, capsicum	Vaughan (1990)* Adams (1990) * & Chambers (1990) *
	2001	460	NFT, rockwool, perlite	Tomatoes, cucumber, cut flowers	Jeremy Badgery-Parker (<i>pers. comm.</i>) and Donnan (1998)
South Africa	1984	75	Various media	Tomato, cucumber, lettuce, flowers	Smith (1986) *
	1996	420	Sawdust & bark		Donnan (1998)
Italy	1990	50		Roses, tomato, gerbera, strawberry	Pardossi <i>et al.</i> , 1999
	1999	400			Pardossi <i>et al.</i> , 1999
USA	1984	228	Perlite, gravel, sand, NFT	Tomato, cucumber, lettuce	Carpenter (1985) USA Current Research & Developments*
	1999	400			Sullivan <i>et al.</i> , 1999
Finland	1996	370			Donnan (1998)
Korea	1987		NFT, rockwool	Tomato, cucumber, lettuce	Kim <i>et al.</i> , 1999
	1996	274	Perlite, NFT, DFT, rockwool, & aeroponics		Donnan (1998)
Mexico	1996	15			Donnan (1998)
	1999	120		Tomato, cucumber	Sullivan <i>et al.</i> , 1999
China	1987	5	Gravel bed	Tomato, cucumber, lettuce, melon, capsicum, pak choi, chive, flowers	Shijun (1998) The Advances of Soilless Culture in China*
	1999	120		Tomato, cucumber, melon, celery, capsicum, lettuce & strawberry	Xing <i>et al.</i> , 1999
Greece	1996	33			Donnan (1998)
	1999	60	Rockwool, perlite & NFT	Tomato, cucumber, capsicum, lettuce	Mavrogianopoulos, 1999
Brazil	1999	50	NFT	Lettuce, arugula, water cress	Furlani, 1999
Taiwan	1996	35			Donnan (1998)
Singapore	1996	30			Donnan (1998)
Total Production	Late 1980s		5,000 to 6,000 ha		
	2001		20,000 to 25,000 ha		

* See Hanger (1993) pp.12 for complete reference

Key points of note from the table are:

- Production is dominated by developed western countries, Mexico (which exports product to North America and China (which exports product to Japan));
- The world area of hydroponic production has increased four to five fold in the last 10 years;
- Media systems, particularly rockwool dominate production;
- There are a limited number of crops grown commercially using hydroponics and these are largely the same worldwide;
- The most important commercial hydroponic crops are tomatoes, cucumbers, lettuce, capsicums and cut flowers; and
- There is a steady movement away from open systems towards closed or ‘recirculating’ systems.

The most important commercial hydroponic crops are examined from an economic perspective, for Australian conditions, in Chapter 6.

3.1 Western Europe

Holland

The Dutch are the recognised world leaders in commercial hydroponics. Holland has a total hydroponic production area of some 10,000 ha made up of 13,000 mostly family based holdings that employ an estimated 40,000 people (Netherlands Department of Environment, Food and Rural Affairs, NDEFRA).

Hydroponics accounts for 50% of the value of all fruit and vegetables produced in the country. Holland’s most important vegetable/fruit crops are capsicum, tomatoes and cucumbers and production is export focused. Important cut flowers are roses, gerbera, carnation and chrysanthemum, again produce is grown for largely export markets (NDEFRA). The Dutch have been highly successful at fresh horticultural produce marketing and worldwide trends in this sector, driven by the Dutch, are noted separately at the end of this chapter.

In Holland, nearly all glasshouse production is hydroponic. Conversion of greenhouses to rockwool and other media based hydroponic systems was necessitated by widespread soil depletion, a buildup of soil disease, salinisation, high water tables and favourable economic returns (Hanger, 1993).

The Dutch hydroponic industry is well serviced with government support for research, training and information provision. The industry enjoys efficient commercial infrastructure (including provision of production inputs), transport, cluster based production and marketing systems. In the face of rising competition, especially from lower cost southern Europe, Dutch growers have moved away from employing brokers and auction sales and towards direct contracting with major retailers (NDEFRA).

The Dutch government has recently legislated to reduce the number of chemicals registered for application to food crops from 600 to 200 and Dutch hydroponic producers have responded by developing, implementing and marketing produce under Integrated Pest Management (IPM) systems. More than 70 percent of Dutch hydroponic production is now produced using IPM and for tomatoes and capsicum it is more than 90 percent. IPM relies on the use of natural predators, eg parasitic wasps, lacewings, bugs, spiders, mites and ladybirds, rather than chemicals to control harmful insects. If reduction in availability of registered agricultural chemicals becomes a worldwide trend, then hydroponics is favourably placed for a major period of growth (van Os *et al.*, 1999).

The Dutch hydroponic industry is characterised as having:

- A history of glasshouse production that facilitated adoption of hydroponic systems;
- Efficient and established crop production and marketing systems that made commercialisation of hydroponics possible;
- A willingness by producers to fully commit to new and best practice technology;
- Government support for the industry in the form of assistance with an appropriate legislative environment, training and information provision;
- A greenhouse industry that was concentrated over a relatively small area and was therefore easy to service;
- Market demands determining production;
- Producer specialisation and therefore leading edge efficiency in a single crop;
- Clusters of like producers who jointly market produce and share information and experiences;
- Increasing business size over time and glasshouses now measured in hectares rather than square metres;
- Continuous productivity improvement including cost control and therefore decreasing unit cost price;
- Quality control systems and branded product marketing, including the butterfly symbol to signify low chemical usage and the use of IPM;
- Marketing based on product quality rather than the type of production systems (ie hydroponics); and
- Local suppliers who are world leaders in glasshouse and hydroponic technology.

(NDEFRA, 2001; Hanger, 1993; Carruthers, 1999; and Rick Donnan *pers. comm.*)

Trends in the Dutch hydroponic industry are summarised by the Netherlands Department of Environment, Food and Rural Affairs as including:-

- Increasing influence of the market on production – ie contract production for retailers, fewer middlemen;
- Increasing social pressure for a product this is produced without chemicals, ‘in-harmony’ with nature makes use of IPM;
- Rationalisation and increasing business size;
- Quality control systems. Objective definition of quality and accurately predicted harvest times;
- Full automation of glasshouses with research on energy efficiency; and
- Additional Government funding of research on floriculture and horticulture.

Lessons for Australia: the Dutch industry provides a useful model for the further development of Australian commercial hydroponic production and the Australian situation is contrasted with that of the Dutch in Chapter 6 – Constraints to Further Expansion of Commercial Hydroponic Production.

Spain

Spanish hydroponics has grown rapidly on the back of a fast growing horticultural sector. The area of Spanish greenhouses now stands at 30,000 ha and it is estimated that some twelve or more percent of this area is dedicated to hydroponic production (Ministry of Agriculture, Food and Fisheries Spain).

Greenhouse production in Spain has grown with the adoption of best management practice and technology from Holland and the UK combined with EC market access, a favourable year round climate and lower labour costs.

Initially Spanish hydroponic production was constrained by poor support infrastructure, shortages of nutrient solution and early failures with nursery stock. However, once these initial difficulties were addressed, and using the Dutch industry as a model, it is anticipated that the Spanish industry will continue to grow rapidly over the short to medium term (Ministry of Agriculture, Food and Fisheries Spain).

Lesson for Australia: adoption of large-scale best practice combined with core comparative advantages (labour and climate).

Germany

The German production industry is small and in the past hydroponic production was not well regarded. Pushed by the Greens, there was a perception in Germany that hydroponic production was not natural and that it was reliant on chemical inputs. At the time much of Germany’s imports were from Holland who responded by emphasising that their produce was free from many agricultural chemicals. The Dutch do not market their product as hydroponically grown, rather they focus on the ‘clean and green’ image they have established for their produce (Rick Donnan *pers. comm.*).

Lesson for Australia: it is important either to market produce on the basis of its qualities (eg flavour, freshness, visual appeal) or to increase consumer understanding of the beneficial qualities of hydroponic produce (lower chemical and water usage, sustainability of production, better flavours in fruit and vegetables) so that the actual production method does not work against growers.

3.2 North America

Canada

Canada has rapidly embraced commercial hydroponic production, expanding in total greenhouse area from as little as 100 ha in 1987 to approximately 2,000 ha in 2001. Canadian production systems utilise rockwool, perlite and NFT for the production of tomatoes, cucumber and capsicum. Some 50% of tomatoes and capsicum and 25% of cucumbers produced hydroponically are exported to the United States (Khosla, 1999).

Hydroponics is the most popular method of growing vegetables in glasshouses in Canada and in 1998, the most recent data available, greenhouse vegetable production accounted for almost one quarter of total vegetable production (an industry with a farm gate value of CD\$1.4 billion). Potatoes are the most valuable Canadian vegetable crop and these are not grown hydroponically (Department of Agriculture and Agri-food, Canada website).

Hydroponic production has grown in popularity with Canadian commercial vegetable producers as it is a less labour intensive way to manage larger areas of production and an efficient way to control inputs and manage facilitates for disease and pests. Hydroponics eliminates the need for soil fumigants and can increase yields of popular vegetables by up to 100 per cent. (Department of Agriculture and Agri-food, Canada website).

Industry trends within Canada include:

- Continued conversion of conventional soil based greenhouses to hydroponics;
- Use of IPM rather than chemicals such as methyl bromide;
- Increasing greenhouse size. The average size of a commercial Canadian hydroponic operation is already around 1.5 ha;
- An increasing need to further differentiate hydroponic product on quality attributes;
- Fight back from soil growers. The quality of field tomatoes is improving and sale price has always been very competitive; and
- Export markets threatened by expansion of greenhouses in the US and Mexico.

(Department of Agriculture and Agri-food, Canada; Jensen, 1999 and Sullivan *et al.*, 1999)

Lessons for Australia: marketing and product differentiation are the keys, export and home markets are quickly lost if these issues are not constantly addressed. Breakthroughs in industry prosperity will be driven by marketing rather than further improvement in technology (see also USA section below).

United States of America

United States crops and production techniques are similar to those in Canada. However, the industry has been slower to develop in the US. Jensen and Collins (1985) attributed this to:

- A history of extremely high levels of failure (several thousand operations) caused by the entrepreneurial promotion of hydroponic systems to the wrong people for the wrong reasons;
- A diverse climate. Fresh produce can be grown somewhere on mainland USA anytime of the year (unlike Europe and Japan with defined seasons);
- Rapid and effective transport;
- A perception of high energy costs associated with hydroponics;
- Stigma associated with historically high levels of chemical usage; and
- High levels of technical and economic management required for profitable production.

In the last three to five years there has been a major turnaround in the United States perception of commercial hydroponic production, with industry promoters and advocates marketing improved technology and management. This in turn has led to something of a production push, as different from a market led, approach to hydroponic production. Sullivan and Garleb (1999) point to an industry at the cross roads with high potential for continued expansion if a strategic approach to market development is taken, but with high risks of oversupply, low prices and marginal returns under existing production driven approaches.

Other US industry trends include:

- US government targeting emerging agricultural systems like hydroponics for support;
- Increasing planting densities to constrain root area and save on rockwool costs, maximising control over nutrition, pH, aeration and root diseases;
- Aim for all future systems to be closed (ie no run-to-waste systems), preventing any loss of mineral elements and the contamination of groundwater (USDA); and
- For health reasons, hydroponic systems may be used to reduce nitrogen levels in leafy vegetables at harvest. This may be especially important for leaf crops grown under low winter light intensities (Jensen, 1999).

Lesson for Australia: USA production currently expanding at a rate that is not economically sustainable without urgent attention to market development.

3.3 Asia and New Zealand

East and South East Asia

Significant producers in Asia include Singapore, Taiwan, Japan and China who exports produce to Japan. Asian countries that import hydroponic produce include Hong Kong, Korea, Taiwan and Malaysia.

In Japan hydroponic production is undergoing vertical integration with the food-processing sector. Produce is destined for sandwiches and side dishes and only a small percentage retails on supermarket shelves. Production is sanitised and sealed to a level equivalent to that of food processing plants. The industry is a major utiliser of IPM systems and is largely chemical free. Sanitisation and low or no chemical usage is extremely important to Japanese consumers who are prepared to pay prices 20-30 percent higher than those received for conventionally grown produce. Exports of fresh hydroponic produce from Australia to Japan from all but Tasmania are restricted by the presence of fruit fly on the Australian mainland

Lesson for Australia: While Singapore, Malaysia, Hong Kong and Taiwan markets hold potential for produce exports, opportunities in Japan are limited under current sanitary - phytosanitary arrangements.

New Zealand

New Zealand is a major producer of greenhouse, and more recently hydroponic, fruit, vegetables and cut flowers. Almost all New Zealand greenhouses are now hydroponic. The industry is efficient (best practice management and technology), large scale and export oriented. A significant percentage of the technology employed in Australia for commercial hydroponic production is of New Zealand origin. The New Zealand government encourages the development of the New Zealand industry and policies are in place to facilitate industry growth in peri-urban areas. It would appear likely that in the next three to five years New Zealand will be able to overcome Australian sanitary/phytosanitary obstacles and gain access to Australian domestic markets.

Lessons for Australia: New Zealand will be competing in our domestic market place with efficiently produced, high quality hydroponic produce in the short to medium term.

3.4 International Trends in the Industry

The following worldwide trends in horticultural marketing and production have been noted as affecting the future of commercial hydroponics:

- The internationalisation of the supply of fresh fruit and vegetables. Global specialist food companies are seeking large continuous volumes of produce. These same companies are then capable of packing handling and distributing this produce worldwide.
- The extension of this trend is that producers who find themselves outside this system will gradually lose access to all but low margin residual markets.

- The Dutch have responded to this challenge by shedding brokers and auction based sales and establishing forward linkages with international food companies.
- Dutch producers also work in clusters that share information and marketing costs.
- Worldwide, there is a major rationalisation of production as a result of international industry integration.

3.5 In Summary

The key messages to emerge from the review of the global hydroponics industry are:

- The commercial hydroponics industry has grown four to five fold in the last 10 years;
- Production is focused in affluent countries with discerning consumers or countries which have access to these markets;
- Worldwide, there are a limited number of crops grown hydroponically. Tomatoes, cucumbers, lettuce, capsicums and cut flowers are the most important;
- Hydroponics has embraced IPM and is moving away from ‘run-to-waste’ systems;
- Success in the short to medium term will come from a market focus not a break through in hydroponics technology;
- The Dutch provide an efficient industry model for Australia to emulate;
- The reaction of German consumers to an ‘unnatural’ production system needs to be noted and addressed by the Australian industry;
- North American expansion is currently driven by ‘production push’ and is set for an expanded period of low returns if a Dutch style market focus is not introduced to their industry;
- Competition on the domestic Australian market can be expected from New Zealand, and possibly Holland, in the short to medium term; and
- International integration of production and marketing will ‘shut out’ producers who are not sufficiently large scale or part of a cluster arrangement.

The following chapter presents the existing Australian situation against this international backdrop.

4. Australian Hydroponics Industry - Characteristics and Trends

At the present time, Australia is recognised as the largest hydroponic lettuce grower in the world (with over 240 hectares under cultivation). Australia's hydroponic strawberry cultivation is larger than that achieved in the United States, and the flower industry is almost as large as that in the US (*Accent Hydroponics*, unpublished).

4.1 Industry Location, Major Products and Grower Numbers

An overview of Australian commercial hydroponic industry location and products is provided in this section. The data is based on material provided by Hanger (1993); Bailey (1997) and industry consultation. A summary of grower numbers and area of production is provided in the table below for 1990 with an update based on limited survey data for 1996. A brief commentary on each state's industry follows.

Table 6. Industry Size - Number of Growers, Area Used and Crops Produced

State and Crop	No of Growers	No of Growers	Area (ha)	Area (ha)
	1990	1996	1990	1996
NSW				
Lettuce	97	147	47.5	112.5
Strawberry	24	35	9.5	7.7
Flowers	18	58	6.0	36.6
Cucumber	12	37	5.5	10.1
Tomato	11	55	9.0	14.9
Other	5	26	1.0	7.1
Other vegetables	4	N/A	1.5	N/A
<i>SUB TOTAL</i>	<i>171</i>	<i>358</i>	<i>80.0</i>	<i>188.9</i>
Victoria				
Lettuce	10	40	2.5	30.6
Strawberry	17	20	4.0	4.4
Flowers	77	60	19.5	37.9
Cucumber	N/A	3	N/A	0.8
Tomato	15	135	4.0	36.7
Herbs	4	N/A	0.5	N/A
Witloff	2	N/A	0.1	N/A
Other	N/A	8	N/A	2.2
<i>SUB TOTAL</i>	<i>125</i>	<i>266</i>	<i>30.6</i>	<i>112.6</i>

State and Crop	No of Growers		Area (ha)	
	1990	1996	1990	1996
Queensland				
Lettuce	30	100	20.0	76.5
Strawberry	2	40	2.1	8.8
Flowers	25	41	10.0	25.9
Cucumber	N/A	12	N/A	3.3
Tomato	1	40	0.1	10.9
Capsicum	1	N/A	2.0	N/A
Other	N/A	20	N/A	5.4
<i>SUB TOTAL</i>	<i>59</i>	<i>253</i>	<i>34.2</i>	<i>130.8</i>
Western Australia				
Lettuce	2	15	0.4	11.5
Flowers	4	20	3.5	12.6
Cucumber	3	30	0.2	8.2
Tomato	N/A	20	N/A	5.4
Other	N/A	13	N/A	3.5
<i>SUB TOTAL</i>	<i>9</i>	<i>98</i>	<i>4.1</i>	<i>41.2</i>
Tasmania				
Lettuce	N/A	5	N/A	3.8
Strawberry	1	1	0.1	0.2
Flowers	2	5	0.9	3.2
Cucumber	2	7	1.2	1.9
Tomato	2	12	1.5	3.3
<i>SUB TOTAL</i>	<i>7</i>	<i>30</i>	<i>3.7</i>	<i>12.4</i>
South Australia				
Lettuce	1	9	0.2	6.9
Strawberry	2	1	0.1	0.2
Flowers	12	6	1.8	3.8
Cucumber	N/A	2	N/A	0.5
Tomato	2	5	0.2	1.4
Other vegetables	2	N/A	0.1	N/A
Other	1	1	0.1	0.3
<i>SUB TOTAL</i>	<i>20</i>	<i>24</i>	<i>2.5</i>	<i>13.1</i>
TOTAL	391	1,029	155	499

(Hanger, 1993; Bailey, 1997 and industry consultation)

N/A - Figures not available.

Table 7. Industry Size Summary - 1990 and 1996

Crop	No of Growers	No of Growers	Area (ha)	Area (ha)
	1990	1996	1990	1996
Lettuce	140	316	70.6	241.8
Strawberry	46	97	15.8	21.3
Flowers	138	190	41.7	120
Cucumber	17	91	6.9	24.8
Tomato	31	267	14.8	72.6
Capsicum	1	N/A	2.0	N/A
Herbs	4	N/A	0.5	N/A
Witloff	2	N/A	0.1	N/A
Other vegetables	6	N/A	1.6	N/A
Other	6	68	1.1	18.5
AUSTRALIAN TOTAL	391	1,029	155.1	499.0

(Hanger, 1993; Bailey, 1997 and industry consultation)

N/A – Figures not available.

New South Wales

NSW is the state with the largest commercial hydroponics industry. The industry includes significant areas of cut flowers, tomatoes and cucumbers but it is lettuces which dominate, especially 'open head' gourmet style products. Open head lettuce include varieties such as cos, mignonette, butter, oakleaf and so on. These products are well suited to hydroponic production, as a soil free growing environment produces a clean fresh looking and good tasting product. Hydroponic lettuce are grown outdoors in a netted environment using NFT or modified NFT (with a gravel or perlite media). As much as 90% of the lettuce consumed in NSW is now hydroponically produced (Jim Delaney *pers. comm.*). All but traditional iceberg varieties are produced hydroponically.

Hydroponic production is concentrated in the Sydney Basin, within close proximity to markets. However, with urban expansion and conflicting land use issues the industry is expanding into the Central Coast. The north coast of NSW is also a major production hub with centres of activity located in Port Stephens, Port Macquarie, Coffs Harbour, and the Tweed Valley (Jonathon Eccles *pers. comm.*). A number of Central Coast and North Coast lettuce growers belong to a successful cooperative export marketing arrangement known as Lotus Red.

A recent trend to emerge in the industry is the establishment of new large commercial enterprises, run by extended family units in regional NSW centres (eg Tamworth, Yass and Mittagong). These enterprises are targeting both regional centre markets and markets in the capital cities (Leigh James *pers. comm.*).

Victoria

While NSW commercial hydroponic production is dominated by lettuce, Victoria is evenly split between cut flowers, tomatoes and lettuce. Popular hydroponically grown cut flowers include roses, gerberas carnations and lisianthus. Flowers are grown in greenhouses, often in a pine bark media using run-to-waste systems.

Production tends to be concentrated in an arc around Melbourne and Port Phillip Bay with pockets of activity in Gippsland, the Mornington Peninsula, the Dandenongs, the Bellarine Peninsula, Seymour and northern Victoria (Graeme Smith, Robert Hayes, Keith Ellerton *pers. comm.*).

The Victorian industry has a number of big commercial hydroponic tomato growers and marketers (including Flavorite and Horizon). These large operations act as packers and marketers for clusters of independent growers and ensure large consistent lines of product are available to customers. For example in Victoria, Flavorite supply 50% of the hydroponic tomatoes sourced by Coles. Most of Woolworth's demand for hydroponic tomatoes is also satisfied by Flavorite (Mark Millis *pers. comm.*). Woolworths market up to four grades of tomato at any one time and hydroponic produce, including vine-ripened tomatoes, attract the highest prices per unit.

South Australia

Commercial hydroponic production in South Australia is concentrated to the north of Adelaide and around Virginia and the Fleurieu Peninsula. Production services the Adelaide market and the big commercial hydroponic tomato growers and marketers of Victoria. South Australian production is dominated by lettuce, tomato and cut flowers, other significant minor crops include strawberries, cucumber, herbs and Asian vegetables (Jonathon Eccles *pers. comm.*).

Queensland

Queensland is the second largest commercial hydroponic production state after NSW. Production is dominated by lettuce, flowers and tomatoes. Significant other products include cucumbers and strawberries. Much of the produce tends to be grown outdoors.

The industry is concentrated in the south east of the state and services Brisbane and the Gold Coast. There are pockets of growers throughout Queensland including hydroponic strawberry production on the Atherton Tablelands, cucumbers in Bundaberg and Toowoomba. Hydroponic cucumbers include Lebanese and continental varieties. They are generally grown in run-to-waste systems utilising the most acceptable locally available media, for example sawdust (Andrew Youngberry *pers. comm.*). Hydroponic cucumbers hold a significant share of the total domestic market.

Tasmania

Tasmania has a small, export oriented, commercial hydroponics industry. Major products are lettuce, flowers and tomatoes. Significant other products include cucumbers, capsicums and eggplant. Tasmania has fruit fly free status which facilitates the export of fresh horticultural produce to countries like Japan.

Western Australia and the Northern Territory

Western Australian production is spread across lettuce, cucumber, flowers and tomatoes. Production occurs in the outer areas surrounding Perth with some activity at Bunbury and Albany (Jonathon Eccles *pers. comm.*).

It is understood that there are a handful of producers supplying Darwin in the Northern Territory.

In Summary

The commercial hydroponics industry is scattered over all Australian states;

- Best available data on industry size comes from a 1996 national survey commissioned by HRDC;
- Between 1990 and 1996 the area of production increased from 155 to 500 ha. It is quite possible that a similar increase took place between 1996 and 2001;
- Australia is ranked in the top 10 hydroponic producing countries by area, but compared with the areas Holland (10,000 ha) and Spain (4,000 ha) have under hydroponics Australia is still relatively small;
- The major production states are NSW (190 ha), Queensland (131 ha) and Victoria (113 ha); and
- The major commercial crops are lettuce (242 ha, 316 growers), cut flowers (120 ha, 190 growers), tomatoes (73 ha, 267 growers), cucumbers (25 ha, 91 growers) and strawberries (21 ha, 97 growers).

4.2 Value of Production, Employment and Assets

Estimates of production value, employment and industry assets are summarised in the table below.

Table 8. Estimated Industry Farm Gate Value, Employment and Assets (1996)

Crop	Farm Gate Value (\$'million)	Farm Employment (full time equivalents)	Farm Assets (\$'million)
Lettuce	44.9	818	61.7
Flowers	40.7	989	108.3
Tomatoes	35.4	635	43.2
Cucumbers	5.6	121	8.3
Strawberries	4.4	192	7.3
Other Crops #	1.5	316	13.7
Total	132	3,072	242

eg Gerberas and chrysanthemums (Bailey, 1999)

In 1996 the industry had some 1,029 growers, who created 3,072 full time job equivalents from \$242 million in farm assets and generated \$132 million in farm gate production value.

During the course of industry consultation for this study, various industry stakeholders volunteered current industry gross value estimates, these included:

- A 'very conservative' estimate of \$200 million annually at the farm gate (Axford, unpublished);
- A forecast \$300 million, 2,000 growers and the fastest growing horticulture sector (Carruthers, 1997);
- An estimated gross value of \$600 million annually (Jonathon Eccles pers. comm.); and
- Gross value between \$500 million and \$1 billion with tomatoes accounting for \$150-\$200 million and lettuce accounting for \$100 million (Robert Hayes, pers. comm.).

A simple unsupported average of these estimates results in a gross value at farm gate of \$600 million per annum. It is suggested that an estimate of \$300-400 million is more realistic (Rick Donnan, *pers. comm.*). This estimate compares to actual farm gate figures for all of Australian horticultural production of \$4.74 billion. Of this total vegetable and nursery production account for \$2.18 billion (HAL website).

The commercial hydroponics industry may be as large as 20% of total vegetable and nursery production.

4.3 Marketing Channels, Hydroponic Branding, Price Premiums and Export Sales

Marketing Channels

Hydroponic product is distributed through all the normal wholesale and retail distribution channels. The Sydney and Melbourne markets handle the bulk of grower sales (Leigh James *pers. comm.*). Major buyers, including the supermarket chains, source hydroponic product predominantly through the wholesale markets but in some cases also buy direct from growers eg Eden Farms and Flavorite, (John Ransley, Mark Millis, Andrew Youngberry *pers. comm.*).

To facilitate large buyer purchase of hydroponic product, leading edge growers have organised themselves into selling cooperatives to jointly market a line of produce and ensure appropriate product quality. Examples of grower clustering for marketing purposes include Flavorite in Victoria for tomatoes and Lotus Red in NSW for lettuce (see Chapter 7 for a review of Pacific Hydroponics a successful Lotus Red member).

Marketing of Product as Hydroponic

Some hydroponic product, including lettuces and tomatoes, is branded as hydroponic at retail level. However, a lot of hydroponic product is sold on the basis of quality and not by promoting its method of production ie hydroponic versus soil grown. For instance, premium hydroponic tomatoes are often marketed as ‘vine ripened’ rather than hydroponic, fancy hydroponic lettuces are marketed as ‘living lettuce’ in a root on form, rather than as hydroponically grown.

Reluctance of growers and retailers to market product under a hydroponic label is one reason why the industry is perceived as being smaller than it actually is. This issue raises questions about whether the industry should promote itself and the desirable qualities of its products or whether it should remain in the shadows and hope to avoid a German style backlash for producing ‘unnatural’ product. It would seem that on balance the industry would be better to promote its claim to ‘clean and green’ production and dispel any high chemical usage/unnatural system myths before they take root.

Price Premiums

Given that hydroponic produce is marketed through all channels, and some does not compete with soil grown produce, it is difficult to isolate price premiums for all of the major hydroponic products. However, with this said, it is fair to say that where hydroponic produce competes against conventional soil grown products, the hydroponic product tends to occupy a higher price band. Higher unit returns are achieved because not only does the product often look (fruit, vegetables and cut flowers) and taste (fruit and vegetables) superior, but supply is reliable and virtually year round for many crops. The following premiums are provided for farm gate prices and are intended only to be broadly indicative.

Table 9. Indicative Farm Gate Price Premiums (kg farm gate)

Crop	Source	Soil Grown	Hydroponic
Cucumber – average continental	Youngberry	\$1.00	\$1.50
Capsicum –average of yellow, orange, red and green	Wallace	\$2.25	\$3.25
Tomatoes	Smith/Millis	\$1.50	\$2.80
Flowers and Lettuce	Do not directly compete		

The extent to which these premiums are realised in practice will depend on seasonal volumes, marketing, presentation and actual product quality (Leigh James *pers. comm.*).

Export Sales

A small amount of Australian hydroponic produce is exported to regional markets such as Singapore, Hong Kong, Taiwan and Malaysia (Jim Murison *pers. comm.*).

Where Australian hydroponic produce exports have been successful, success has been achieved through cooperative marketing efforts, ie individual growers have pooled, graded and quality assured

product for sale under a single brand name. Generally speaking, at the current time, individual hydroponic growers are of insufficient size to tackle export markets (Jonathon Eccles *pers. comm.*).

Advice from NSW Agriculture's marketing unit AgSell, is that domestic markets for hydroponic produce need to be better served and understood before individual growers tackle export sales. A stronger domestic base, it is argued, will provide a platform for export sales and absorb any produce that cannot be exported. Furthermore, it needs to be remembered that the bulk of South East Asian demand for both lettuce and tomato is for low-grade 'commodity' style product for the hamburger market (Jim Murison *pers. comm.*).

In the short to medium term it is likely that Australian hydroponic export markets will remain as Singapore, Hong Kong, Taiwan and Malaysia. Freight costs for export of fresh produce to Europe are prohibitive and regulatory controls, together with freight advantages for hydroponic producing countries such as China and Korea make Japan a difficult market (Jim Murison *pers. comm.*). Tasmania is the only Australian state able to tackle high freight costs to Japan because it is an area certified as being free from fruit fly and therefore favourable access arrangements with Japan may be negotiated.

In the longer term there may be potential for hydroponically grown native cut flowers in discerning markets such as Europe and Japan (Jim Murison *pers. comm.*).

4.4 Seasonality of Production, Environmental and Health Impact

Seasonality of Production

Generally speaking hydroponic produce can be grown and marketed on a year round basis. Certainly this is true for production in the warmer parts of Australia. This is not to say that product is always grown and marketed year round. Some producers manage their production so that crop change over and greenhouse maintenance occurs during peak production periods for soil based producers (ie late spring through summer) when prices for produce are at their lowest (David Wallace *pers. comm.*). Furthermore, not all hydroponic production systems are able to produce all year round. Mark Millis of Flavorite comments that even with greenhouse technology and heating, tomatoes cannot be produced economically through winter in Victoria and supply needs to be sourced from northern Australia to provide continuity to customers.

Impact on the Environment and Human Health

Older style greenhouse and hydroponic production systems were not especially environmentally friendly. Fruit, vegetables and cut flowers were grown using large amounts of chemical sprays and nutrient laden water was disposed of on to surrounding land from run-to-waste production systems. While some older hydroponic production systems still operate this way, the industry is moving towards low chemical input IPM based systems and reuse of nutrient solution. In 1996 more than half of all growers used closed production techniques (Bailey, 1999).

Remaining environmental issues for the industry include the potential for 'visual pollution' from poorly maintained greenhouses in peri-urban areas and disposal of growing media and plastic greenhouse sheeting at the end of its economic life (Jeremy Badgery-Parker, *pers. comm.*).

While there are some reports of greenhouse based production, especially in Western Sydney, being carried out contrary to National Registration Authority requirements for use and application of agricultural chemicals, generally speaking the industry is highly concerned with chemical minimisation. Australian commercial hydroponic producers should therefore be well placed strategically to respond to consumer concerns regarding chemical residues and planned supermarket implementation of residue testing.

4.5 Strengths, Weaknesses, Opportunities and Threats

A description of the positive and negative aspects of hydroponic production and the Australian hydroponics industry in particular are presented in the section below in the form of a SWOT (Strengths, Weaknesses, Opportunities and Treats) Analysis. Information was compiled from the literature and industry consultation.

Strengths of hydroponic production

No soil

Good quality soil is not a requirement and therefore lower cost land can be utilised for hydroponic production (Carruthers, 2001).

Nutrient and pH control

The crop will receive the correct nutrients provided systems are appropriately calibrated and managed. In addition, pH can be more easily and quickly tested and controlled.

Higher yield

The turnaround time between crops is shorter, and therefore total production should be higher than in conventional soil based systems. For example conventionally grown lettuces might produce 3-4 crops on the north coast of NSW, hydroponics will produce between 7 and 14 (Leigh James *pers. comm.*). For tomatoes, hydroponic production yields between 25 and 50 kg/m² while field grown tomatoes average 15kg/m² (Graeme Smith *pers. comm.*).

Pest, disease and weed control

Hydroponics facilitates the adoption of IPM and a reduction in agricultural chemical use. It reduces production loss and control costs from soil born diseases and removes the need for weed control (as the reservoir for weed seeds – soil, is not present in hydroponic systems) (Donnan, *pers. comm.*)

Climate certainty

Hydroponics has the potential to overcome production uncertainty caused by climatic variability (drought, flood, heat and cold stress) and therefore to provide a consistent and higher quality yield. Many greenhouse systems include the ability to warm the crop's root zone.

Production in difficult environments

Hydroponics permits production in climatic areas not normally suited to commercial growing, eg hydroponic production of lettuce in Far North Queensland, an area not normally suited to lettuce production.

Suits crops, which require a closed environment

Some crops need a closed environment, for example, to avoid cross-pollination with other crops (Hassall, 1993).

Lower level land and water requirements

Hydroponics has a smaller land area requirement than conventional soil based systems and uses less water (see table below).

Table 10. Water Use – Hydroponic production compared to conventional production

Crop	Water Application (ML/ha/crop)	
	Hydroponic Production	Conventional Production
Lettuce	1.0 ML	3.0 – 4.0 ML
Tomatoes	1.5 ML	7.5 ML (flood irrigation) 2.0 ML (trellis with drip irrigation)

(Leigh James *pers. comm.*)

Potentially higher product price

Hydroponic produce can receive higher prices than conventional produce (Hassall, 1993). In practice, however premiums are often not realised (Leigh James *pers. comm.*). See notes on premiums for hydroponics in the above section.

The product appeals to discerning consumers

Hydroponics produces an ultra clean product free from soil splashes and insects, it looks appealing, and for fruit and vegetables, tastes superior. Quality and taste of hydroponic produce are more reliable than field-grown produce (Jim Delaney *pers. comm.*).

DON'T know about this – sounds a bit dodgy. Possibly healthier b/c reduced sprays etc.

Capacity to target specific markets

Hydroponics provides an opportunity to create and target new market niches. For example 'root on' living lettuces and 'vine ripened' tomatoes.

Sustainable production and an answer to urban encroachment on productive agricultural land

Worldwide as urban centres expand, housing and industry displace agricultural production in areas which were formerly market gardening zones. Appropriately managed hydroponics requires less land and is more able to be accommodated (less chemicals, runoff, smell and noise) in an urban area (Jim Delaney *pers. comm.*).

Potentially lower labour costs

Labour can be saved over an equivalent volume of conventional soil based production once the hydroponic production system has been established. Hydroponic systems enjoy lower costs for harvesting, growing and planting (Hassall, 1993).

Strengths of the Australian hydroponic industry

Critical mass of production

For a number of products (tomatoes, lettuce, cucumber, capsicum, cut flowers, etc) production has reached a critical mass, allowing the development of a dedicated marketing chain, specialised marketers and stocking of product by the major food retailers.

Adequate markets

Markets are not a constraint to the industry, the product is in the mainstream and normally competes in the higher quality range (Steve Carruthers *pers. comm.*). With this said, all agricultural markets are easily flooded and returns lowered if production is not driven by demand.

Specialisation in the production of lettuce

Australia is a world leader in the hydroponic production, post harvest care and export of lettuce (Garry Cahill *pers. comm.*).

Industry supplies and support

The Australian hydroponic production industry is adequately supplied with greenhouse technology and nutrient solutions and is supported with both public and private advice and extension. There is plenty of technology and advice from places like the National Centre for Greenhouse Technology and a wealth of commercial suppliers to the industry (Tony Axford *pers. comm.*).

Development of industry clusters and centres of excellence

Centres of excellence are emerging with concentrations of growers, nursery and technology suppliers and cooperative and university backed research programs. The Central Coast Region of NSW is one such example (Tony Axford *pers. comm.*), another is the Victorian government's proposed Singapore style Agrotechnology Park (Carruthers, 2001).

Horticulture Australia Limited (HAL) research funding

Research levies are collected from Australian producers of lettuce, cucumber and capsicum regardless of their production technology. Funds are available for production and marketing research.

Innovative and professional industry participants

A number of growers are using the latest technology and are constantly looking for new methods of production and updated systems to improve their operation. Individual growers and growers involved with AHGA undertake study tours both in Australia and overseas (particularly The Netherlands and New Zealand) to keep abreast of the latest technology and industry developments.

Weaknesses of hydroponic production

High capital costs

Hydroponics is capital intensive and start-up costs (greenhouses, irrigation, computer operating systems, etc) can be substantially more than for conventional (soil based) systems. A commercial hydroponics system requires highly effective marketing to achieve an acceptable return on capital. A prospective grower therefore needs to have identified and secured a profitable market niche (Jim Delaney *pers. comm.*).

New and unfamiliar technology

For most producers the concept is new and mistakes will be made. In comparison to conventional soil based production, aspects may still be unproven and therefore risky.

Precise and time consuming production system

The system requires constant monitoring, is not conducive to owners taking holidays and has little margin for error (Steve Carruthers, 2001).

Labour intensive for larger operations

Diseconomies of scale would appear to operate in the industry once enterprise size increases beyond what can be managed by a family unit. Returns may not be sufficient to support the labour required (Jim Murison *pers. comm.*) and the operator may have difficulty securing labour with appropriate skills and commitment (Jonathon Eccles *pers. comm.*). Efficient large-scale operations may need to shed labour and invest in automation to achieve an appropriate return on capital.

Poor consumer perception

Consumers may not understand hydroponics, some could perceive it as an unnatural and chemical-reliant production system (Carruthers, 2001). See notes on Germany in Chapter 3.

High energy usage

The industry is dependent on high priced energy for greenhouse heating and much research effort in Holland and the USA is directed at addressing this cost.

Hydroponics is not a suitable production system for all crops and flowers

Not all crops can be economically produced using hydroponic systems, root crops such as potato and carrot and long life perennial species do not appear suitable. It is worth noting that the Israelis are experimenting with hydroponic citrus.

Weaknesses of the Australian hydroponic industry

A fragmented industry

While large producer selling groups (grower cooperatives) are beginning to emerge in Australia along Dutch and New Zealand lines, much of the Australian industry is geographically isolated and operates in a non cooperative manner (Jim Delaney *pers. comm.*).

Grower secrecy

In other countries, notably Holland, there is willingness by growers to share information among their peers. Growers in districts meet regularly for open discussions on markets and production methods. By contrast much of the Australian industry is secretive and in some parts divided by ethnic loyalties (Jeremy Badgery-Parker *pers. comm.*).

Need for industry leadership and planning

Commercial stakeholders currently manage the commercial hydroponics industry on a voluntary basis. The lack of a paid industry Chief Executive Officer and an industry strategic plan has slowed industry development (Jim Delaney, Graeme Smith *pers. comm.*).

Promoted by dubious means

Hydroponics has sometimes been promoted as both a tax driven investment by corporates and as a “get rich quick” scheme for the newly retired or redundant. In the past a number of hydroponic investment schemes have failed (Rick Donnan *pers. comm.*) which in turn has labelled hydroponics in the eyes of many as a poor investment. Consequently the industry has low credibility with financial institutions and has difficulty attracting capital (Mark Millis *pers. comm.*).

An image linked to backyard marijuana growing

The lay image of the industry is often of backyard and hobby style operations for the purposes of marijuana growing.

No industry standards or statistics

A lack of industry standards for production includes means of objectively describing the product and its method of production (eg IPM, organic, etc). Regular statistics on the industry including production volumes, producer numbers, industry value, location and so on are not collected (Carruthers, 2001).

A dearth of management and marketing skills amongst growers

Small-scale operators get caught up in establishing the perfect production system and focus on technical detail rather than management and marketing (Leigh James *pers. comm.*). Retired or redundant workers use their redundancy packages to set up a hydroponics operation with no real plan on how to market the produce or even knowledge of production (Jim Delaney *pers. comm.*). Industry focus needs to be on the crop and horticultural skills rather than on the hydroponics technology. Success is more likely to come from existing growers converting to hydroponics than from first time horticultural producers.

Unrealistic expectations from first time horticultural producers

New entrants often enter the industry with unrealistic expectations of industry profitability and find themselves in a business characterised by high debt, lower than expected returns and a very high labour requirement. Unfortunately these systems (set up by inexperienced growers with unrealistic expectations) often fail and the business collapses (Leigh James *pers. comm.*).

Energy costs in a hot climate

It costs three to five times as much to cool a greenhouse as it does to heat one (Jim Murison *pers. comm.*). However, it needs to be remembered that Australia has low energy costs by world standards and less than half of all hydroponics in Australia is grown in greenhouses.

Inappropriate planning policies

An absence of planning policies sympathetic to hydroponics in peri-urban environments results in a climate of conflict and potentially industry under investment. One notable exception in NSW is Wyong Council on the Central Coast, which has a specific Development Control Plan for hydroponics to encourage the industry to locate within the local government area.

Opportunities for the Australian hydroponic industry

Promotion of hydroponic product, where appropriate, as low or no chemical use and sustainable

The Dutch make use of a butterfly label to denote hydroponic product that is produced using IPM ie fewer chemicals and 'in harmony' with the environment. Hydroponics also has advantages associated with lower water use, no reliance on arable land and sustainability of production. Greater differentiation of product already produced in Australia in this environmentally friendly manner would seem like an obvious opportunity for the industry.

Development and certification of organic hydroponics

Hydroponics with its use of IPM, natural pesticides and sustainable production systems by the best industry operators is closer to organic production than some conventional soil based systems. If cost effective natural alternatives to inorganic nutrients such as liquidised manures can be identified, pursuit of organic certification and targeting of this growing market is an opportunity for the industry. Leading producers and the National Centre for Greenhouse Technology are currently working towards this goal.

Further use of cooperative marketing by hydroponic producers

Following the trend from Holland and other developed hydroponic sectors, grower direct links to the food industry and combining of individual production outputs to provide larger and consistent product lines, is one way of ensuring the industries future relevance. Cooperative marketing provides opportunities to increase hydroponics penetration of domestic markets and overcome reluctance, high entry costs and production shortages associated with securing export markets.

Additional value-adding of hydroponic produce

Marginal returns, on even large production enterprises run by experienced horticulturists (see Chapter 6), may be addressed through value-adding to products prior to them leaving the farm. While value-adding has proved successful for growers consulted during the study, it has as many pitfalls as any other aspect of hydroponic production. For instance, the preparation of value-added salad mixes from hydroponic lettuce will create new issues for growers unused to sterile food production and handling techniques. Packaging equipment will also need to be purchased (Garry Cahill, Leigh James *pers. comm.*).

Growth opportunities presented by reform to conventional production systems

Conventional soil based production systems have, and will continue to, undergo major structural adjustment as a result of changes to their operating environment. Regulatory reform in relation to water access and use, and key chemical availability (eg the phasing out of methyl bromide an important soil sterilisation agent) will favour low water and chemical use systems like hydroponics. A strategically focused industry, perceived as being environmentally friendly as well as efficient, should be able to grow on the back of these changes.

New or growth products

Opportunities would also appear to exist to extend the range of products grown hydroponically. The fastest growing vegetable product is currently capsicums (of various colours). Researchers have also indicated a potential for production and export of select Australian native cut flowers that are grown hydroponically (Jim Murison *pers. comm.*).

Threats to the Australian hydroponic industry

Improved, cost effective soil grown products

Hydroponic produce tends to be higher priced than soil grown produce and is therefore vulnerable to improvements in lower cost soil based produce, for example, calyx-on soil grown tomatoes that give the appearance of a high quality, hydroponically grown, 'vine ripened' product.

Imports of fresh produce from New Zealand or Holland

It is quite possible that importers will satisfy Australian Import Risk Assessment procedures in the next few years and efficient and low cost imported hydroponic product will compete with the domestically grown. It is important that the industry's house is in order before this happens.

Consumer backlash on hydroponic produce

Unless consumers understand the beneficial features of hydroponic produce the industry may potentially be threatened by a consumer backlash if hydroponics is presented by the media as chemically driven and unnatural.

Vertical integration of the supply chain

Growers, who do not organise themselves into lasting supply arrangements, may find themselves shut out of the most profitable markets.

Rising energy costs

The industry is vulnerable to rising energy costs and industry research needs to be directed towards heating efficiency and alternative means of heating.

4.6 Domestic Trends in the Industry

The following trends are noted in the Australian commercial hydroponics industry:

- The formation of selling and marketing cooperatives to achieve market critical mass on both domestic and export markets;
- Corporate interest in hydroponic production and marketing;
- Multi site operations, with full time employees located close to major markets (metropolitan and regional);
- European or New Zealand study tours by growers to identify best practice;
- New growers adopting best practice in modern greenhouse structures and using IPM and recirculation rather than run-to-waste systems;
- Product value adding including improved packaging and first stage transformation; and
- Larger hydroponic business units, with operations that are measured in hectares under production rather than metres square.

Each of these trends is an indicator that the industry is capitalising upwards in order to compete successfully for domestic and export markets, at a premium price. This growth is also being driven to some extent by market demands for safe, high quality food (Carruthers, 2001).

4.7 Industry Structures, Associations and Government Support

Industry Structures and Associations

The hydroponics industry is represented nationally by the Australian Hydroponic and Greenhouse Association (AHGA), formally the Australian Hydroponics Association Inc. AHGA's objectives are:

- To be recognised as the national body representing the Australian hydroponic industry;
- To encourage local groups and national interaction in the Australian hydroponic industry;
- To collect, produce and disseminate information to members;
- To improve the credibility of the hydroponic industry;
- To encourage and support research and development activities aligned with the Australian hydroponic industry;
- To act as the voice of the hydroponic industry to government; and
- To undertake any activities, which may foster the development of a rational, coordinated and sustained hydroponic industry in Australia.

The AHGA maintains a website through which contact can be made and publications purchased. AHGA also has state based affiliates in Victoria (Hydroponic Farmers Federation of Victoria), NSW (Greenhouse Vegetables NSW) and Tasmania (Tasmanian Greenhouse Growers Association). Contact details for all organisations associated with the industry, identified during this study, are provided in Appendix 2.

Private Extension and Magazines

The Australian industry has a world class private sector industry magazine behind it with an international readership. The magazine is called *Practical Hydroponics and Greenhouse Magazine*. The magazine evolved from rationalisation of agricultural extensions services in the mid 1990s and provides the industry with information and a forum to air and discuss industry issues.

One other publication widely utilised by the hydroponics industry is the Good Fruit and Vegetable Magazine.

Government and Public Sector Support

The commercial hydroponics industry receives support from all three tiers of government. For example the Lotus Red grower marketing cooperative received establishment funding through the Commonwealth Department of Employment, Working Relations and Small Business under their Regional Assistance Program.

As previously indicated, Horticulture Australia Limited manages research and development levies, which are matched by the Commonwealth government, on behalf of Australian lettuce, cucumber and capsicum growers. This includes growers who produce hydroponically.

At the state level, assistance is provided with the location of hydroponic businesses in Agrotechnology parks in Victoria and the NSW government has worked to establish both centres of excellence in research and production clusters on the Central Coast.

At the local government level, a limited number of councils have provided a planning environment that facilitates industry investment, however it is widely believed by the industry that more could be done to encourage local planning harmony. Western Sydney is one area of greenhouse industry-urban residential conflict. The Gosford City Council and the Wyong Shire Council provide core funding for the Central Coast Regional Development Corporation's hydroponic industry development activities.

4.8 In Summary

The key messages to emerge from a review of the Australian commercial hydroponics industry are:

- The area of commercial hydroponic production increased from 150 ha in 1990 to 500 ha by 1996, it is feasible that the area of production could be double this in 2001. There are between 1,000 and 2,000 domestic commercial hydroponic growers. Industry value is estimated by industry leaders at approximately \$400 million gross at farm gate. If this is accurate, it is the equivalent to 20% of the value of total vegetable and cut flower production;
- Commercial production includes an array of techniques, and no one system is considered best. Media based systems (eg rockwool or sawdust) and NFT are the backbones of the Australian industry. Many Australian systems are moving towards recirculation. More than half of all Australian hydroponic production is grown outdoors reflecting the high proportion of lettuce grown. This is different to the worldwide scene where the majority of hydroponic crops are grown in greenhouses;
- Reluctance of growers and retailers to market product under a hydroponic label is one reason why the industry is perceived as being smaller than it actually is;
- Industry growth is being driven in part by new entrants and in part by conventional soil based growers converting to hydroponic production techniques. Industry growth, is expected to continue in this way over the next few years;
- Australia is ranked in the top 10 of world commercial hydroponic producers by area. This is not to say that that the industry is best practice in critical production and marketing issues. The industry is characterised by a large 'tail' of producers who are reluctant to invest and adopt innovation;
- Production takes place Australia wide but is concentrated in those states with larger population and therefore marketing bases, ie NSW, Queensland and Victoria;
- Australia has a large hydroponic lettuce industry, which dominates the market for fancy lettuce. The industry is largest in NSW and has achieved export success;

- Cut flowers are grown in all the major hydroponic states, typically as run-to-waste systems often using a pine bark based media. Popular commercial hydroponic flowers include roses, gerberas, carnations and lisianthus;
- There are a number of large hydroponic tomato growing and marketing clusters in Victoria which have achieved critical mass and supply the major supermarkets with premium product;
- Hydroponic cucumbers, especially continental varieties, hold a significant share of the total domestic market. Production has achieved appropriate commercial scale and a single Queensland grower has 5.7 ha of continental cucumbers under production;
- Industry strengths/opportunities include real comparative advantages and growth opportunities, industry weaknesses/threats need addressing but can be overcome; and
- The industry has an appropriate representative organisation but commercial stakeholders currently manage this on a voluntary basis. Leadership and planning would benefit from the continuity a paid industry Chief Executive Officer would introduce. All three tiers of government have effectively supported the industry.

All things considered the industry has grown rapidly from a zero base over the last 25 years. False starts and setbacks associated with dubious means of promotion in the mid 1980s and early 1990s have been overcome and the industry is fast reaching critical mass.

5. Requirements for a Commercial Production System

This chapter sets out general information about requirements for a commercial hydroponic production system including family and corporate production, capital requirements, locating the system, risks and reasons for failure. It also includes specific information on production of the more important commercial hydroponic crops and provides a rationale for the analysis assumptions, which drive economic evaluation in Chapter 6.

5.1 Family, Commercial and Corporate Production

The standard production unit in Australian commercial hydroponic production is the family or in the case of larger enterprises, the extended family unit. A family based enterprise provides the flexibility and dedication that employed labour may sometimes lack.

There appears to be three distinct types of successful commercial hydroponic operation emerging in Australia that might form models for potential investors, they are:

- Boutique style producers with a niche market; possibly located close to that market and producing a specialised product. For example culinary herbs or Asian vegetables;
- Family farms that form part of a larger cooperative. Product is supplied to the cooperative to gain scale economies in marketing costs, to attract the interest of larger buyers and provide capacity to suitably grade and quality assure produce; and
- Corporate farms with investors who are not active in day-to-day management and a production unit that is sufficiently large to capitalise on scale economies in its own right. (Leigh James *pers. comm.*)

These trends in ownership, especially cooperative marketing, are consistent with trends in European countries with commercial production sectors.

5.2 Capital Requirements

As discussed in Chapter 4 under Weaknesses of Hydroponic Production, the high cost of capital, relative to conventional production systems, is a constraint to the rapid growth in the industry and while greenhouse construction costs are trending downwards over time, initial capital investment is a major consideration for new entrants. Greenhouse construction costs, range from approximately \$100 to \$200 per square metre (m²) depending on the sophistication of the greenhouse being proposed and the level of equipment being included. Viable production units are a minimum of 1,500m².

5.3 Location and Siting

Industry location is often an accident of history. With sites being selected on the basis of an existing land holding, the proponent’s interest in hydroponics and a level block of land. Only now after 25 years of industry development are individual players becoming sufficiently sophisticated to specifically select sites for target markets and off-season production (Robert Hayes *pers. comm.*).

Ideally, the industry would location using criteria such as climatic conditions (warm winters and cool summers), proximity to markets (capital and regional centres plus suitable transport nodes) and support industries (suppliers of equipment and inputs, research, consulting advice and so on) (Tony Axford *pers. comm.*).

At the micro level hydroponic sites need to consider water supply, topography and annual weather patterns. A hydroponic farm must have an assured adequate volume of water available at all times. The chemical quality of the water is vital. Many water supplies in Australia contain high levels of dissolved solids especially sodium chloride. These can make the water unsuitable for hydroponic use except if treated by reverse osmosis (Rick Donnan, *pers. comm.*). For outdoor production, wind direction and speed, temperature range, frost frequency and degree, rainfall and incidence of hailstorms are all fundamental considerations (Accent Hydroponics, *unpublished*).

5.4 Typical Commercial Systems and Technology

There are no hard and fast rules regarding commercial hydroponic systems and the technology that supports them. The following table can be considered to be indicative.

Table 11. Typical Commercial Technology and System Requirements

Crop	Dominant States	Greenhouse or Outdoors	System Type	Recirculated or Run-to-waste	Scale (m²)
Tomato	Victoria, NSW	Greenhouse	Rockwool, sawdust, scoria	Run-to-waste	1,500
Lettuce	NSW, Qld	Outdoors	NFT	Recirculated	4,000
Cut Flowers (gerberas)	Victoria, NSW	Greenhouse	Pine bark based potting mix (inert)	Run-to-waste	5,000
Cucumber	NSW, WA, Qld	Greenhouse	Sawdust, coco-peat bags	Run-to-waste	4,000
Capsicum	Victoria	Greenhouse	Sawdust	Run-to-waste	4,000

NOTE: This table is used to specify assumptions for economic analysis in Chapter 6.

5.5 Risks and Reasons for Failure

Hydroponics is not a magical production system, it requires more skill to manage than conventional soil based systems and generates more problems. The most common reasons for failure of commercial hydroponic operations are:

- The venture was not established in a realistic economic framework (including manageable loan repayments);
- System design and management were inadequate;
- Crop production management was inadequate. Successful hydroponic producers tend to be good horticultural producers first before embarking on hydroponic production;
- Yield and quality of produce did not meet budget projections;
- Ignorance of the importance of horticultural knowledge in producing a commercial hydroponic crop;
- Labour requirement was underestimated; and
- Insufficient attention to marketing. Producers enter the sector without establishing market outlets, realistic sale prices, tailoring product to meet demand or investigating brand names (Donnan, 1993 and Leigh James *pers. comm.*).

A failure due to any of the above categories, particularly early in a hydroponic venture, can lead to business collapse. Many ventures depend heavily on early cash flow to help repay the capital invested in the project (Donnan, 1993).

6. Economics of Commercial Production

The purpose of this chapter was to provide an assessment of the financial viability of commercial hydroponic production. The chapter provides a discussion of the methodology employed, rationale for crop selection, key assumptions, financial analysis results, threshold/sensitivity testing, a comment on risks, discussion of results and source of analysis data.

6.1 Method of Assessment

Financial analysis of commercial hydroponic production was completed using the discounted cash flow technique outlined in RIRDC's "The New Rural Industries – Financial Indicators" (Hassall & Associates, 1999). The methodology employed relied on a two-stage model:

- Stage One: To give a preliminary concept screening – to ensure fundamental components are in place and to identify any data gaps; and
- Stage Two: Financial feasibility – to ensure the commercial worth of the enterprise.

Stage One is a static state assessment that gauges an opportunities financial worth in a typical year. Stage Two is consistent with full cash flow analysis. Both stages are reported on below and copies of the model are available from RIRDC.

6.2 Selection of Crops

From the analysis completed in the above chapters it can be seen that the major Australian and world hydroponic crops are tomatoes, lettuce, cut flowers and cucumbers. Capsicum is believed to be the fastest growing vegetable crop (Jim Delaney, *pers. comm.*) and is added to the list for financial analysis.

The industry was quick to point out that 'representative' appraisals are limited given the range of technologies and growing conditions used by Australian growers.

6.3 Results and Discussion

A single page analysis result sheet follows for each of the five enterprises assessed. Gross margins are provided as Appendix 3. The single page analysis results sheet details the name of the enterprise, source of data and date, key assumptions including yield and price, financial analysis results, threshold results, risks and a comment on the findings.

From the five summary tables it can be seen that the internal rate of return on the five commercial hydroponic investments varies between a net loss for cucumbers and 10-12% for tomatoes, capsicum, gerberas and lettuce.

This compares to the return on Capital Indexed Treasury Bonds, a risk free investment of 7%, wine grapes of 13%, a highly speculative crop like durian of 25% and an annual crop like sesame of 16% (Hassall & Associates, 1999).

For four of the five hydroponic enterprises the results show modest (to strong) returns for entry-level investment. Financial results are consistent with agricultural production for a mature product, ie hydroponic products are main stream and widely consumed, hydroponic produce does not attract the very high prices of a new or novel crop or product. Returns are less than that forecast for highly speculative crops with limited or newly established markets (durian and sesame).

Indications, gleaned from the industry are that industry profitability, as with most forms of agricultural production, is linked to:

- Production scale, increasing returns with increasing size;
- The capacity to value add; and/or
- Find and exploit a unique and high value market niche.

It is worth stating again that the analysis is provided as a broad indicator of industry profitability and to provide a form of checklist for potential industry investors. It is not intended as an endorsement of any enterprise or system.

Summary of Results

Description: **Tomatoes on Rockwool, Victoria**

Analyst: Hassall & Associates

Date: October 2001

Key Assumptions:

Enterprise scale	1,536 m ²
Geographic location	Victoria
Initial investment	\$ 434,038
Typical recurrent input costs	\$ 139,238
Farm gate (or other) prices	\$ 2.80 per kg
Discount rate	7%
Inflation rate (if any)	n/a
Analysis period	20 years

Present Value @ 7% over 20 years:

Investment inputs	\$ 409,792
Recurrent inputs	\$ 1,475,085
Revenues	\$ 2,089,888
Residual values	\$ 517
Net Present Value of Enterprise @ 7% over 20 years	\$ 205,528

Financial Analysis Results:

Return on recurrent inputs	39% static state
Return on investment and recurrent inputs	3% static state
Internal Rate of Return	12%
Benefit Cost Ratio @ 7%	1.11

Breakeven on cumulative discounted basis after 12 years

Threshold Analysis Results:

Net Present Value of Enterprise equals ZERO when.....

Yield / Prices decreases by (%)	10%
Investment Expenditure increases by (%)	50%
Recurrent Inputs increases by (%)	14%

Major Risks to Financial Viability:

- * The NPV is sensitive to both a decrease in yield or price and an increase in the cost of recurrent inputs.
- * Labour is the largest recurrent cost for the operation with Trays/Inserts and Oil for Heating being the second and third highest recurring costs respectively.

Notes on Tomato Production:

* Yields for hydroponic tomato production can vary widely from around 35 to 50kg/m². It is arguable that an effective system (which this analysis is based on) with good management should achieve yields of 50kg/m².

* The 3 year average of prices for hydroponic tomatoes is \$2.80/kg but to develop a more conservative budget, \$2.50/kg is the suggested price to use (Mark Millis, *pers. comm.*)

(Graeme Smith *pers. comm.*)

Summary of Results

Description: **Capsicums in Sawdust, Victoria**

Analyst: Hassall & Associates

Date: October 2001

Key Assumptions:

Enterprise scale	4,000 m ²
Geographic location	Victoria
Initial investment	\$ 659,730
Typical recurrent input costs	\$ 214,730
Farm gate (or other) prices	\$ 3.25 per kg
Discount rate	7%
Inflation rate (if any)	n/a
Analysis period	20 years

Present Value @ 7% over 20 years:

Investment inputs	\$ 616,570
Recurrent inputs	\$ 2,274,853
Revenues	\$ 3,155,824
Residual values	\$ -
Net Present Value of Enterprise @ 7% over 20 years	\$ 264,401

Financial Analysis Results:

Return on recurrent inputs	18% static state
Return on investment and recurrent inputs	-12% static state
Internal Rate of Return	10%
Benefit Cost Ratio @ 7%	1.09

Breakeven on cumulative discounted basis after 15 years

Threshold Analysis Results:

Net Present Value of Enterprise equals ZERO when.....

Yield / Prices decreases by (%)	8%
Investment Expenditure increases by (%)	43%
Recurrent Inputs increases by (%)	12%

Major Risks to Financial Viability:

- * Labour is a large proportion of the recurrent costs
- * Other relatively large recurrent costs include cost of heating (gas) & electricity and nutrient costs
- * Pressure to retain markets due to supply from other sources including Qld growers, new hydroponic growers and possible imports from NZ and The Netherlands

Notes on Capsicum Production:

- * One crop of capsicums grown per year for around 10 months of the year
- * Two month break occurs when supply from Qld is greatest
- * The budget is sensitive to price. A price of \$3.50/kg takes the Gross Margin to \$58K and the operation breaks even after 13 years. If price is decreased to \$3.00/kg the operation takes 20 years to break even and achieves a Gross Margin of \$19K.

(David Wallace pers. comm.)

Summary of Results

Description: **Gerberas in potting mix, Central Coast, NSW**

Analyst: Hassall & Associates

Date: October 2001

Key Assumptions:

Enterprise scale	5,000 m ²
Geographic location	Gosford, NSW
Initial investment	\$ 1,122,550
Typical recurrent input costs	\$ 297,550
Farm gate (or other) prices	\$ 0.43 per stem
Discount rate	7%
Inflation rate (if any)	n/a
Analysis period	20 years

Present Value @ 7% over 20 years:

Investment inputs	\$ 1,049,112
Recurrent inputs	\$ 3,152,249
Revenues	\$ 4,571,224
Residual values	\$ -
Net Present Value of Enterprise @ 7% over 20 years	\$ 369,863

Financial Analysis Results:

Return on recurrent inputs	50% static state
Return on investment and recurrent inputs	7% static state
Internal Rate of Return	11%
Benefit Cost Ratio @ 7%	1.09

Breakeven on cumulative discounted basis after 13 years

Threshold Analysis Results:

Net Present Value of Enterprise equals ZERO when.....

Yield / Prices decreases by (%)	8%
Investment Expenditure increases by (%)	35%
Recurrent Inputs increases by (%)	12%

Major Risks to Financial Viability:

- * Price and yield need to be sustained for the operation to continue to be viable.
- * This operation appears to be sensitive to price and the cost of recurrent inputs.

Notes on Gerbera Production:

- * Labour and heating are the two biggest recurring costs.
- * Using coal for heating is not possible in some areas (restricted in Sydney for example) but is much cheaper. Gas costs around \$3,500/week which results in the operation becoming unfavourable with a cost benefit ratio of only 0.86 (does not break even). Where coal cannot be used adjustments to variable costs and working practices may need to be made to allow for the greater cost of heating with gas.
- * Operation is price sensitive. For example where the price is \$4.25 per bunch (\$0.43/stem) the enterprise breaks even at 13 years and has a Net Margin of only \$29K whereas at \$4.55/bunch (\$0.46/stem) the Net Margin improves to \$61K and breaks even within 10years.

(Joe Olivieri pers. comm.)

Summary of Results

Description: **Lettuce - NFT, Central Coast, NSW**

Analyst: Hassall & Associates

Date: October 2001

Key Assumptions:

Enterprise scale	4,000 m ²
Geographic location	Gosford, NSW
Initial investment	\$ 445,700
Typical recurrent input costs	\$ 325,700
Farm gate (or other) prices	\$ 0.50 per head
Discount rate	7%
Inflation rate (if any)	n/a
Analysis period	20 years

Present Value @ 7% over 20 years:

Investment inputs	\$ 416,542
Recurrent inputs	\$ 3,450,470
Revenues	\$ 3,963,052
Residual values	\$ -
Net Present Value of Enterprise @ 7% over 20 years	\$ 96,039

Financial Analysis Results:

Return on recurrent inputs	18% static state
Return on investment and recurrent inputs	0% static state
Internal Rate of Return	10%
Benefit Cost Ratio @ 7%	1.02

Breakeven on cumulative discounted basis after 15 years

Threshold Analysis Results:

Net Present Value of Enterprise equals ZERO when.....

Yield / Prices decreases by (%)	2%
Investment Expenditure increases by (%)	23%
Recurrent Inputs increases by (%)	3%

Major Risks to Financial Viability:

- * This operation appears to be sensitive to a number of factors. If yield or prices decrease by 2% the NPV of the enterprise will become zero.
- * The NPV is also very sensitive to an increase in recurrent inputs.
- * Packaging and seed are the two biggest recurring costs for lettuce production.

Notes on Lettuce Production:

1. Lettuce cost around \$0.30 per head to produce (variable cost of production)
2. Gross Income from lettuce production is around \$0.50 per head

(Garry Cahill *pers. comm.*)

Summary of Results

Description: **Cucumbers in Coco-peat**

Analyst: Hassall & Associates

Date: October 2001

Key Assumptions:

Enterprise scale	1,000 m2
Geographic location	Gosford, NSW
Initial investment	\$ 223,213
Typical recurrent input costs	\$ 70,713
Farm gate (or other) prices	\$ 1.50 per kg
Discount rate	7%
Inflation rate (if any)	n/a
Analysis period	20 years

Present Value @ 7% over 20 years:

Investment inputs	\$ 208,610
Recurrent inputs	\$ 749,135
Revenues	\$ 754,299
Residual values	\$ -
Net Present Value of Enterprise @ 7% over 20 years	-\$ 203,446

Financial Analysis Results:

Return on recurrent inputs	6% static state
Return on investment and recurrent inputs	-21% static state
Internal Rate of Return	-
Benefit Cost Ratio @ 7%	0.79

Breakeven on cumulative discounted basis after

The Enterprise does not break even within the 20 year evaluation period.

Threshold Analysis Results:

Net Present Value of Enterprise equals ZERO when.....

Yield / Prices	increased by	27%
Investment Expenditure	decreased by	98%
Recurrent Inputs	decreased by	27%

Major Risks to Financial Viability:

* For this size operation the business is not viable, either yield or prices would need to increase by 27% for the enterprise to achieve a net present value of zero.

* Labour is the most costly recurrent input followed by the commission (note: even where commission of ~\$9,000 is not paid the operation does not break even).

Notes on Cucumber Production:

* The minimum size for a commercial hydroponic cucumber operation is 4,000m². This analysis was carried out based on 1,000m² which was the size of the greenhouse at the National Centre for Greenhouse Horticulture (where Jeremy Badgery-Parker is based).

* For this operation to break even within the 20 year time period the price of cucumbers would need to be \$1.99/kg.

(Jeremy Badgery-Parker and Andrew Youngberry *pers. comm.*)

7. Constraints to Further Expansion

This chapter includes a case study of a successful Australian commercial hydroponic enterprise (Pacific Hydroponics) and a successful commercial industry (The Netherlands). Lessons from these case studies are combined with the output of the SWOT analysis completed in Chapter 4 to provide a statement of constraints to further industry expansion.

7.1 Features of a Commercially Successful Producer (Pacific Hydroponics)

Pacific Hydroponics is a successful large-scale hydroponic lettuce producer on the NSW Central Coast, features of the business that make it a success include:

- Willingness to seek and share information on production and markets. Pacific Hydroponics founder, Garry Cahill, holds industry field days on his property;
- Working in cooperation with other growers and government to meet client needs. Pacific Hydroponics is a foundation member of the successful grower marketing cooperative Lotus Red;
- Effective utilisation of government assistance available to the industry. This includes Commonwealth export assistance, state based NSW Agriculture agronomic advice and local government business development support;
- Market research has included field trips for market appraisal of potential export markets and development of personal relationships with overseas buyers. Garry actively seeks market opportunities and tailors product, such as individual meal portions, to specific client needs;
- A scale of production that permits cost efficiencies and is of interest to major corporates. Clients include Qantas, Woolworths, Greengrocer.com, hotels, clubs and wineries;
- Year round supply, Pacific Hydroponics is able to meet the demands of large clients like Qantas, 52 weeks of the year, every year for the last 11 years;
- Value adding, the company grows lettuce but markets only sealed chilled bags of mixed salad leaves ready for consumption by commercial caterers. Ten years ago the product was 'root-on' lettuce in a box, now bagged product contains a mix of lettuce leaf varieties and herbs, is triple washed, modified atmosphere packed and delivered to the customer in a returnable crate;
- Constant research and development including trials of organic fertiliser with a view towards international organic certification. Already Pacific Hydroponics is using IPM and organic pesticides;
- Competitively priced product to entice customers away from competitors and encourage the outsourcing of the service component of the product ie salad preparation and not just bulk lettuce sales.
- Market rather than technology focus. Success is driven by attention to market needs rather than by constant striving for technological innovation.

The business is the antithesis of inward looking units selling undifferentiated product through the wholesale bulk markets.

7.2 Features of a Commercially Successful Industry (The Netherlands)

The Dutch commercial hydroponics industry is widely acknowledged as the world leader. Features of the Dutch industry that make it a leader are contrasted to the Australian industry at the current time. The results are presented in the table below.

Table 12. Comparison of the Dutch and Australian Industries

Features of a Successful Hydroponic Industry (The Netherlands)	Features of the Australian Industry (2001)
History of glasshouse production from which to make the conversion to hydroponic production.	No (limited).
Producer willingness illustrated by their commitment to new and best practice technology.	Industry leaders – yes. Balance of producers - no.
Government support.	Commonwealth and states are supportive. Greenhouses not liked by some local governments (plastics, chemicals, etc).
Geographically concentrated industry with clusters of like producers.	Is starting to occur in Australia eg Victorian tomatoes, Central Coast NSW lettuce.
Market demands determining production.	For better producers – yes, but many new, small scale operations without a marketing plan.
Producer willingness to share information among other growers. Growers in districts meet regularly for open discussions.	Generally no.
Glasshouses in hectares not square metres.	Relatively few larger enterprises. This is beginning to change
Branding of low chemical IPM produce.	Not yet, researching organics.
Branding of produce.	Larger growers and cooperative marketing groups only.
Full automation of glasshouses, research on energy efficiency.	Leading edge producers only.

Features of a Successful Hydroponic Industry (The Netherlands)	Features of the Australian Industry (2001)
Producer specialisation and therefore leading edge efficiency in a single crop.	Many grow more than one crop or alternate crops on a biannual basis.
Local government policies that facilitate industry growth in peri-urban areas.	Policies are in place in only a few local government areas.

To continue to grow the Australia industry must address relevant points of contrast.

7.3 Industry Constraints

The Australian industry is highly successful as a commercial producer, to build on that success, the following key constraints will need to be addressed:

- Grower cooperation to ensure production volumes, adequate grading and market interest in industry output;
- A retreat from the amateurism that characterises a new or emerging industry, ie use of substandard equipment and a reluctance to invest/embrace a commercial scale of production;
- Promotion to shift public opinion away from an image of backyard marijuana production or a high chemical input/unnatural system;
- Information, freely available to counter the dubious claims made by some industry promoters regarding industry yields and profits. This information together with industry promotion would assist to improve the industry's image with the financial institutions;
- Attention to a constantly shifting and ever more sophisticated market, including one that is starting to demand the low chemical, sustainably produced product that is the industry's strength. Product branding may be one way to capture this market;
- Industry education and training at a grass roots level of production is important. This might include education on climate control, crop environmental requirements and IPM programs within greenhouses (Glassan Al Saboh and Ashcroft 1999);
- Industry data and standards including, potentially formal QA procedures or a suitable HACCP assessment; and
- Full time professional industry leadership to drive the industry from a strategic position. This might include formulation and resourcing of an industry strategic plan.

None of these industry constraints are intractable.

8. Conclusions on the Future and Study Recommendations

The commercial hydroponic industry is successful and rapidly expanding. It dominates the production of a limited number of crops and is probably the fastest growing Australian horticultural sector. The industry is larger than might commonly be perceived and this is because a lot of product is marketed on quality (eg vine ripened) rather than method of production (hydroponically grown).

Not all crops are suitable for growing hydroponically and the technology is unlikely to displace soil production for bulk commodity items in the foreseeable future.

The industry will continue to grow over the next three to five years, especially if identified opportunities are brought to fruition.

It is the recommendation of this study's authors that the industry convene through AHGA and form a working group to examine options to fund the creation of a full time industry CEO's position. It would be the responsibility of the hydroponic industry's CEO to formulate an industry plan, with the industry, to address both the industry constraints and opportunities identified in this study.

Appendices

Appendix 1. Reference List

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Soladome www.olis.net.au/soladome/what.html

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United States Department of Agriculture www.usda.com

Appendix 2. Contact Database

Surname	First Name	Position	Company	Category (commercial grower, retailer, equipment supplier)	Crops
AXFORD	Tony	Industry Development Officer	Central Coast Regional Development Corporation	Industry Facilitator	
BADGERY-PARKER	Jeremy	Horticulturalist, Protected Cover Crops	National Centre for Greenhouse Horticulture (NSW Agriculture)	Economics	
BAKER	John & Mark		Produce Marketing Australia	Marketing	
BIGGS	Tony	Editor	Good Fruit & Vegetable Magazine		
BLANCH	Saskia	Administrator	AHGA	Retailer & AHGA	
CAHILL	Garry	Producer	Pacific Hydroponics	Exports Lotus Red Lettuce	
CARRUTHERS	Steve	Publisher	Casper Publications Pty Ltd (Practical Hydroponics & Greenhouse Magazine)		
DAVIDS	Joe		Galuku Pty Ltd	Import coco-peat & supply Australia wide	
DELANEY	Jim	Vice President	Australian Hydroponic Growers Association, Director HydroShop	Industry Leader, equipment, commercial consultancy service	
DOMINELLO	Sam & Phil		Dominello Flower Growers	Hydroponic Gerberas (GROWER)	Cut Flowers
DONNAN	Rick	Secretary	Australian Hydroponic Growers Association	Consultant	
ECCLAN	Joseph		NSW Agriculture - QA Systems		
ECCLES	Jonathon	Senior Program Manager	Horticulture Australia Limited	will call Fri	
ELLERTON	Keith		Elmac Hydroponics	Commercial	Tomatoes
FAY	Jim		AutoPot Australia		
GARZOLI	Keith	Research Scientist	Australian National University		
GOLLNOW	Bettina		NSW Agriculture - Menangle	Horticulturist	Cut Flowers
GOODWIN	Steven		National Centre for Greenhouse Horticulture (NSW Agriculture)		
HALL	David	Director	National Centre for Greenhouse Horticulture (NSW Agriculture)	call 10:30 23 Aug	
HANGER	Brian	Consultant			
HARDY	Sandra		National Centre for Greenhouse Horticulture (NSW Agriculture)		
HAYES	Robert	Grower- Herbs		Organic Grower	Herbs
HEARNE	Ron	Partner	Simple Grow Hydroponics	Supplier of nutrient solution	
JAMES	Leigh	District Horticulturist	NSW Agriculture		

Surname	First Name	Position	Company	Category (commercial grower, retailer, equipment supplier)	Crops
KENNEDY	John	Ex-president	AHGA		Strawberries
KIM	Trevor	Director	Swan Hydroponics	Manufacture of equipment, growing ??	
KOREVAAR	Sue	President	Hydroponics Farmers Federation (Vic)		
LAFFER	Bruce	President	Tasmanian Greenhouse Growers Association		
LANE	Christine	Information Specialist	GrowSearch, QDPI	Source of information and publications	All
LIDBETTER	Jonathon		NSW Agriculture (Research Station - Central Coast)		Research on Native Flowers
LIPTON	Helen	Mgr - Quality Control	Moraitis Wholesale	Wholesaler	
McATTAMNEY	Jon	Senior Business Manager	Woolworths	Retailer (buyer of hydroponic produce)	
McINERNEY	Matthew		Moraitis Wholesale	Sydney Markets/ Wholesaler	
MILLIS	Mark	Grower/Marketer	Flavorite Hydroponics	Large Commercial Grower	Tomatoes
MOODY	Tony	Policy Officer, ESU	NSW Agriculture	Markets	
MURISON	Jim		AgSell (Sydney Office)		
NOYE	Max		Active Industry Training		
OLIVIERI	Joe & Tony	Grower	Lake Munmorah Flower Farm	Hydroponic Gerberas (GROWER)	Cut Flowers
RANSLEY	John	State Senior Buyer (NSW)	Coles Supermarkets		
ROBERTS	Steven	Technical Representative	Rijk Zwaan	Seed Supplier	Fruit & Vegetables
ROBINSON	Eva	Government	Department of State and Regional Development, Central Coast		
SMITH	Graeme	President	Australian Hydroponic Growers Association		Tomatoes (& others)
WALLACE	David	Committee Member	AHGA	Grower	Capsicum
WALTA	Gus	Secretary	Hydroponics Farmers Federation (Vic)		
WILLS	Ron	Professor	Department of Food and Technology, University of Newcastle		
WINSLADE	Christine	Territory Manager	New Zealand Hydroponics International Ltd	Hydroponic Supplies	All
YOUNGBERRY	Andrew & Jennifer	Manager	Eden Farms	Commercial cucumber grower	Cucumber

Surname	First Name	Address	Postal Address	Town	State	Postcode	Phone	Fax	Mobile	email and/or website
AXFORD	Tony	Ourimbah Campus, Uni Newcastle Enterprise Drive	PO Box 3009 TUGGERAH NSW 2259	GOSFORD	NSW		02 4362 3100	02 4362 3211	0410 454 915	tonya@ccrdc.org.au
BADGERY-PARKER	Jeremy	Research Rd, NARARA		GOSFORD	NSW		02 4348 1920	02 4348 1910	0412 819 465	www.agric.nsw.gov.au
BAKER	John & Mark				NSW		02 9744 6366			
BIGGS	Tony									
BLANCH	Saskia		PO Box 538	NARRABEEN	NSW	2101	02 9939 5993	02 9939 5993		aushydro@bigpond.com
CAHILL	Garry		62 Pacific Hwy	LAKE MUNMORAH	NSW	2259	02 4399 1500		0414 601 560	
CARRUTHERS	Steve		PO Box 225, Narrabeen	NARRABEEN	NSW	2101	02 9905 9933	02 9905 9030		www.hydroponics.com.au
DAVIDS	Joe	Offices - Vaucluse Warehouse - Botany	PO Box 253, Grosvenor Pl	SYDNEY	NSW	2000	02 9337 2195	02 9337 2648		www.cocopeat.com.au
DELANEY	Jim						02 4960 0707			www.hydroshop.com jim@hydroshop.com.au
DOMINELLO	Sam & Phil	45 Euloo Rd		PEATS RIDGE	NSW	2250	02 4373 1112 02 4373 1042			
DONNAN	Rick		PO Box 120	KURMOND	NSW	2757	02 4567 7685	02 4567 7684		
ECCLAN	Joseph									
ECCLES	Jonathon	Level 1, 50 Carrington St		SYDNEY	NSW	2000	02 8295 2300	02 8295 2399		www.horticulture.com.au jonathan.eccles@horticulture.com.au
ELLERTON	Keith		PO Box 2735	ALLANSFORD	VIC	3277	03 5565 1601	03 5565 1606		elmac@standard.com.au
FAY	Jim									
GARZOLI	Keith									

Surname	First Name	Address	Postal Address	Town	State	Postcode	Phone	Fax	Mobile	email and/or website
GOLLNOW	Bettina	Woodbridge Road		MENANGLE	NSW	2568	02 4640 6333			www.agric.nsw.gov.au
GOODWIN	Steven		Locked Bag 26	GOSFORD	NSW		02 4348 1929			www.agric.nsw.gov.au
HALL	David		Locked Bag 26	GOSFORD	NSW		02 4348 1900			david.hall@agric.nsw.gov.au
HANGER	Brian				VIC					
HARDY	Sandra		Locked Bag 26	GOSFORD	NSW		02 4348 1916			
HAYES	Robert		1023 Coolamon Scenic Drv.	Coorabell	NSW	2479	02 6884 4580		0418 376 258	
HEARNE	Ron	Hassall St (cnr Widemere St)		WETHERILL PARK	NSW	2164	02 9604 0469			
JAMES	Leigh	299 George St	Locked Bag 11	WINDSOR	NSW	2756	02 4577 0622	02 4577 0650	0412 429 418	
KENNEDY	John				QLD					
KIM	Trevor						02 4358 4414			
KOREVAAR	Sue						03 5983 6281			www.hff.org.au pres@hff.org.au
LAFFER	Bruce						03 6225 4289			
LANE	Christine	Redlands Research Station	PO Box 327	CLEVELAND	QLD	4163	07 3821 3784	07 3286 7618		
LIDBETTER	Jonathon	Research Rd, NARARA		GOSFORD	NSW		02 4348 1900			www.agric.nsw.gov.au
LIPTON	Helen						02 9647 2133			
McATTAMNEY	Jon	Buying & Marketing Dept		YENNORA	NSW		02 9892 7111		0404 829 603	
McINERNEY	Matthew			SYDNEY	NSW				0417 468 828	

Surname	First Name	Address	Postal Address	Town	State	Postcode	Phone	Fax	Mobile	email and/or website
MILLIS	Mark	Copelands Road		WARRAGUL	VIC	3820	03 5623 1693	03 5623 1869	0417 394 122	flavorite@iprimus.com.au www.flavoritetomatoes.com
MOODY	Tony		161 Kite St	ORANGE	NSW	2800	02 6391 3647	02 6391 3650		Tony.Moody@agric.nsw.gov.au
MURISON	Jim			SYDNEY	NSW	2000	02 9372 0126			
NOYE	Max			WARNAVALE	NSW		02 4393 6900			
OLIVIERI	Joe & Tony		422 Pacific Hwy, Doyalson 2262	LAKE MUNMORAH	NSW	2259	02 4358 8331	02 4358 1332		
RANSLEY	John	Flemington Fresh Produce			NSW		02 9751 6500			
ROBERTS	Steven			CENTRAL COAST	NSW			02 4975 3895	0408 613 534	rzaunsw@tpgi.com.au
ROBINSON	Eva						02 4323 9587			
SMITH	Graeme						03 5427 2143			
WALLACE	David	Lot 13, Cnr Arundel & Brown's Rd		KEILOR	VIC	3036	03 9336 3892	03 9331 6978	0408 547 708	wallwvg@bigpond.com
WALTA	Gus						03 5427 0301			www.hff.org.au secretary@hff.org.au
WILLS	Ron	University Drv, Callaghan				2309				
WINSLADE	Christine	43 Burrows Street	PO Box 949	TAURANGA	NZ		0011 64 7278 0849	0011 64 7578 0847		chrisw@nzhydroponics.com WEB: www.nzhydroponics.com
YOUNGBERRY	Andrew & Jennifer	Lot 81, New England Hwy		HIGHFIELDS	QLD	4352	Highfields (Toowoomba) office 07 4696 8311	Highfields (Toowoomba) office 07 4696 8322	0427 968 311	

Appendix 3. Gross Margin Budgets for Selected Hydroponic Crops

Gross Margin Budget

Crop Enterprise

Tomatoes on Rockwool, Victoria

- * Unit of production used: 1536 m²
 * For a typical year or season of production, once the enterprise has been established, estimate all unit costs and revenues by following the instructions under each section below.

Investment Inputs

- 1 Decide on size of enterprise, considering machinery and processing capacities, for instance.

Size of enterprise: 1 1,536 m²

- 2 Estimate the first-time cost of all investment items.

- 3 Then estimate the expected useful life of each in years.

- 4 Calculate the approximate annualised cost of each.

- 5 Total both the cost and annualised cost columns.

Assumed real interest rate: 7% pa

	Units	Number	Price	Cost	Useful Life (yrs)	Annualised Cost
Site preparation	square meters	1,536	\$3	3,840	20	362
Greenhouse (with computers, heating)	square meters	1,536	\$160	245,760	20	23,198
Utilities (included with site prep)	establishment		\$40,000	0	20	0
Packing shed (included with greenhouse cost)	packing shed		\$30,000	0	20	0
Cool room	cool room	1	\$10,000	10,000	12	1,259
Greenhouse sundries	forklift/office	1	\$10,000	10,000	10	1,424
Trolleys - up & down	picking trolleys	2	\$3,500	7,000	20	661
Trolleys - low	shifting produce	2	\$600	1,200	15	132
Fogging system (installed)	system installed	1	\$17,000	17,000	15	1,867
Working capital	years	2	\$139,238	278,475	7%	19,493
TOTAL:				\$573,275		\$48,396
				\$373.23	per	m ²

- 6 Calculate the total investment cost and total annualised investment cost per production unit.

Total investment cost per unit: \$573,275 per 1536 m²

Total annualised investment cost per unit: \$48,396 per 1536 m²

Recurrent Inputs

- 1 For the selected unit of production (eg. hectare of growing area), estimate all input costs.

- 2 Note the information source of each line item, and estimate its confidence limits.

- 3 Total the cost column.

Costs calculated per: 1536 m²

	Units	Amount	Price/Unit	Cost		
Nutrient	litres	33,768	\$0.10	3,377		
Electricity	kWh	6,700	\$0.18	1,206		
Waste Oil	litres	90,000	\$0.18	16,200		
CO ₂	kgs	3,040	\$1.15	3,496		
Water	litres	1,688,400	\$0.001	1,688		
Chemical & IPM	square metres	1,536	\$1.00	1,536		
Trays + Inserts	na	20,846	\$1.00	20,846		
Cartons + Bubble	na	413	\$1.30	537		
Stickers	rolls	521	\$3.00	1,563		
Freight	per pallet	206	\$30.00	6,180		
Rockwool Slabs	per slab	35	\$63.50	2,223		
Seedlings	rockwool cubes	3,360	\$1.35	4,536		
Labour (casual)	per hour	390	\$15.00	5,850		
Labour (family)	per annum	2	\$35,000	70,000		
TOTAL:				\$139,238	per	1536 m ²
				\$90.65	per	m ²

Tomatoes (cont)

Yield

* For the selected unit of production, estimate the anticipated yield for the primary crop.

Demand/Revenues

1 For the selected unit of production, estimate the anticipated farmgate price for the primary crop.

Primary crop	Crop Tomatoes (45kg/m ²)	Crop Unit kg	Unit Yield 69,120	Yields estimated per:	1536 m ²	Farmgate Price \$2.80	Income 193,536		
				Prices estimated per:	kg			per	1536 m ²
TOTAL:							\$193,536	per	1536 m ²
							\$126.00	per	m ²

FINANCIAL ANALYSIS RESULTS

Static Analysis:

For a typical year or season of production, once the enterprise has been established:

Revenue	193,536	per	1536 m ²	
Less Recurrent Inputs	<u>-139,238</u>	per	1536 m ²	
= Gross Margin (gross margin)	\$54,298	per	1536 m ²	Favourable Outcome
	\$35.35	per	m ²	
	=			39.0% return on recurrent inputs only
Less Investment Input: annualised	<u>-48,396</u>	per	1536 m ²	
= Net Margin	\$5,903	per	1536 m ²	Favourable Outcome
	\$3.84	per	m ²	
	=			3.1% return on investment & recurrent inputs

Sensitivity Analysis:

Gross Margin = 0 when:	Revenue is reduced by	28%	Not sensitive
	Recurrent Inputs are increased by	39%	Not sensitive
Net Margin = 0 when:	Revenue is reduced by	3%	Very sensitive
	Recurrent Inputs are increased by	4%	Very sensitive
	Investment Inputs is increased by	12%	Sensitive

(Graeme Smith *pers. comm.*)

Gross Margin Budget

Crop Enterprise

Capsicums in Sawdust, Victoria

- * Unit of production used: 4,000 m²
 * For a typical year or season of production, once the enterprise has been established, estimate all unit costs and revenues by following the instructions under each section below.

Investment Inputs

- 1 Decide on size of enterprise, considering machinery and processing capacities, for instance.

Size of enterprise: 1 4,000 m²

- 2 Estimate the first-time cost of all investment items.

- 3 Then estimate the expected useful life of each in years.

- 4 Calculate the approximate annualised cost of each.

- 5 Total both the cost and annualised cost columns.

Assumed real interest rate: 7% pa

	Units	Number	Price	Cost	Useful Life (yrs)	Annualised Cost
Site preparation	square meters	4,000	\$3	10,000	20	944
Greenhouse (with computers, heating)	square meters	4,000	\$60	240,000	20	22,654
Heating	square meters	4,000	\$35	140,000	20	13,215
Computer System	per greenhouse	1	\$25,000	25,000	20	2,360
Greenhouse sundries	per greenhouse	1	\$30,000	30,000	20	2,832
Working capital	years	2	\$214,730	429,460	7%	30,062
TOTAL:				\$874,460		\$72,067
				\$218.62	per	m ²

- 6 Calculate the total investment cost and total annualised investment cost per production unit.

Total investment cost per unit: \$874,460 per 4,000 m²

Total annualised investment cost per unit: \$72,067 per 4,000 m²

Recurrent Inputs

- 1 For the selected unit of production (eg. hectare of growing area), estimate all input costs.

- 2 Note the information source of each line item, and estimate its confidence limits.

- 3 Total the cost column.

Costs calculated per: 4,000 m²

	Units	Amount	Price/Unit	Cost	
Nutrient	litres	60,000	\$0.200	12,000	
Electricity & gas (including CO ² - produced as by-product of gas heating)	square metres	4,000	\$4.38	17,500	
Water (0.5L/plant/day for 10 mths)	litres	1,800,000	\$0.0006	1,080	
Seedlings	individual seedling	12,000	\$1.50	18,000	
Chemical (including labour)	square metres	4,000	\$5.00	20,000	
Consultant	square metres	4,000	\$4.00	16,000	
Sawdust	metres cubed	120	\$15.00	1,800	
Black plastic bags	bag	12,000	\$0.20	2,400	
Cartons & stickers	carton	14,400	\$1.60	23,040	
Freight	per carton	15,600	\$1.10	17,160	
Labour (casual)	per hour	1,050	\$15	15,750	
Labour (family)	per annum	2	\$35,000	70,000	
TOTAL:				\$214,730	per 4,000 m ²
				\$53.68	per m ²

Capsicums (cont)

Yield

* For the selected unit of production, estimate the anticipated yield for the primary crop.

Demand/Revenues

1 For the selected unit of production, estimate the anticipated farmgate price for the primary crop.

Primary crop	Crop Capsicums (3 plants/m ² @ 6.5kg/plant)	Crop Unit kg	Unit Yield 78,000	Yields estimated per:	4,000 m ²	Farmgate Price \$3.25	Income <u>253,500</u>			
				Prices estimated per:	kg					
TOTAL:								<u>\$253,500</u>	per	4,000 m ²
								\$63.38	per	m ²

FINANCIAL ANALYSIS RESULTS

Static Analysis:

For a typical year or season of production, once the enterprise has been established:

Revenue	253,500	per	4,000 m ²	
Less Recurrent Inputs	<u>-214,730</u>	per	4,000 m ²	
= Gross Margin (gross margin)	\$38,770	per	4,000 m ²	Favourable Outcome
	=	\$9.69	per m ²	
		=	18.1%	return on recurrent inputs only
Less Investment Input: annualised	<u>-72,067</u>	per	4,000 m ²	
= Net Margin	<u>-\$33,297</u>	per	4,000 m ²	Unfavourable Outcome
		per	m ²	
	=	-\$8.32	per m ²	
		=	-11.6%	return on investment & recurrent inputs

Sensitivity Analysis:

Gross Margin = 0 when:	Revenue is reduced by	15% Sensitive
	Recurrent Inputs are increased by	18% Sensitive
Net Margin = 0 when:	Revenue is increased by	13% Sensitive
	Recurrent Inputs are reduced by	16% Sensitive
	Investment Inputs is reduced by	46% Not sensitive

(David Wallace pers. comm.)

Gross Margin Budget

Crop Enterprise

Gerberas in Potting Mix, NSW

- * Unit of production used: 5,000 m²
- * For a typical year or season of production, once the enterprise has been established, estimate all unit costs and revenues by following the instructions under each section below.
- * Gross margin relates to one year of production. Gerbera plants last 3 years so the cost of pots & potting mix etc. has been divided by three to illustrate that they are only replaced once every three years.
- * For an operation of 5,000m² you require approximately 10,000m² (or 1 ha) of land
- * Land is around \$44,000/acre or \$108,500/ha.

Investment Inputs

- 1 Decide on size of enterprise, considering machinery and processing capacities, for instance.

Size of enterprise: 1 5,000 m²

- 2 Estimate the first-time cost of all investment items.

- 3 Then estimate the expected useful life of each in years.

- 4 Calculate the approximate annualised cost of each.

- 5 Total both the cost and annualised cost columns.

Assumed real interest rate: 7% pa

	Units	Number	Price	Cost	Useful Life (yrs)	Annualised Cost
Site preparation	per 1,000m ²	5	\$2,500	12,500	20	1,180
Greenhouse	square meters	5,000	\$163	812,500	20	76,694
Heating	square meters	included with greenhouse			20	0
Computerised System	per greenhouse	included with greenhouse			20	0
Greenhouse Sundries (include)	per greenhouse	included with greenhouse			20	0
Working capital	years	2	\$297,550	595,100	7%	41,657
TOTAL:				<u>\$1,420,100</u>		<u>\$119,531</u>
				\$284.02	per	m ²

- 6 Calculate the total investment cost and total annualised investment cost per production unit.

Total investment cost per unit: \$1,420,100 per 5,000 m²

Total annualised investment cost per unit: \$119,531 per 5,000 m²

Recurrent Inputs

- 1 For the selected unit of production (eg. hectare of growing area), estimate all input costs.

- 2 Note the information source of each line item, and estimate its confidence limits.

- 3 Total the cost column.

Costs calculated per: 5,000 m²

	Units	Amount	Price/Unit	Cost	
Heating (coal)	per week	52	\$1,600	83,200	
Water (including fertiliser & application labour)	per stem	1,050,000	\$0.028	29,400	
Seedlings	individual seedling	30,000	\$2.30	23,000	Divided by 3 to account for plants
Chemical (including labour)	per stem	1,050,000	\$0.028	29,400	
Consultant (\$50-70/hr, ~5hrs/i)	per month	12	\$350	4,200	
Potting mix (mix & fill)	per plant	30,000	\$1.00	10,000	Divided by 3 to account for plants
Pots	per pot	30,000	\$0.57	2,850	Divided by 6 b/c pots are re-used
Packing (one bag/bunch)	per bag	105,000	\$0.10	10,500	
Labour - full time (family)	per annum	3	\$35,000	105,000	
TOTAL:				<u>\$297,550</u>	per 5,000 m ²
				\$59.51	per m ²

Gerberas (cont)

Yield

* For the selected unit of production, estimate the anticipated yield for the primary crop.

Demand/Revenues

1 For the selected unit of production, estimate the anticipated farmgate price for the primary crop.

Primary crop	Crop Gerberas (6plants/m ² & 35 blooms/plant)	Crop Unit stems	Yields estimated per:	5,000 m2	Farmgate Price	Income		
			Prices estimated per:	stem				
			Unit Yield	1,050,000	\$0.43	446,250		
	TOTAL:					\$446,250	per	5,000 m2
						\$89.25	per	m ²

FINANCIAL ANALYSIS RESULTS

Static Analysis:

For a typical year or season of production, once the enterprise has been established:

Revenue	446,250	per	5,000 m2	
Less Recurrent Inputs	<u>-297,550</u>	per	5,000 m2	
= Gross Margin	\$148,700	per	5,000 m2	Favourable Outcome
(gross margin)	\$29.74	per	m ²	
	=			50.0% return on recurrent inputs only
Less Investment Input: annualised	<u>-119,531</u>	per	5,000 m2	
= Net Margin	<u>\$29,169</u>	per	5,000 m2	Favourable Outcome
	\$5.83	per	m ²	
	=			7.0% return on investment & recurrent inputs

Sensitivity Analysis:

Gross Margin = 0 when:	Revenue is reduced by	33% Not sensitive
	Recurrent Inputs are increased by	50% Not sensitive
Net Margin = 0 when:	Revenue is reduced by	7% Very sensitive
	Recurrent Inputs are increased by	10% Very sensitive
	Investment Inputs is increased by	24% Not sensitive

(Joe Olivieri pers. comm.)

Gross Margin Budget

Crop Enterprise

Lettuce - Nutrient Film Technique, NSW

- * Unit of production used: 4,000 m²
- * For a typical year or season of production, once the enterprise has been established, estimate all unit costs and revenues by following the instructions under each section below.
- * Grow around 6 lettuce crops per year

Investment Inputs

- 1 Decide on size of enterprise, considering machinery and processing capacities, for instance.

Size of enterprise: 1 4,000 m²

- 2 Estimate the first-time cost of all investment items.

- 3 Then estimate the expected useful life of each in years.

- 4 Calculate the approximate annualised cost of each.

- 5 Total both the cost and annualised cost columns.

Assumed real interest rate: 7% pa

	Units	Number	Price	Cost	Useful Life (yrs)	Annualised Cost
Site preparation	square meters	4,000	\$2.5	10,000	20	944
NFT set up (outdoor tables, tank, troughs & pump)	square meters	4,000	\$25	100,000	20	9,439
Sundries	forklift/office	1	\$10,000	10,000	20	944
Working capital	years	2	\$325,700	651,400	7%	45,598
TOTAL:				\$771,400		\$56,925
				\$192.85	per	m ²

- 6 Calculate the total investment cost and total annualised investment cost per production unit.

Total investment cost per unit: \$771,400 per 4,000 m²

Total annualised investment cost per unit: \$56,925 per 4,000 m²

Recurrent Inputs

- 1 For the selected unit of production (eg. hectare of growing area), estimate all input costs.

- 2 Note the information source of each line item, and estimate its confidence limits.

- 3 Total the cost column.

Costs calculated per: 4,000 m²

	Units	Amount	Price/Unit	Cost		
Nutrient	square metres	4,000	\$2.20	8,800		
Electricity	square metres	4,000	\$1.50	6,000		
Water	litres	5,000,000	\$0.001	3,000		
Chemical & IPM	square metres	4,000	\$1.50	6,000		
Packaging	per ctn	96,000	\$0.40	38,400		
Freight	per ctn	96,000	\$1.00	96,000		
Seeds	per seed	960,000	\$0.10	96,000		
Labour (casual)	per hour	100	\$15.00	1,500		
Labour (family)	per annum	2	\$35,000	70,000		
TOTAL:				\$325,700	per	4,000 m ²
				\$81.43	per	m ²

Lettuce (cont)

Yield

* For the selected unit of production, estimate the anticipated yield for the primary crop.

Demand/Revenues

1 For the selected unit of production, estimate the anticipated farmgate price for the primary crop.

Primary crop	Crop	Crop Unit	Yields estimated per:	4,000 m2	Income		
			Prices estimated per:	head		Farmgate Price	
	Lettuce	heads of	Unit Yield				
	(40head/m ²)	lettuce	160,000	\$0.50	80,000		
	Losses of 20%		32,000	\$0.50	<u>16,000</u>		
	Total per crop		128,000		\$64,000		
	Per Year (6 crops)		768,000	\$0.50	<u>384,000</u>		
TOTAL:					\$384,000	per	4,000 m2
					\$96.00	per	m ²

FINANCIAL ANALYSIS RESULTS

Static Analysis:

For a typical year or season of production, once the enterprise has been established:

Revenue	384,000	per	4,000 m2	
Less Recurrent Inputs	<u>-325,700</u>	per	4,000 m2	
= Gross Margin	\$58,300	per	4,000 m2	Favourable Outcome
(gross margin)	\$14.58	per	m ²	
=				17.9% return on recurrent inputs only
Less Investment Input: annualised	<u>-56,925</u>	per	4,000 m2	
= Net Margin	<u>\$1,375</u>	per	4,000 m2	Favourable Outcome
	\$0.34	per	m ²	
=				0.4% return on investment & recurrent inputs

Sensitivity Analysis:

Gross Margin = 0 when:

Revenue is reduced by 15% Sensitive
 Recurrent Inputs are increased by 18% Sensitive

Net Margin = 0 when:

Revenue is reduced by 0% Very sensitive
 Recurrent Inputs are increased by 0% Very sensitive
 Investment Inputs is increased by 2% Very sensitive

(Garry Cahill *pers. comm.*)

Gross Margin Budget

Crop Enterprise

Cucumbers in Coco-peat, NSW

- * Unit of production used: 1,000 m²
- * For a typical year or season of production, once the enterprise has been established, estimate all unit costs and revenues by following the instructions under each section below.
- * Gross margin is for one year (approximately 2.5 crops of cucumbers)

Investment Inputs

- 1 Decide on size of enterprise, considering machinery and processing capacities, for instance.

Size of enterprise: 1 1,000 m²

- 2 Estimate the first-time cost of all investment items.

- 3 Then estimate the expected useful life of each in years.

- 4 Calculate the approximate annualised cost of each.

- 5 Total both the cost and annualised cost columns.

Assumed real interest rate: 7% pa

	Units	Number	Price	Cost	Useful Life (yrs)	Annualised Cost
Site preparation	per 1,000m ²	1	\$2,500	2,500	20	236
Greenhouse (all inclusive)	square meters	1,000	\$150	150,000	20	14,159
Heating	square meters	included above			20	0
Computerised System	per greenhouse	included above			20	0
Greenhouse Sundries (include	per greenhouse	included above			20	0
Working capital	years	2	\$70,713	141,426	7%	9,900
TOTAL:				\$293,926		\$24,295
				\$293.93	per	m ²

- 6 Calculate the total investment cost and total annualised investment cost per production unit.

Total investment cost per unit: \$293,926 per 1,000 m²

Total annualised investment cost per unit: \$24,295 per 1,000 m²

Recurrent Inputs

- 1 For the selected unit of production (eg. hectare of growing area), estimate all input costs.

- 2 Note the information source of each line item, and estimate its confidence limits.

- 3 Total the cost column.

Costs calculated per: 1,000 m²

	Units	Amount	Price/Unit	Cost		
Nutrient	square metres	1,000	\$3.30	3,300		
Electricity & gas (including CC	square metres	1,000	\$4.38	4,380		
Water (560L/plant/crop)	litres	2,200,000	\$0.0006	1,320		
Seedling (planted seed)	per seedling	4,000	\$0.500	2,000		
Chemical	square metres	1,000	\$1.45	1,450		
IPM	square metres	1,000	\$0.00	0		
Consultant (not used by many	per hour		\$65.00	0		
Coco-peat Growbags	per bag	666	\$5.50	3,663		
String	per plant	4,000	\$0.05	200		
Cartons (10kg)	carton	4,000	\$1.50	6,000		
Freight	per ctn	4,000	\$1.10	4,400		
Labour	per person	1	\$35,000	35,000		
Commission (12% of gross sa	per crop	75,000	12%	9,000		
TOTAL:				\$70,713	per	1,000 m ²
				\$70.71	per	m ²

Cucumbers (cont)

Yield

* For the selected unit of production, estimate the anticipated yield for the primary crop.

Demand/Revenues

1 For the selected unit of production, estimate the anticipated farmgate price for the primary crop.

Primary crop	Crop Cucumbers (2plants/m ² @ 10kg/plant)	Crop Unit kg	Unit Yield 50,000	Yields estimated per:	1,000 m2	Farmgate Price	Income		
				Prices estimated per:	kg				
				\$1.50			<u>75,000</u>		
	TOTAL:						\$75,000	per	1,000 m2
							\$75.00	per	m ²

FINANCIAL ANALYSIS RESULTS

Static Analysis:

For a typical year or season of production, once the enterprise has been established:

Revenue	75,000	per	1,000 m2	
Less Recurrent Inputs	<u>-70,713</u>	per	1,000 m2	
= Gross Margin	\$4,287	per	1,000 m2	Favourable Outcome
(gross margin)	\$4.29	per	m ²	
=				6.1% return on recurrent inputs only
Less Investment Input: annualised	<u>-24,295</u>	per	1,000 m2	
= Net Margin	<u>-\$20,008</u>	per	1,000 m2	Unfavourable Outcome
	-\$20.01	per	m ²	
=				-21.1% return on investment & recurrent inputs

Sensitivity Analysis:

Gross Margin = 0 when:	Revenue is reduced by	6% Very sensitive
	Recurrent Inputs are increased by	6% Very sensitive
Net Margin = 0 when:	Revenue is increased by	27% Not sensitive
	Recurrent Inputs are reduced by	28% Not sensitive
	Investment Inputs is reduced by	82% Not sensitive

(Jeremy Badgery-Parker and Andrew Youngberry *pers. comm.*)