Australian vegetable crops - Maximising returns from water

Mark Hickey
NSW Department of Primary Industries

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Know-how for Horticulture™

Final Report
Project number VGO 4010

"Australian vegetable crops – Maximising returns from water"

(Completion Date 31st April 2006)

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NSW Department of Primary Industries, Yanco

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Know-how for Horticulture™

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Project Title	Australian Vegetable crops – Maximising returns from water

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Media Summary

The Australian vegetable industry is the largest of the Australian horticultural industries, with an estimated gross value in excess of $2 billion. It has vibrant export and processing sector, employing 15,261 people directly (ABS 2001) and when downstream industry activity, such as wholesale retail, value adding and processing is taken into account, provides employment for an estimated 45,000 people.

Of all the inputs that drive the vegetable industry, water is one of the most critical. Apart from irrigation, water is used for washing produce prior to packaging, and is essential for most vegetable processing and value adding. But the vast majority of water used in the industry is for irrigating crops.

When measured in terms of value produced for each megalitre (ML) of water applied, vegetables rate as one of the most efficient of all agricultural industries. A report published by the Australian Bureau of Statistics in 2005 quotes average water use in the vegetable industry at 4.1 ML per hectare, which is less than the average across all crops (4.3 ML/ha). The ABS also estimated that in 2001, the gross return from each ML of water used in the vegetable industry was $3,207/ML.

While the returns from vegetable growing look attractive, large investments in machinery and technology combined with high costs of production and high land value are typical in the industry. The vast majority of vegetables produced in Australia are sold on the domestic market, and therefore prices are highly sensitive to increases in production. In addition, large investment and increased farm size is often required for irrigation systems used in vegetable production (ie drip), and specialised skills are required to drive those systems to achieve optimal product quality. With a diminishing number of vegetable farms in Australia, there is a greater concentration of production and increased reliance on technology, automation and integration of irrigation and closely related systems (such as soil and nutrition management) at the farm level.

Across all vegetable production regions in Australia, there is an increasing trend towards highly efficient irrigation systems, such as sub-surface drip irrigation, and computer controlled overhead sprinklers. Apart from the water savings possible with these systems, growers are also aware of the importance of precise water management in achieving high product quality. As a result, irrigation scheduling and soil moisture monitoring are also becoming essential features of vegetable growing in Australia.

The report for this project presents a detailed description of water use in the major vegetable production regions and associated river catchments. The value of output, and a description of market orientation including domestic, processing and exports are also discussed. Technology case studies were conducted with vegetable growers detailing the costs and benefits which flow from a shift to more efficient irrigation systems, demonstrate real investments being made in the industry at farm level. The report also identifies issues for possible future research, which are likely to maximise returns on grower investment of research and development funds.

Technical Summary

A series of eight reports (six states, one national and one technical) has been produced as part of VGO 4010 on vegetable industry water use in Australia.

The vegetable sector is the largest segment of the horticultural industry in Australia. The most recent ABS survey (2000/01) revealed the vegetable industry had a gross value of around $ 2.1 billion, derived from some 2.9 million tonnes of produce. Export value of Australian fresh and processed vegetable products in 2004/05 was in excess of $192 million. The major crop types are potatoes (1.2 million tonnes from 36,800 ha), tomatoes (414,000 tonnes from 8,300 ha), carrots (283,000 tonnes from 7,000 ha) and onions (247,000 tonnes from 5,300 ha).

The 2000/01 ABS survey reported 5,300 vegetable establishments Australia wide (with estimated value of agricultural operations worth $5,000 or more), employing some 15,621 people directly. The industry is comprised mainly of single unit farming families, who generally specialise in vegetable production. Average farm size is about 25 hectares, from which produce worth $230,000 per annum at first point of sale is generated.

Water is an essential input to sustainable vegetable production. The October 2005 ABS report Cat 4618.0 "Water Use on Australian Farms" stated that in 2003/04, the vegetable industry accounted for 477,136 megalitres (ML) or just 4.6 % of the total water used for irrigation. The report also estimated that average water use per hectare was 4.1ML/ha, compared to the estimate overall application rate for water across all crops of 4.3 ML/ha. The value return from vegetable production per ML increased from $1,762/ML in 1996/97 to $3,207/ML in 2000/01 (ABS 2001).

The productivity increases achieved by the vegetable industry can be partly attributed to increased use of water efficient delivery systems such as drip irrigation, increased use of re-cycling on farm, wide scale adoption of irrigation scheduling and soil moisture monitoring and a tendency towards whole farm planning and soil mapping. Although more difficult to measure, some part of that increase in product value is most likely related to quality improvements as a direct result of improved irrigation practices.

Vegetable growers throughout Australia face a challenging operating environment under the various water reforms that have occurred over the last five years. Indeed, the debate surrounding making the best use of scarce water resources in Australia often quotes vegetables as being one of the best performers in terms of $ return per ML. While gross returns from vegetables often exceed those of other crops, it is simplistic to use this criterion alone in deciding where best to allocate water. A better understanding of the complex nature of the vegetable industry, production methods and product marketing is required before recommendations can be made in areas such as state and federal government water policy.

The vast majority of vegetables produced in Australia are sold on the domestic market, and therefore prices are highly sensitive to increases in production. In addition, large investment and increased farm size is often required for irrigation systems used in vegetable production (ie drip), and specialised skills are required to drive those systems to achieve optimal product quality. With vegetable grower numbers in Australia declining, down to 4,541 establishments in 2003, and average farm area increasing, there is a greater concentration of production and increased reliance on technology, automation and integration of irrigation and closely related systems (such as soil and nutrition management) at the farm level.

During the same period of water reforms at governmental levels, market factors have also impacted grower operations and decision making. The advent of quality assurance system programs such as Freshcare for horticultural produce, and environmental management systems (EMS) has heightened grower awareness of the possible effects of poor water management. This has resulted in implementation of on-farm systems and technology which will reduce the negative impacts, such as that resulting from use of saline or contaminated water and excess irrigation close to harvest leading to reduced product shelf life and low soluble solids.

Table 1: Summary of Estimated Productivity from Water by the Vegetable Industry

State	Value of Industry Farm gate $ million	Water used for vegetable production ML	Employment
Queensland	641	109,750	13,500**
Victoria	582	131,000	21,725
NSW	305	96,000	3,100
South Australia	280	74,536	1603
Western Australia	222	83,000	1546
Tasmania	140	49,000	3,620
Australia***	2,170	564,750	45,094

(*Source: ABS 2001(employment and industry value) or 2002-03 (water use) unless otherwise stated*)

* Employment figures include direct on farm and indirect downstream processing/ value adding related industry.

** from CDI Pinnacle Management and Street, Ryan and Associates 2004

***Northern Territory not included

Table 1 shows the estimated productivity from water achieved in the vegetable industry in 2001. Economic studies, such as a recent one by CDI Pinnacle Management and Street, Ryan, Street & Associates in Queensland have shown that down stream industries and operations added another 100% of value on the farm gate contribution.

Nationally, this equates to $7.7 million of total regional output, and 80 jobs for every 1,000ML of water used by the vegetable industry in Australia.

The report for this project presents a detailed description of water use in the major vegetable production regions and associated river catchments. The value of output, and a description of market orientation including domestic, processing and exports are also discussed. Technology case studies were conducted with vegetable growers detailing the costs and benefits which flow from a shift to more efficient irrigation systems, demonstrate real investments being made in the industry at farm level. The report also identifies issues for possible future research, which are likely to maximise returns on grower investment of research and development funds.

In future, the irrigation practices in the vegetable industry are likely to undergo further change. The estimated 7,500 ha of irrigated vegetables in NSW and Victoria under furrow irrigation will be largely replaced by drip and spray irrigation systems. Some sectors of the vegetable industry, such as the fresh and processing tomato and melon industries, have already embraced high efficiency irrigation systems such as sub-surface drip irrigation, and this trend is expected to continue in other vegetable industries.

Introduction

Vegetable growers throughout Australia face a challenging operating environment under the various water reforms that have occurred over the last five years. Indeed, the debate surrounding making the best use of scarce water resources in Australia often quotes vegetables as being one of the best performers in terms of $ return per ML. While gross returns from vegetables often exceed those of other crops, it is simplistic to use this criterion alone in deciding where best to allocate water. A better understanding of the complex nature of the vegetable industry, production methods and product marketing is required before recommendations can be made in areas such as state and federal government water policy.

The vast majority of vegetables produced in Australia are sold on the domestic market, and therefore prices are highly sensitive to increases in production. In addition, large investment and increased farm size is often required for irrigation systems used in vegetable production (ie drip), and specialised skills are required to drive those systems to achieve optimal product quality. With vegetable grower numbers in Australia declining, down to 4,541 establishments in 2003, and average farm area increasing, there is a greater concentration of production and increased reliance on technology, automation and integration of irrigation and closely related systems (such as soil and nutrition management) at the farm level.

During the same period of water reforms at governmental levels, market factors have also impacted grower operations and decision making. The advent of quality assurance system programs such as Freshcare for horticultural produce, and environmental management systems (EMS) has heightened grower awareness of the possible effects of poor water management. This has resulted in implementation of on-farm systems and technology which will reduce the negative impacts, such as that resulting from use of saline or contaminated water and excess irrigation close to harvest leading to reduced product shelf life and low soluble solids.

In order to describe current water use practices, and current constraints in relation to water use and access, six state agencies and CSIRO pooled knowledge and recent research outcomes to produce a series of detailed reports on water use in the Australian vegetable industry.

Project Objectives

The project objectives were to provide the industry with;

- *An accurate description of current water use practices in the major vegetable production regions in Australia*
- *Objective measures, where possible, of the high productivity achieved by the industry for water used including water use efficiency*
- *An indication of where knowledge and technology gaps to achieving high water use efficiency exist*
- *Recommendations to industry on an agreed set of water related research priorities which address those existing knowledge gaps*

Methods

As a national project, and given the specific nature of water resources and methods of access across the major vegetable production catchments in Australia, it was essential to have specialists from each state represented on the project team. Irrigation researchers from CSIRO had also expressed an interest in making inputs to the project on technology options available to vegetable growers, and suggested models for water use efficiency within the industry.

The project team members were as follows;

Organisation	Name	Report/case study
NSW DPI	Mark Hickey Robert Hoogers Rajinder Singh	State & National Technology case studies
Queensland DPI&F	Craig Henderson	State Lettuce case study
DPI Victoria	Bill Ashcroft Murat Top	State Processing tomato case study
Tasmania DPI&E	Dave O'Donnell	State
PIRSA South Australia	Shirley Silvia	State
WA Agriculture and Food	Harald Hoffman	Glasshouse cucumber case study
CSIRO Land and Water	Evan Christen John Hornbuckle Nihal Jayawardane Phil Charlesworth	Technology case study Water use efficiency framework Soil moisture monitoring booklet

A project steering committee including Jeff McSpedden (Vegetable IAC and HAL Water initiative representative) Alison Anderson (NSW Vegetable IDO) and Matt Dent (Queensland Vegetable IDO) was also established. All three attended the planning workshop in Melbourne.

The initial activity was a project formulation workshop held in Melbourne on 26th October 2004. A water industry consultant, Charles Thompson from Rendell McGuckian McGuiness in Bendigo facilitated the workshop. Charles is also the coordinator for the HAL Water Initiative. At the workshop, data needs fro the project were decided on and are summarised below.

Previous work (or aligned projects) was presented in some detail, to consider the approach in specific areas of the project. These included:

- Water Use Efficiency Framework (Nihal Jayawardane)
- Soil Moisture Monitoring Publication (Evan Christen)
- Vegetable Benchmarking (Bill Ashcroft)
- Economic Model (Rajinder Singh)

Core and Non Core Data Requirements (State Reports, Section 4) were discussed, with a list circulated to each of the participants. The agreed list is displayed in the table below:

CORE DATA	NON CORE DATA
• Crop types • Crop Area • In season rainfall • Value $ farm gate • Value added (multipliers, process/retail value) • Export value • Total water used /crop/catchment (available where metered) • Tonnes/ML/crop • Water costs to farm boundary (water charges or private pumping costs) • Gross returns $/ML/crop • Gross Margins $/ML/crop (main crops) • Irrigation management & end product quality • Salinity impacts on production • Other water quality impacts on production • Access to water impacts on production • No. full time equivalent jobs • Water trading flexibility (price) • On-farm metering & water licensing • Benchmarking data – general • Benchmark ET requirement • Benchmark irrigation requirement • Use of soil moisture monitoring • Use of weather based systems for scheduling	• Total catchment water used for vegetable crops • Average water allocation/farm(type, high/low security) • Average allocation % / farm over last 10 years • Average allocation over last 3 years (drought affected) • Crop types / farm (ie vegetable and non vegetable crops/ rotations) • % total allocation devoted to vegetables vs other crops • Trend (% change) in high tech adoption, past 5 years (remain open for interpretation) • Delivery capacity of irrigation schemes • Delivery reliability of schemes • Information accessibility • Service (commercial and government) provision, surrounding infrastructure • Drainage/ recycling capacity/ farm • Production trend / catchment (expanding/declining) • Land value • Number of growers, completed irrigation training

- Data on Non AUSVEG crops are to be included but referenced and segmented where possible
- Both quantitative and qualitative data will be included (where possible quantitative data will be provided)

A general agreement on the project objectives was reached, although the following areas/issues were also addressed *(aligned with the report, table of contents):*

- assessing the impact of technology, benefit/cost analysis and sensitivity analysis, *(cost of technology adoption)*
- benchmarks for regional water use and production, with clear recommendations *(water utilisation)*
- overall water audit for vegetables, *(separate background section)*
- the implications of water trading and available options at a state/regional level, *(water utilisation)*

Other outcomes from the workshop are summarised as follows;

- A final agreement was reached on task list and data collection responsibilities, reviewer (State based Vegetable Industry Development Officer), communications and timelines.

- A task list will be forwarded to participants via email.
- Pro forma was developed (State Reports) and circulated to the group.
- A communications plan was put in place. To involve four phone hook-ups, at project milestones. Will be arranged at some point in the future to discuss progress. Date not discussed, will be arranged.
- A CSIRO website, developed "partner portal" for communication. A username/password is to be arranged via email, to allow access to the site. This will allow shared information, documentation on a secure system. Contacts, announcements, events, links and tasks will be included. This portal was established in December 2004, and actively used by the group in the first half of the project. Project documents and photos etc were placed on the portal.
- External communication will be in the form of water related industry forums, with a power point presentation and summary report to be developed.

Several phone hook-ups were conducted at critical times during the development of reports. The hook-ups were conducted in December 2004, and March, June and September 2004. A report finalisation meeting was also held at the HAL Office in Sydney on 13th December 2005. At this meeting, presentations from all report authours and comments and suggestions on the content for the national report were made.

It was decided that separate state and technical reports should be printed. As each report was 60 to 70 pages in length, it was felt that a single report would be too large, and separation of reports would enable circulation of relevant information to be made in each state. It was agreed that individual state reports and a technical report would be printed, and a small number bound as a complete set for the industry. The national report would also include the technical case studies which highlight individual grower's experience with adoption of new irrigation technology.

A NSW DPI editor specialising in water related publications was recruited, and a system of editorial checks by the steering committee was also conducted on each report. Another water industry consultant, Lauren Thompson reviewed the national report prior to final publication.

Communication

During the project, a workshop session on irrigation was made at the 3rd Australian Lettuce conference in Melbourne in May 2005 entitled "Soil moisture monitoring in lettuce made easy". A poster was presented on the project at the conference, and the workshop included presentations from Robert Hoogers, Mark Hickey (NSW DPI) and Richard Stirzaker (CSIRO Land and Water).

All eight project reports will be available in printed version (250 copies of each) and PDF versions will be made available to HAL and Ausveg for posting on their respective websites as appropriate. Copies will also be sent to the irrigation Association of Australia, the Cooperative Research Centre for Irrigation Futures and other key industry groups with an interest in water.

A joint presentation on the outcomes from the project will be made with project VGO 4015 at the Australian Vegetable Industry Conference in Brisbane on 11th May 2006.

Results and Recommendations

Based on analysis of information in the state reports, and discussion with industry at a local level, the authors have compiled the following recommendation for areas of future research in water which would benefit the vegetable industry, and for which industry funding through Horticulture Australia, AusVeg or other sources could be applied.

ECONOMICS OF WATER

1. Conduct regular analysis of industry trends and issues, similar to the HAL / Growcom study ‘Economic Contribution of Horticulture Industries to the Queensland & Australian Economies’ (CDI Pinnacle Management and Street, Ryan & Associates 2004);

2. Develop whole farm economic models that incorporate overheads and operating costs, and fluctuating water, yield and price scenarios, as tools to enhance the evaluation and comparison of vegetable enterprises and industries, and impacts of changing technologies and external environments on net farm cash income, farm operating surplus, and business returns on equity at farm level. The value of owner/operators time needs to also be recognised.

3. Develop clear economic drivers to support improved irrigation management. Include published benchmarks of economic return per ML relevant to the main vegetable crops and a clear demonstration of potential to improve return per ML applied.

4. Develop a program to regularly update regional vegetable crop gross margins, as the fundamental building block for enterprise/industry analysis. At the same time, investigate technical reasons for differences in water use efficiency indices between regions for like crops;

5. Conduct a detailed study of the threshold cost of water, beyond which vegetable growing becomes uneconomic. For instance, in the Lachlan Valley in NSW in 2004/05, it was “guesstimated” that up to $400/ML could be paid for temporary water before it became unfeasible to grow vegetables. This is particularly important where limited resources of good quality water are driving higher land and water prices.

6. Investigate the feasibility and consequences of on and off farm water recycling. Significant intensive vegetable growing is centralised around urban centres across Australia, in prime position to utilise urban produced recycled water resources, and where joint government and business investment can be harnessed for efficient and sustainable water use.

7. Develop more quantitative data on product quality improvements which can be achieved through use of highly efficient irrigation systems such as sub-surface drip. Assuming this translates into better product prices in the market, it will be a strong driver for adoption of highly water efficient delivery systems and irrigation timing in the vegetable industry, and can be developed through joint investment from the manufacturer and vegetable industry.

BENCHMARKING, TECHNOLOGY AND TRAINING

8. Conduct extensive benchmarking of water use in the major crops, as present data is inaccurate, or relevant only to specific regions. Encouragement for growers to install flow meters on their pressurised water delivery points to farm and crops would be an excellent start. Benchmarking should be focussed on particular factors (eg irrigation type, crop, soil, region) and needs to be conducted over a sufficient interval to allow meaningful comparisons to be drawn. Metering water use is already

compulsory in some growing regions and has facilitated effective resource use and monitoring of pump and irrigation systems for optimum performance. Installation and monitoring of on-farm testwells has also proven an effective learning tool amongst groups in catchment areas, and provides a wider regional measure of water management.

9. Current irrigation scheduling and irrigation efficiency knowledge needs to be extended and best practices for vegetable growers demonstrated to improve the figure of establishments using irrigation scheduling (currently 39.9 % for all Horticulture), and of increased interest, management practices which account for reduced water allocations under drought

10. Provide guidelines that vegetable producers, catchment managers and EPAs can readily adopt to assist them effectively and sustainably use alternative water sources, such as recycled water, or non-potable aquifers.

11. Support irrigation efficiency training and demonstration, particularly skill training to manage "new" types of irrigation systems, scheduling tools and crop/soil management on a wider range of soil types than traditionally irrigated throughout Australia.

12. Use economic case studies of leading vegetable irrigators as "showcase" examples of what is being achieved throughout the industry. Present these case studies to the wider media in order to raise awareness of industry advances in irrigation management, productivity per unit of water and water use efficiency.

RELIABLE INDUSTRY DATA

13. To be less dependent on the ABS, AusVeg could collect independent statistical production data. Growers would have more confidence in the security of data they provide to their own industry than what they provide to a government body. To resolve the issue of inaccurate industry data, AusVeg could then relate the ABS statistics to actual field data and coordinate to get a better quality of statistics, which do not completely rely on grower's statements and also take into account 'unofficial' products. A clear example of the inaccuracy is the Carnarvon horticultural production figures. Whilst production value figures for vegetables in 2001 are estimated by the ABS to be $11,328,022, data collected from trucking companies state the same value to be $27,410,314, that is 142% more. While ABS figures rely on grower estimates, trucking data reflect the actual product, leaving the district and do not include private or local sales or movements North of Carnarvon. Also, future ABS scope and coverage estimates will be further limited to production values of over $22,500, which may exclude a significant number of smaller vegetable businesses.

14. Investigate methods to increase collection frequency of consistent, reliable, verifiable volumes and prices of production inputs and outputs for vegetable industries across Australia;

Discussion

As suggested by the project recommendations, many of the issues relating to water impacting the vegetable industry relate to economics. Apart from specific catchment related constraints in regions such as Gatton and Werribee, where water restrictions curtailed vegetable production for a period during the 2001-05 drought, water trading instruments have enabled vegetable production to continue, even through the driest periods in recent years. However, with water prices set at a higher level, some negative effects on profit margins are likely to be felt by vegetable growers. Hence the need to look at studies such as the threshold cost of water for vegetable production, and detailing the cost of investment in new high costs technologies and demonstrating clear benefits in that investment through higher water efficiencies and profit.

The four technology case studies give some indication of the type of investment required for new, more water efficient irrigation systems. Although the benefits accrues over a number of years, in many cases, the additional investment can be returned within 2 or 3 years, providing the production and quality benefits are significant. For example, in the case of the Queensland lettuce and broccoli grower, the "no change" alternative (ie continuing to sprinkler irrigate) for the grower would have resulted in a depletion of the aquifer to a point where irrigation was not possible. With drip irrigation he was able to maintain his cropping area by making the available water irrigate a larger area compared to sprinklers.

A difficulty experienced by the report authours was the lack of reliable industry statistics on crop area and value. The agreed data source common to all reports was the ABS 2001 survey data. However, the flaws in this data was demonstrated in the Queensland report. For determining crop water use, Craig Henderson compared ABS derived crop yield and water use figures with DPI crop yield figures and estimated water use. The results indicate that although there was good agreement between the two methods for the 12 highest total value crops, ABS over estimated tomato WUE by 50%, lettuce sweet potato and pumpkin by 25-30% and underestimated French bean WUE by 25% compared to the DPI&F method. In addition, for the 5 crops with values less than $15million (carrot, eggplant, onion, cabbage and celery) the ABS method overestimated water use efficiency by 50-150%.

It was also apparent that there is a scarcity of reliable crop water use data to use in benchmarking studies. Most data is based on grower estimates, and although most of the waster applied to vegetable crops is pressurised, water flow meters are either not installed or used correctly. In time this could addressed through programs such as Enviroveg, or quality assurance systems that require crop water use data. The approach taken by the recently completed HAL project on benchmarking water use in the vegetable industry (VGO 4015) if replicated on a wider scale could also help address this issue.

One of the project recommendations is to look at support mechanisms to increase grower adoption of crop use water monitoring. One of the fundamental tools used to measure water application to crops is a flowmeter, which are generally installed on the discharge side of the irrigation pump. In pressurised systems, flowmeters are used to monitor water applied to particular blocks, crops, or to measure water used on the farm over a period of time, depending on how often the meter is checked. Modern irrigation controllers can also measure water applied, and being automated make it simple for growers to collect data on water use. In order to be able to improve, it's vital to be able to measure current water use, so that a benchmark is established. Subsidising the cost of flowmeters would be a good first step to gradual industry wide improvements in water use efficiency. Experience from the Simplot supported potato program in Tasmania suggests that flowmeters can shed new light onto the effectiveness of growers irrigation practice, and when combined in a regional benchmarking exercise can be a powerful tool for efficiency improvements in a community of growers.

Such programs require some extension support, either from a government program, or private industry such as a processor (ie Simplot). As public sector extension is gradually wound back in Australia, the vegetable industry will need to look at alternative means of providing such technical information to growers if it is to seriously address continuously improved water management in the larger regional vegetable production areas in Australia.

Publications

1) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – QUEENSLAND - Craig Henderson March 2006

2) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – VICTORIA - Murat Top and Bill Ashcroft March 2006

3) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – TASMANIA - David O'Donnell March 2006

4) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – SOUTH AUSTRALIA - Shirley Silvia March 2006

5) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – WESTERN AUSTRALIA - Harald Hoffmann, Dennis Phillips and Bob Paulin March 2006

6) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – NEW SOUTH WALES – Mark Hickey and Robert Hoogers March 2006

7) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – NATIONAL REPORT - Mark Hickey, Robert Hoogers, Rajinder Singh, Evan Christen, John Hornbuckle, Craig Henderson, Bill Ashcroft, Murat Top, David O'Donnell, Shirley Silvia and Harald Hoffmann March 2006

8) MAXIMISING RETURNS FROM WATER IN THE AUSTRALIAN VEGETABLE INDUSTRY – VEGETABLE IRRIGATION TECHNICAL REPORT - Evan Christen, John Hornbuckle and Nihal Jayawardane March 2006

9) SOIL MOISTURE MONITORING EQUIPMENT FOR VEGETABLE CROPS – Phillip Charlesworth and Robert Hoogers, March 2006

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Attachment 1

An Economic Assessment of the adoption of Improved Irrigation Technologies in the Vegetable Industry in Australia

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1. Background

Most irrigation areas in Australia are experiencing problems of deep drainage, rising water-tables, soil salinity, and excessive amounts of chemicals in the drainage water. Also, the current water reforms that includes provisions of diverting water from agriculture to the environment and for maintenance of river health has lead to less water available for irrigation, with potentially serious repercussions on profitability and economic viability of different agricultural industries.

Although the vegetable industry is considered to be more efficient compared to most other agricultural industries in terms of water use efficiency and profitability, stiff competition in the local and international markets have resulted in declining farm profits and economic sustainability is under serious threat. This is evident from the fact that number of vegetable farms has declined over time but the farm size has increased. Vegetable farming is very labour intensive, with labour costs being one of the major components of the total variable costs. Furthermore, most of the vegetable farms have limited water supplies due to reduced general security allocations. Therefore, vegetable growers are being encouraged to upgrade their current less efficient irrigation systems with more efficient high tech irrigation systems to help improve productivity, profitability, water use efficiency and labour savings in the vegetable industry.

However, installation of different high tech irrigation systems like centre pivot and drip involves significant initial capital investment, replacement and maintenance costs. Depending upon the crop type, farmer’s management skills, availability of labour, pricing and marketing arrangements in place, irrigation systems perform differently for growing different vegetable crops. Therefore, it is important to know the type of irrigation technology most suited to a particular vegetable crop and the benefits of switching over to a high tech irrigation system compared to the costs involved in installation of such systems before recommendations are made to the farmers.

One of the aims of the research project, ‘Australian Vegetable Crops – Maximising Returns from Water’ funded by Horticulture Australia Limited, was to identify irrigation technologies most suited for different vegetable crops. The study has considered several farm level case studies to identify irrigation technologies most suited to different crops grown in vegetable growing regions in Australia.

The main objectives of the economic analyses are to measure the potential economic and environmental benefits of conversion from an existing less efficient irrigation system to a new more efficient irrigation system on several selected case study vegetable farms representing different crop types in different vegetable growing regions in Australia.

More specifically the aims of the economic analysis are:

1. To measure the potential financial benefits to the farmers from adoption of different improved technologies;
2. To identify the economic and environmental benefits from adoption of an improved irrigation system over an existing less efficient irrigation technology on different case study vegetable farms; and
3. To compare benefits with the costs involved in adoption of different improved technologies for growing vegetables on different selected farms.

The high tech irrigation systems involve huge initial capital investments and the stream of benefits flow over the life of a system ranging between 20 to 30 years. To measure returns to the on-farm investment on such technologies, the benefits from a new system were measured taking into account the total impacts of the option; improvement in yield, quality, shifts in cropping rotation, reduction in input costs, labour savings, water savings and social and environmental benefits. Similarly the study has considered different costs involved eg capital cost, installation costs, operational costs, repair and maintenance costs and replacement costs on a particular farm.

2. METHODOLOGY

2.1 Features of Economic Analysis

The analysis involves a partial budgeting approach in which the additional and foregone annual costs and benefits of an option were compared. The analysis was carried out both from financial and economic prospective.

A financial evaluation was undertaken in order to ascertain the attractiveness of the option from the perspective of the farmers. In undertaking a financial evaluation, it is appropriate to use financial values for all relevant inputs and outputs. 'Financial values' refer to the prices / benefits actually received by farmers for outputs or actually paid by them for inputs or losses suffered by farmers.

Economic analysis considers the total impacts of the option, both direct and indirect. Economic values also correct any distortion in the financial values due to government intervention (e.g. taxes or subsidies on inputs) or to the market power certain producers may exhibit (e.g. monopolies).

The period over which benefits and costs of the proposal were accounted for in calculating present values of costs and benefits was 20 years ie from year 2005. It is anticipated that the effective life of most of the high tech irrigation systems is for 20 years. Although some irrigation systems may last longer than 20 years, the costs involved in repair and maintenance and replacement of some of the components such systems are so huge, it is considered to be economical to replace the old irrigation system with a new system.

Two criteria were used in assessing the financial and economic merit of the conversion, these being the **Net Present Value (NVP),** and the **Benefit–Cost Ratio (BCR)** of the proposal.

The net present value is described as the difference between the present value of costs associated with the proposal and the present value of benefits accruing from the proposal. The proposal is deemed to have a positive impact if its NPV exceeds zero.

The benefit-cost ratio is the ratio of the net present value of total benefits and the net present value of total costs. The proposal is deemed to have a positive impact if the BCR exceeds unity.

A real discount rate of 4 per cent per year has been used in under taking economic evaluation of proposals. It ensures that all future costs and benefits will be measured in relation to the current purchasing power of money and that any inflation of future costs and benefits will not distort the results.

Risk is an important component of the production environment. Different enterprises will have different levels of associated production and price risks. Sensitivity budgets would be developed with respect to yield and prices that may help vegetable growers / industry to understand the effect of these variations on returns to investment on such conversions.

4.1 Value of increase in crop yield and or quality

Improved irrigation technologies help improves water use efficiency that would also lead to increase crop yield or higher output price due to better quality of fruit. The improvement in quality or yield would increase gross returns from a crop but it would also involve some additional costs harvesting, transporting and marketing of additional quantities of the output. Therefore the benefits from yield or quality improvements are worked out through the increase in gross margins from a crop.

4.2 Value of water saved

At the farm level, there are a number of choices concerning any water saved as a result of reduction in water use due to efficient use of water. Farmers may choose to use the saved water in increasing the area under different crops, or carry over this water to the next irrigation season or sell any water saved. In these evaluations, we assume that the value of saved water is the price it could be sold for. Market value of water in different irrigation areas would vary depending upon the availability of water and supply of water to vegetable farms i.e. surface water, regulated or unregulated supply of water , river pumping, or bore bumping water etc.

4.3 Value of labour saved

Growing vegetables using less efficient irrigation technologies involves a lot of farmer's time on different irrigation operations. The adoption of high tech irrigation technologies for growing vegetables helps save human labour required for irrigation operations. The saving of farmer's time on different irrigation operations is valued at a basic rate of @25 per hour.

4.4 Environmental benefits

There are expected to be some benefits to the broader Australian community from the adoption of improved irrigation technologies on vegetable farms that help prevent deep drainage of water from vegetable farms due to improved WUE. It is hard to directly measure the benefits of a reduction in ground water accessions. Alternative for measuring benefits of reducing ground water accessions is by considering cost of pumping out 1Ml of ground water if the area has suitable aquifers. Whilst it is unlikely that spear points could remove all of this water, a cost of $43/ML for pumping out ground water has been used as surrogate measure of the benefits of reducing ground water. This includes the cost of pumping out --

The reduction in ground water accessions would also lead to a reduction in irrigation salinity. It has been found that irrigation salinity leads to a loss of infrastructure. The study has assumed the value of $15/ML in reduction in loss of infra structure due to salinity as an economic benefits to the community (Singh, R. 2005).

3. Case studies considered

The study would measure returns to investment on the conversion to more efficient irrigation technologies from different existing less efficient technologies on the four pre selected case study farms growing different vegetables in different regions / states of Australia. Details of the case studies considered for the economic analysis are given in Table 1

Table 1: New irrigation technologies type and location of different case study farms in Australia

	New irrigation technology	**Existing irrigation system**	**Type of case study vegetable farm**	**Location/region**
1	Centre pivot	Travellers	Sweet corn	Bathurst, NSW
2	Drip irrigation	overhead sprinkler	Broccoli	Queensland
3	Drip	furrow irrigation	Tomatoes	Echuca, Victoria
4	Drip with recycled water	Drip with bore water supply	Cucumber	South Australia

Since the existing irrigation systems are being replaced with different new irrigation technologies that involve different capital and maintenance costs, and lead to different benefits for different crops, therefore, the study would analyse the returns to investment for each of the selected case study farm separately.

4. Vegetables Technology Conversion Case Study 1 – Traveller to Centre Pivot for Sweet Corn Production

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To measure benefits and costs involved in the conversion to Centre Pivot from an existing Traveller irrigation on vegetable farms, a vegetable farm of Mr. Jeff McSpedden, located at The Lagoon, 20km from Bathurst on the Central Tablelands in NSW was selected as an irrigation technology case study farm. The soils of the farm are of friable black loam to clay loam overlying medium black clay loam (Prairie soil) and are suitable for growing vegetable crops. The farmer grows 100 ha of area under different vegetable crops mainly sweet corn, Broccoli, Radicchio and Lettuce. Irrigation water is used directly from the Campbell River downstream from Chifley Dam.

A traveller irrigation system was being used to irrigate 34 ha of Sweet corn crop (Super Sweet for processing). The existing system was not efficient in terms of uniform application of water to the crop, leading to low crop yields and poor quality of corn, thus attracting lower price due to rejection of some crop because of poor quality. To improve yield, quality and water use efficiency he decided to replace the existing traveller irrigation with a new Centre Pivot, a more efficient irrigation technology to irrigate the same size and type of the crop.

In the economic analysis, the information used on crop yield, prices received, input use, water and labour used and capital and operating costs etc. for both the systems is based on the farmer's records and accounts. To fill a few gaps in the data required for the analysis, information was collected through personal discussions with the local irrigation and industry people and the technical staff involved in the project.

The information on crop yield, prices, water volumes, water costs, input use, water losses through surface and sub surface drainage, capital costs, installation and other maintenance costs and expected life of different of components of both the irrigation system is given in Tables 2 & 3 and 4.

Table 2: Operation area, crop yield and market price of sweet corn for both centre pivot and travellers irrigation for sweet corn production

	Traveller	Centre Pivot
Total area covered	34	34
Area under roads	0.5	0.25
Operational area	33.50	33.75
Crop yield	16	19.2
Market price	168	192.5

Table 3: Changes in Water usage, water and labour costs and water losses through seepage and surface run-off for both centre pivot and travellers for sweet corn production

	Traveller	Centre Pivot
Water used (ML/ha)	3.0	2.5
Water costs ($/ML)	$10	$10
Running electricity costs ($/ha)	$67	$17
Labour costs	130	32
Water losses through seepage (%)	15%	0%
Surface run-off (%)	20%	5%

Table 4-: Details of the capital, installation and maintenance costs involved for both the Centre Pivot and Traveller irrigation systems

	Traveller	Centre Pivot
Cost of irrigation system ($)	32,000	84,000
Life of the system (years)	20	20
Cost of pipes ($)	6,900	14,000
Crop life of pipes (years)	40	40
Cost of hydrants ($)	$2,500	
Cost of head works ($)		$1000

Cost of Tyres ($/yr)	$500	$3000
Life to tyres (years)	5	5
Other maintenance cost ($/yr)	$300	$300

The information given in Table 2, 3 and 4 shows that both the systems are used to irrigate 34ha of sweet corn crop. Although initial capital costs are much higher in case of centre pivot compared to the traveller irrigation, centre pivot is found to be much more efficient in terms of crop yield, price, use of area, water and labour use and reduction in water losses compared to the Traveller irrigation.

4. Technical and financial impacts of conversion to Centre Pivot System

Table 5: Financial benefits of conversion to centre pivot from Traveller system

Measure	Value
Increase in yield (t/ha)	3.2
Price premium on quality ($/t)	$6.25
Water saved (ML/ha)	0.5
Value of water saved ($/ML)	$50
Value of electricity saved ($/ha)	$50

Table 6: Economic benefits of conversion to centre pivot irrigation

Measure	Value
Reduction in deep drainage (ML/farm)	15.1
Reduction in loss of water though service run-off (ML/ha)	0.5
Reduction in losses to infrastructure due to salinity ($/ML)	5
Value of reduction in seepage losses ($/ML)	43

It has been found that the adoption of centre pivot leads to an increase in the crop yield by 20% that is from 16 tonnes per hectare under traveller to 19.2 tonnes per ha using centre pivot irrigation. Furthermore, the uniform application of water helps to improve the quality of sweet corn. It is assumed that there would be a $26/t premium on 25% of the crop yield, i.e. on average $6.50/t for 19.2 t/ha of the crop (Personal communication, Mark Hickey). The increase in yield also involved an additional harvesting cost of $51/ha, therefore, the net benefit from yield and quality improvements was $565/ha.

The new irrigation system also used 0.5 ML/ha less water to irrigate sweet corn crop thus, improving the water use efficiency by 20%. It not only helped to reduce the cost of production, the saved water was an extra source of income for the farmer.

4.1 Value of water saved

In the regulated river supply system, the water trading price varies inversely with availability of water for example, in the MIA from $30/ML when allocations are up-to 80 percent, to $50/ML at 50 percent availability and $70/ML at 30 percent water availability (Singh, R. 2005). It is assumed that the average annual water allocation may only be around 50 percent of the total annual water entitlement of a broadacre rice farm (Personal Communication John Lacy). Therefore a price of $50/ML has been considered as a surrogate value of water saved on the case study farm.

4.2 Environmental benefits

The improved water use efficiency would help to reduce losses through deep drainage and surface run-off. The conversion to centre pivot would help prevent loss of 15.1ML and 17ML of water to deep drainage and surface run-off respectively.

5. Results

1

2 TABLE 7: RESULTS OF THE BENEFIT-COST ANALYSIS

2.1 MEASURE	2.2 FINANCIAL analysis	ECONOMIC analysis
Present Value of benefits	$330,000	$338,000
Present value of costs	$45,500	$45,500
Net Present Value	$284,000	$292,000
Benefit – Cost Ratio (%)	7.2	7.4

The results of the benefit cost analysis presented in Table 7 show that the present value of benefits, present value of costs and the net present value of the financial benefits from adoption of the improved technology on production of sweet corn were $330,000, 45,500 and $284,000 respectively. The benefit cost ratio of 7.2 indicates that every dollar spent on the improved technology leads to $ 7.4 increase in income. The economic benefits that take into account the environment and community benefits were even high. Therefore the adoption of centre pivot on the selected case study farm is viable from both financial and economic perspective. Furthermore, the study has found that the conversion to centre pivot irrigation helped the farmers to receive an extra benefits of $31000.00 through increase in yield, area under cropping, value of water and labour saved. That means the farmer was able to recover the additional costs of $45,500 involved in conversion to centre pivot irrigation system in the second year.

Sensitivity analysis

Better irrigation management leads to increase in crop yield and or quality of the output. There are some incentive payments made for higher quality of the sweet corn. Sensitivity analysis was also undertaken to analyse the effect of variations in increase in crop yield and quality premium on total benefits from conversion to centre pivot.

Table8: Sensitivity of results to variations in yield and quality premium from adoption of centre pivot irrigation

Measure	Financial analysis	Economic analysis
Yield		
No increase in yield	**3.2**	**3.4**
10% increase in yield	**5.2**	**5.4**
Premium		
No premium	**6.3**	**6.4**

The results of the sensitivity analysis presented in Table 8 revealed that the returns from the investment are more sensitive to increase in yield than the premium received through quality improvements.