Peter Wadewitz | National Chair and SA Branch Chair|
Australian Organics Recycling Association Ltd

W: www.aora.org.au

30 April 2018

Carolyn Lee,
Director
Murray-Darling Basin Royal Commission
GPO Box 1445
Adelaide SA 5001

By email: mdbroyalcommission@mdbrc.sa.gov.au

Dear Ms Lee,

Re: Submission from the Australian Organics Recycling Association

The Australian Organics Recycling Association is the peak body for the organics recycling industry in Australia.
Our membership includes recycled organics processing operators, state and local government representatives and industry stakeholders including individual and student members and those representing associated industry organisations.

Around half of all material destined for landfill is organic. In Australia, this represents around 19 million tonnes annually. The recycled organics industry currently processes around 6 million tonnes annually and is seeking to increase this volume by diversion into beneficial reuse as soil conditioners, composts and mulches. Where policies, practices and technologies allow, every kilogram has potential for beneficial reuse, taking organic material back to agricultural and other soils where it is increasingly needed.

Recovery of 450GL for Enhanced Environmental Outcomes (Item 28 c of the Issues Paper)

With reference the MDB Royal Commission's Terms of Reference and specifically 28c) of the Issues Paper we offer information that demonstrates compost and other related organic products produced by our industry as an Efficiency Measure in a range of Agriculture sectors. Efficiency Measures are described in the The Basin Plan as contributing to the recovery of an additional 450GL, aimed at achieving the "enhanced environmental outcomes" outlined in Schedule 5 of the Basin Plan.

Our reasoning for putting forward the application of compost as an efficiency measure is based on research findings and the experience of our Processing Members linked to experience in applying compost. Some sources are provided below:

AGRONOMIC AND SUSTAINABILITY OUTCOMES FROM COMPOST APPLICATION IN SOUTH AUSTRALIAN CITRUS ORCHARDS, P. Crisp, G. Baker, S. Wheeler, South Australian Research and Development Institute.

International Symposium on Organic Matter Management and Compost Use in Horticulture, Adelaide, South Australia, April 2011, Article number 1018_50 Pages 457-464
https://www.actahort.org/books/1018/1018_50.htm

Summarised Findings:

In this research SARDI undertook trials with compost mulch, grape marc and animal manure at sites on three citrus orchards in Loxton South Australia for a number of years. The trials were established to evaluate the potential of soil amendments as part of an integrated management program for Kelly's citrus thrips (KCT).

Three types of organic soil amendments were trialed including Composted Green Organics, CGO supplied by Jeffries, a long-standing SA AORA Processing Member and was a blend of lawn clippings, branches, and garden prunings mixed with timber waste in pallets, crates and boxes. The CGO had 40+% organic carbon with a carbon/nitrogen ratio of approximately 12:1 and has a pH of around 8.

The key conclusion from the Abstract was that:

> "The recycled green waste and composted animal manure have provided significant pest management and agronomic benefits through suppression of KCT and improved yield and fruit size. There were considerable economic net benefits from every type of trial application to citrus at both sites over the four year period assessed. For example, for every dollar invested in an application of 40 m3 ha-1 compost mulch at Loxton North, a return of about $ 5 dollars was realised. Returns ranged from $ 1.91 to 4.96. There also is the benefit of improved water efficiency that could provide significant cost savings.
>
> The longevity of these benefits remains unknown and is currently being evaluated. Whilst the grape marc treatments improved yields, and are cheaper than the composted green waste, the level of suppression of KCT was not as good as that provided by the compost, and the increased acidity that resulted from the high phosphate levels associated with the grape marc treatments could result in reduced quality. It seems that higher levels of application for compost mulch create more overall benefits in terms of fruit quality and tree health".

The researchers in their Discussion of the results conclude (amongst other things):

> "The increase in yield and fruit size achieved on trees treated with composted soil amendments could be attributable to a range of factors, including improvements to soil structure, cation exchange, reduced bulk density, increased plant nutrient availability and humic substances acting as plant stimulants (Reeves, 1997; Weil and Magdoff, 2004). However, it is most likely that in these trials the increased availability of soil moisture was the major contributing factor. Improved nitrogen levels in the soil were

also likely to have been an important driver for yield increases, although there was no significant difference in nutrient levels in leaves in 2009."

Another benefit suggested by the authors is that application of synthetic sources of nitrogen, such as urea, could be reduced, or ceased completely given the high content of nitrogen in the soil amendments trialled, with the nitrogen composition in CGO being 2.2% and which appeared to have been retained in the top 5 cm of the soil profile.

The authors do highlight one cautionary finding requiring further investigation:

> "The results from soil, soil water and leaf analysis testing indicate that in most instances there were no long term detrimental effects associated with the application of these soil amendments. However, EC levels in water samples taken from the highest application rate of CGO and the GM were elevated and could potentially be of concern. In these cases the samples collected from the Solu-sampler were of lower volume than other samples, and while concentration of ions may be higher in the solution, actual concentrations in the soil may be no higher than in control samples. This needs further investigation."

AORA has prepared a fact-sheet on compost used aimed at citrus growers, linking to the findings from this SARDI research in Loxton:

https://www.aora.org.au/wp-content/uploads/2018/03/compost_in_citrus-factsheet_web_2017.pdf

It is important to recognise that the CGO from Jeffries used in this research, a blend of lawn clippings, branches, and garden prunings mixed with timber waste in pallets, crates and boxes, could, with the right policy/program measures, be produced in regional centres throughout the Murray Darling Basin with feedstocks of organic waste from various industry sectors and rural communities. Hence a greater social benefit around waste management is also derived through the application of compost.

BENEFIT COST ANALYSIS OF COMPOSTED ORGANIC MULCH IN HORTICULTURAL INDUSTRIES: VINES, CHERRIES, ALMONDS, PEARS, CITRUS AND POTATOES, CAPSICUMS, CARROTS AND FLOWERS, SOUTH AUSTRALIAN CENTRE OF ECONOMIC STUDIES

This report examines the economic return on each dollar invested in compost applications for nine different horticultural/agricultural industries based on two years of field trials undertaken by the CSIRO between 1997 and 1999 with 'green-organics' compost, derived from municipal green wastes (leaves, lawn clippings and prunings).

A period of three years was considered for Benefit Cost Analysis and included increased yield and revenue that translated into increased revenue, as compared against the costs for compost application. The results demonstrated positive BCA across most sectors but don't include savings on water for irrigation or for reduced herbicide, or fertiliser costs (in some cases). However CSIRO's experience suggests that there is the potential for large water savings in horticultural crops using compost, easily up to 30 per cent for some crops.

The authors highlight that:

> "The results must be considered as indicative only, given the lack of statistical significance between the control and compost applications in most of the crop trials" .

However the results of BCA as given in the report are summarised for some sectors below as they are indicative along with other conclusions on the nature of benefits achievable, including with respect to water savings, it should be noted that the dollar benefits stated were relevant to the year that the report was published, 1999:

<u>Vines (McLaren Vale, SA):</u>

> "The trials were established in 1996 to demonstrate to growers the potential for more efficient management of irrigation, in a region where water availability was an increasing concern."
>
> "The BCA's indicated that for every dollar invested by growers in McLaren Vale in the 10 mm mulch they would receive $8.85 in return, Willunga growers $4.27 in return and McLaren Flat growers $6.47 for their mature vines"

Other conclusions included:

> "Water availability is a key issue for grape growers, and the potential for water savings to be derived from compost mulch is a significant benefit in terms of costs and improvements in the management of their vines. Growers could save up to $100 per hectare in water costs."
>
> "The most significant economic impact of the use of compost mulch on the production of grapes is the potential to improve conditions for the establishment of young vines, giving growers more options for management of early training, pruning, harvest and quality. With more options to manage the growth of young vines, growers have opportunities to reduce establishment costs and lessen the time for the vineyard to achieve economic yields."

Hence it can be reasoned that compost application will minimise establishment costs for winegrowers in regions connected to the Basin who chose to replace existing grape varieties and root stocks with those that are more tolerant to dryer conditions.

<u>Cherries (Forreston, SA):</u>

With respect to the BCA:

> "For every dollar invested by growers in the 10 mm mulch (depth of application) they received $73.78 in return. This benefit was a direct consequence of the grower receiving higher prices for the improvements in cherry size."

Other conclusions and improvements noted by grower:

> "By applying composted mulch, cherry growers could save up to $45 per hectare in water costs."
>
> "The increase in cherry size was of considerable benefit, with the grower noting that the picking costs and time for larger cherries are the same or lower than the costs for smaller cherries."

<u>Almonds (Willunga)</u>

With respect to BCA:

> All rates of application at depths of 10 mm, 50 mm and 150 mm, at a cost of $24.50 per cubic metre provided negative economic returns.

However importantly it was concluded:

> "Given the importance of water availability to almond growers, the water savings of compost mulch provide a considerable benefit. Growers could save up to $157 per hectare in water costs."

<u>Pears (Coromandel Valley, SA)</u>

With respect to BCA:

> "Strong economic returns were obtained for the 10 mm and 150 mm mulch scenarios, with the 10 mm mulch providing the highest return with $5.30 for every dollar invested. The 50 mm mulch did not have any economic return."

Other conclusions and improvements noted by grower:

> "By applying composted mulch, pear growers could save up to $3,200 hectare/year in water costs."
>
> "The trial was established in 1997 in an orchard in which the trees had not established as quickly as expected; after five years they had not reached the top of the trellis. This limited the options for the grower to train and prune the trees to achieve optimal production. Within six weeks of compost mulch application, growers reported obvious responses in growth, and after three months, shoot length in the mulched trees extended well beyond the upper trellis wire".

<u>Citrus (Waikerie, SA)</u>

With respect to BCA:

> "Composted mulch was applied to citrus at Waikerie at depths of 10 mm, 50 mm and 150 mm, and at a cost of $37.50 per cubic metre. The additional delivery costs added to the overall cost of the mulch. Negative economic returns were obtained for all mulch scenarios."

Costs of transport for compost delivery remains a hurdle in the Riverland, highlighting the possible gap for a commercial composting facility taking organic waste streams for composting within this region.

Other conclusions:

> "By applying composted mulch, citrus growers could save up to $95 per hectare in water costs.
>
> Water is not expensive in the Riverland irrigation areas, and growers are not seeking to save irrigation to reduce costs."

Obviously, the prices for water have significantly increased since the late nineties when this report was written and growers are far more motivated to save on irrigation today.

<u>Potatoes (Northern Adelaide Plains)</u>

With respect to BCA:

> "There was little economic return achieved from the potato trials, with the 20 mm compost providing a return of $1.30 for every $1 invested. The 75 mm compost did not have any economic return."

Other conclusions and points noted by the Grower:

> "By applying composted mulch, potato growers could save up to $41 per hectare in water costs."
>
> "There were significant changes in soil properties, with organic carbon levels increased by over 40% under the highest rate of compost. A shift towards neutral pH altered the availability of nutrients in the soil, with the grower noting that he would be able to reduce his use of fertilisers."

AORA EVENTS and TOOLS FOR ENGAGEMENT WITH GROWERS

The Australian Organics Recycling Association links all stakeholders in the organics recycling sector to drive uptake of compost by growers for increasing farm productivity. Our Compost for Soils toolkit on the AORA web site provides information in the form of case studies, fact-sheets and tools for growers on the benefits of compost as well as advice on how to address specific issues such as salinity or specific plant diseases relevant to a particular sector.

AORA also seeks to provide informative seminars and site visits for Growers linking them with the latest technology for soils assessment and compost application, for example using precision farming. An example of one such event is the one on Composting Viticulture held in the Barossa region of South Australia; a site visit opportunity with Nigel Blieschke, Head Viticulturist at Torbreck Vintners and also featuring a seminar from leading soil scientists and the latest on precision farming technology for compost application. A flyer for the event which was funded by a government department, is attached.

AORA STRATEGIC ENGAGEMENT

In-kind support towards the CRC for High Perfromance Soils

AORA NSW has made a commitment to the CRC for High Performance Soils to the amount of $16500 over the next 6 months for in kind work by NSW AORA Chair, David Bonser.

This assistance will be in the area of Expert Technical Support to an ongoing project and will yield information on increased mineralisation of nutrients, increased water holding capacity due to organic carbon increase as well as increasing soil microbial activity.

ERF Soil method update creates new opportunities for compost

AORA has actively followed and advocated for the Emissions Reduction Fund (ERF) determination for the *Measurement of Soil Carbon Sequestration in Agricultural Systems* which was was released by the Department of Environment in late January 2018.

It's good news for landowners working to improve soil carbon, and potentially great news for those helping their efforts by supplying compost.

The new determination builds on two previous soil carbon methods and makes it easier for landowners to claim creditable carbon with lower compliance costs. For the first time this determination allows landowners to claim credits for increasing soil carbon on cropped land using a direct measurement method. This means growers using eligible practices to build soil carbon on cropping properties can apply for Australian Carbon Credit Units (ACCUs). The determination also recognises the application of compost as an eligible activity for building soil, and compost application will be a useful tool for farmers wanting to boost the carbon benefits they get from other land use changes.

The direct measurement method means that landowners can get credits for both the carbon in composts as well as the increase in biotic carbon achieved by having healthier soils and more plant growth. Better soil means more root and plant growth, and with good soil management practices that means more soil carbon. Every 1% increase in soil carbon levels is equivalent to carbon abatement of around 80-110 tonnes CO2 per hectare with a current ACCU value in Australia of around $960 -1,540 per hectare. Most cropping soil has soil carbon levels of less than 1%, with potential to increase levels to at least 4-5%. An achievable target of a 4% increase would sequester 320-440 tonnes CO2-equivalents per hectare, with an ACCU value of $3,840-6,160 per hectare.

Most of the carbon in compost is in a slower-to-degrade form than Carbon in plant matter grown in the paddock. Periodically applying compost will see soil carbon levels build more rapidly and reliably than land use changes alone, so any grower with a recognised carbon abatement project would be wise to consider using composts to build and maintain soil carbon and improve the productivity of their soil.

Compost gives the dual carbon benefit of carbon contained in the compost plus the benefit compost has on helping soils to grow and store soil carbon. Composts can be expected to directly contribute 180-300 kg CO2-equivalents of slow-to-degrade carbon to the soil per tonne of compost, and with good soil management, more than 70% of this will still be present in the soil after ten years. This does not count the sequestration from improved plant growth and soil health. US EPA modelling suggests this additional sequestration can be higher than the carbon contained in the compost, but soil type and other land management practices will affect how much benefit landowners see from compost application.

The main opportunity for composters will be to work with landowners who are striving to meet a soil carbon target. Research suggests soils need at least 4-5% organic carbon to function as a healthy ‘living’ soil, with a thriving soil biology that boosts nutrient availability and plant growth. On many Australian soils it is hard to build and maintain such levels under dry-land cropping systems, but applying compost at rates of 10-20 tonnes per hectare every few years will more reliably build soil carbon to such levels and help soils grow and retain other carbon. The new ERF methodology should help landowners to see the benefit of compost and should help composters promote products to farmers working to improve soil carbon and health.

OPPORTUNITIES SOUGHT BY AORA

As the industry body for the organics recycling sector, AORA welcomes opportunities to establish compost and mulch application as a recognised Efficiency Measure for the purposes of the Basin Plan. AORA would welcome:

- Further resources for education and promotion of the benefits of compost to target agricultural sectors within the basin, as well as continuing research and development into the water savings achievable through application of compost in such sectors.
- Opportunities for our Processing Members, growers who are experienced in using our products and agronomists and other experts within our network to have appropriate consultation opportunities with those responsible for designing and implementing Efficiency Measures.
- Opportunities to link the expertise and experience of our Processing Members in developing new composting operations, in areas within the Basin which are presently disadvantaged by not having a nearby composter, contributing to high delivery costs and therefore making the use of compost unviable. Along with new regional composting operations would come associated jobs in composting and allied activities (e,g, delivery and spreading of compost).

I look forward to further discussing the matters raised above further, please do not hesitate to contact me on

Yours Sincerely

Peter Wadewitz

Natonal AORA Chair
SA AORA Branch Chair
Director, Peat’s Soil and Garden Products

30 April 2018

Testimonial from Nigel Blieschke, Head Viticulturist at Torbreck Vintners:

By using compost for the last twelve years on vineyards that I've worked within or managed, in every case I've been able to increase carbon levels in soils by at least 1% and save between 30% and 40% on water usage. Other benefits have included uniformity of vine growth and improved consistency and quality of grapes. It is acknowledged that other farming practices have also contributed to these results such as: smart irrigation (for example maintaining or upgrading the best drip irrigation systems to deliver water efficiently and during the cooler hours between 6pm and 6am); no tillage of self-sowed cover crops as well as addressing issues of soil, water or recycled water chemistry. However the management of soil carbon through application of compost is a vital component of a broader strategy I have used in building the physical, biological and chemical aspects of soil functionality, for optimum vine performance.

The source of compost products that I've applied to vineyards have included mulch and various grades of compost which I have found to contribute to increased carbon at depth, improved water infiltration and increased microbial activity at depth, all of which contribute to good soil structure. Through carbon strategies involving cover crops between rows, compost has become a catalyst for generating more carbon. Here at Torbreck Vintners in Marananga in the Barossa Valley I have used a range of soil assessment tools including EM38 TopSoil Mapping and near infrared photography in order to understand exactly where carbon needs to be added to soils in various parts of a particular block and at what rate of application; this has been key to reducing the amount of differential vigour and lifting yield, quality and consistency of grapes harvested, whilst minimising the amount of irrigation used to that which is only required by soils and reducing potential for high nutrient run-off.

In my own Barossa vineyard, 8 years of applying compost in areas where needed, carbon levels have been raised from 1.2 % to 2.2% and despite a dryer year this year so far the soils is still soft and has good structure. With innovations such as E38 Mapping and the use of an emerging mobile application to make precision farming accessible, (Platfarm) at Torbreck I now hope to raise carbon level in the coming years to between 2-3% (from the current 0.8 – 1.4 %)and be able to dry-grow grapes in certain areas of the vineyard, i.e. without the use of irrigation. I also welcome the opportunities for increased carbon sequestration including with respect to the Commonwealth Emissions Reduction Fund as liked to the measurement method for Agriculture.

T O R B R E C K

BAROSSA VALLEY

In recent years I have had much support from organisations such as AORA in learning more about compost and compost additions. Through an AORA initiative I have also attended a microscopy course to learn how to assess my soils which has been of great value.

Signed:

Nigel Blieschke 30.4.18

___________________________________ _________________

Nigel Bleischke, Head Viticulturalist, Torbreck Date:

Torbreck Vintners

info@torbreck.com

Compost in citrus

Compost in Citrus - can it make a difference?

Soil amendments, including composted green organics, are making a difference in many agricultural and horticultural operations - including the citrus industry. Recent research conducted at SARDI (Dr Peter Crisp and Greg Baker) and the University of South Australia (Dr Sarah Wheeler) has highlighted several key benefits of using compost in citrus production.

Compost and yield

Applying compost can have substantial yield benefits. SARDI trials in Navel oranges in Loxton, SA demonstrated that yield can increase by 60% when compost is applied. A range of soil amendments were applied at varying rates and yield was measured over two seasons (Table1).

Increased yield was achieved through increases in fruit size as well as fruit density - on average, fruit increased by 5-7mm. This gives growers about an extra $100 per tonne ($4,000/ha) on fruit for high value markets. A similar study in Valencia oranges achieved similar if not slightly better results.

Yield benefits of soil amendments last well beyond the first year and monitoring is continuing to evaluate the persistence of increased yield after the initial application.

Navel Oranges -Loxton North % increase in yield compared to no treatment		
Treatment	**2007**	**2008**
Animal manure 40 m^3ha^{-1}	5.0	28.8
Grape marc 200 m^3ha^{-1}	25.5	51.2
Compost 40 m^3ha^{-1}	11.7	16.8
Compost 120 m^3ha^{-1}	16.9	43.4
Compost 200 m^3ha^{-1}	25.7	62.9

Table 1: The average percentage increase in Navel orange fruit yield recorded for five soil amendment treatments in 2007 and 2008 (compared to the untreated control).

Compost and pest management

One of the major pests in citrus production, particularly in the Riverland and Sunraysia regions is Kelly's citrus thrips (KCT), *Pezothrips kellyanus*.

KCT feed on developing fruit causing damage which often reduces fruit quality and in some cases can make fruit unsaleable. The most common method to control KCT is application of organophosphate insecticides but KCT are developing insecticide resistance. These insecticides can also kill beneficial insects within the orchard, disrupting integrated pest management programs (IPM).

Predatory mites have been identified as a biological control agent of KCT pupae in the soil and, when these mites are in high numbers, KCT emergence from the soil can be reduced by more than 50%.

Increases in fruit size and density are consistently achieved with compost

SARDI research has found that predatory mite numbers increase, and KCT emergence from the soil decreases, when composted green organics is applied to citrus.

In the first year of compost application, KCT adult emergence was reduced by 50%. In the second year after application, KCT emergence had reduced by 90% compared to trees without compost. This reduction represents a significant contribution to KCT management and prevention of fruit damage.

Not all composted materials are created equal when it comes to KCT control. Composted grape marc and composted dairy organics both increased the numbers of arthropods (insects and allied forms like mites and spiders) found in the soil, but there was no significant reduction in KCT emergence.

Composted green organics applied to citrus can play an important role in a KCT IPM program.

Composted green organics can significantly reduce KCT emergence for at least 2 years

Compost and Water Conservation

Applying composted green organics to citrus trees can also significantly increase moisture levels in the soil.

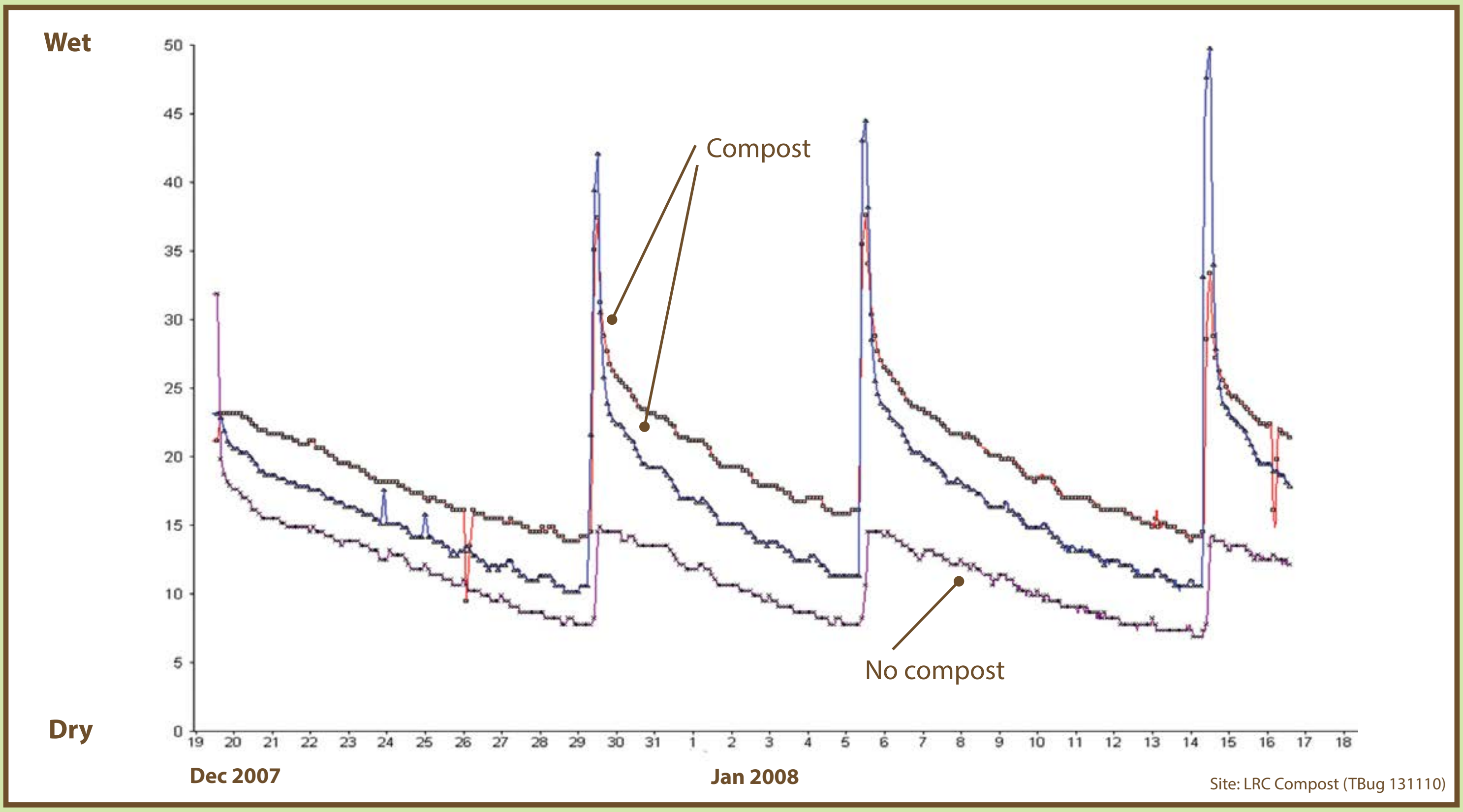


Fig 1: Sample data of soil moisture at a depth of 10-15 cm under Valencia trees at Loxton Research Centre (SA) from control trees without soil amendments or trees treated with 200 $m^3 ha^{-1}$ composted green organics.

Applying soil amendments can increase soil moisture levels in the top 25 cm of the soil - this can reduce the demand for irrigation without impacting on yield or tree health. Soil moisture monitoring is still underway at Loxton (SA) with sensors added at different soil depths for more detailed measurements of the effect of amendments. Stay tuned for the next round of results!

See the difference……

Fig 2: Valencia orange trees at Loxton Research Centre, October 2007.
Left to right; Untreated control, Grape Marc 200 m^3ha^{-1}, Compost 200 m^3ha^{-1}.

Compost and nutrients

It is well known that compost can supply vital nutrients to the soil after application - particularly nitrogen, phosphorus and potassium.

Soil sampling in citrus orchards highlighted significantly higher nitrogen levels where soil amendments had been applied compared to no application. This increase could be a result of the nitrogen present in the soil amendments, reduced leaching of nitrogen through the soil profile or increased microbial activity in the soil (through bacteria that fix nitrogen). More research is needed to determine the exact cause of the increased nitrogen levels. Regardless of the nitrogen source, the good news is that application of soil amendments could reduce the need for fertiliser applications such as urea, saving significant amounts of time and money.

Soil carbon plays a vital role in soil health and fertility. Increasing soil carbon levels helps to improve root and plant growth and leads to healthier, more productive plants. Soil amendments provide a great source of soil carbon and can add up to 44 tonnes of carbon per hectare when applied at 200 m^3ha^{-1}. SARDI trials in citrus have also demonstrated that composted green organics can increase soil carbon beyond the level that can be explained just by the carbon content of compost. Composted green organics added to citrus trees at 200 m^3ha^{-1} provided around 40 t/ha but after 28 months soil carbon levels had increased to 100 t/ha. This means that carbon is being stored or accumulated in the soil. An increase in stored carbon may also provide additional commercial opportunities (as well as improved plant growth) for individual growers and the citrus industry if carbon trading is introduced and this type of carbon storage is included.

Compost application can significantly increase the amount of nutrients in your soil

Getting bang for your buck - cost benefit analysis

Application of soil amendments in citrus orchards can be expensive, even though it may only need to be applied every 3 - 5 years. This initial investment can be a barrier for many growers, but rigorous cost-benefit analyses have shown it is well worthwhile (Table 2).

All amendments used in SARDI citrus trials (composted green organics, grape marc, animal manure) showed a positive return on the initial investment. Benefits varied between sites, for example the 120 m^3 ha^{-1} composted green organics application returned the lowest benefit of 1.9 ($1.90 for every $1.00 spent) on Valencia oranges at Loxton Research Centre, but the same treatment returned a 2.81 benefit in Washington Navel oranges at Loxton North.

An application of 40 m^3 ha^{-1} of composted green organics in Loxton North gave the highest benefit at 5.38. This means that for every dollar invested around $5.00 is returned to the grower!!

	Benefit Cost Ratio	Net Profit value /5 years /ha $
Compost 40	5.38	16,471
Compost 120	2.81	18,270
Compost 200	3.16	22,180
Mark 200	3.11	18,461
Animal 40	4.24	13,347

Table 2: Benefit cost ratios of trial applications for Navel citrus at Loxton North

All amendments used in SARDI citrus trials (composted green organics, grape marc, animal manure) showed a positive return on the initial investment.

Growers can expect between $1.90 and ~$5.40 for every dollar they invest in compost.

Low applications of animal manure and composted green organics gave the largest financial returns but high levels of compost resulted in greater overall farm and environmental benefits - including improved soil and water quality, leaf and fruit quality and decreased thrips presence.

The benefit cost figures in Table 2 are a conservative estimate as they do not include the potential water savings associated with compost use, reduction in thrips presence and associated chemical control savings or improvements in fruit quality. When all of these factors are taken into consideration compost applied at 200m^3 ha^{-1} is the most sustainable option with the highest overall net benefits.

References

Crisp, P., S. Wheeler and Baker G. (2009). Synthesis of a citrus thrips IPM system with production and environmental benefits. Horticulture Australia Limited Final Report No CT06007. South Australian Research and Development Institute (Sustainable Systems) Adelaide

For more information please contact your State Compost Industry Development Officer at www.compostforsoils.com.au or:

Dr Peter Crisp or Greg Baker
South Australian Research and Development Institute
Waite Campus
GPO Box 397
SA 5001, Australia

www.sardi.sa.gov.au

aora
australian organics recycli... ...iation

compost for soils.com.au
the resource for compost users

An initiative of Australian Organics Recycling Association

AORA SA Breakfast Seminars

Adelaide 22nd February 2018 &

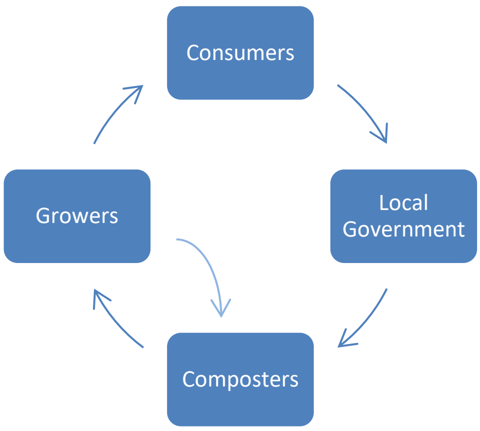
Mount Gambier 23rd February 2018

AORA's role in supporting South Australia's Circular Economy Driven Composting Sector, including facilitation of Carbon Sequestration opportunities.

Hear about and Contribute to:

How AORA can best foster the multiple benefits delivered by the SA composting sector, profiling and further developing it as a successful **circular economy**.

How AORA can best disseminate information on **carbon sequestration** and maximise opportunities for its members through changes proposed to the Commonwealth Emissions Reduction Fund, ERF.



Location and Time:
Adelaide Thurs 22nd Feb: The Pavilion, Cnr. South Tce & Peacock Rd.
Mount Gambier Fri 23rd Feb: Commodore on the Park, 1 Jubilee HWY East.

Both Seminars: Start: 7:15am for 7:45am Finish: 10am then informal networking

Breakfast: Hot breakfast served with Tea, coffee and Juice.

Cost/Bookings Members $55 (GST Inc); Non-Members $65 (GST Inc).
Bookings and payment will be taken from Tuesday 23rd January via AORA Events page

RSVP Please email Uma at _by 19th February 2018

Hear From Guest Speakers followed by Panel Discussions:

Jodie Bricout, CEO, Loop Circular Economy Platform and Circular economy manager, Lifecycles: Jodie has been active in corporate sustainability, life cycle thinking and the circular economy in Europe and Australia for 15 years. As circular economy manager for lifecycles Jodie led a team of professionals to evaluate the potential impacts of transitioning to a circular economy for Green Industries South Australia. In 2017 she co-founded Loop Circular Economy Platform, who welcomed 200 professionals from different countries and every Australian state and territory to the Powering the Change to a Circular Economy Conference, held at the Tonsley Innovation District.

Matthew Warnken, Managing Director, Corporate Carbon: Corporate Carbon is an experienced one stop shop for carbon: from credit creation to sale, enabling companies to monetise carbon abatement activities and secure viable returns in the Australian market. They have developed a range of solutions to facilitate participation in the Commonwealth Emissions Reduction Fund, ERF and are working with many of Australia's leading emissions reduction project developers and owners.

AORA is grateful for the significant technical expertise and facilitation provided by Matthew on behalf of AORA in facilitating inclusion of composting within the Commonwealth's ERF program.

Michael Eyres, Soil Systems Engineer and Ed Scott, Soil Systems Scientist, Field Systems Australia: Michael and Ed will share their wealth of knowledge on a range of carbon management applications for agricultural success. Attendees will gain insight into the benefits of compost and related carbon rich products in measurably lifting and stabilizing agricultural productivity and improving product quality, whilst improving regional sustainability within the broadacre farming sector, including benefits for the end consumer.

Michael and Ed have been involved in several soil carbon projects in relation to agriculture, including the T-Zero project with CSIRO and a DCCEE Australian Government agricultural soil carbon scoping study. Field Systems is a well established strategic soil management advisory consultancy working with farmers across Australia. They have also undertaken projects in Canada, USA, Argentina, Brazil, South Africa and Mongolia.

Peter Wadewitz, Peats Soil and Garden Supplies: Peter who is the AORA National Chair and AORA SA Chair, will facilitate both Breakfast Seminars including a panel discussion at the end on how AORA can best promote and support the multifaceted benefits that the South Australian organics circular economy delivers.
The Seminar will be followed by informal opportunities to meet with Sponsors and also to meet other AORA members (10 – 11.00 am)

Membership

Participants attending the seminars, who are not yet AORA members, will be encouraged to become members. By becoming a member of AORA you will benefit from the support & advocacy that AORA provides on behalf of our membership particularly regarding issues such as policy development and implementation, regulatory changes and standards management.
In South Australia, AORA seeks registrations of interest from the following groups seeking to become members in 2018:

- Composters
- Growers who use finished compost and/or who compost their own organic streams
- Local Governments collecting organic kerb-side waste and their transporters
- Product Distributors/Retailers
- State or Federal Government departments
- Consultants and Students with an interest in organic waste and composting

To become a member please contact Uma Preston, AORA SA Secretary in the first instance:

aora
australian organics recycling association

2018
ANNUAL CONFERENCE

Recycled Organics - The Circular Economy in Action

2 - 4 May 2018 I Hotel Jen, Brisbane

PRELIMINARY PROGRAM AND INVITATION TO REGISTER

Thank you to the following organisations for their generous support of the AORA 2018 Annual Conference

Queensland Government
Proudly supported by the Queensland Government

HITACHI
Reliable solutions

KOMPTECH
TECHNOLOGY FOR A BETTER ENVIRONMENT

GCM enviro pty ltd

C·WISE™
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STEINERT
MAGNETIC + SENSOR SORTING SOLUTIONS

suez

FOCUS enviro

AGSIGHT
PUTTING THE CARBON BACK INTO SOIL

NuGrow

MEDIA PARTNER
waste
MANAGEMENT REVIEW

INVITATION

On behalf of the Organising Committee, we take great pleasure in inviting you to join us for the 2018 AORA Annual Conference to be held at Hotel Jen Brisbane from 2-4 May 2018.

The AORA Annual Conference is well established as the principal conference in Australia for the recycled organics industry. Each conference is a forum for education, discussion and networking related to Organics Recycling.

This event will provide industry stakeholders with access to prominent experts in the field of organics recycling as they share their expertise and knowledge, demonstrate their apparatus and techniques, and showcase their innovative ideas.

The theme for the 2018 conference – ***Recycled Organics - The Circular Economy in Action*** – will explore user experiences in using recycled organics for soil health, as well as consider risk and contamination management.

We invite you to take advantage of early booking discounts and register as soon as possible.

We look forward to seeing you in Brisbane this May.

Peter Wadewitz
Chairman

Martin Tower
Executive Director

The AORA Annual Conference provides delegates with an opportunity to learn, develop new skills and broaden their networks.

Recycled Organics Industry stakeholders gather to learn, network and discuss practical outcomes and solutions for production and use of recycled organic materials in an open forum with like-minded and interested companies and individuals.

ABOUT

HOST ORGANISATION

The Australian Organics Recycling Association (AORA) works on behalf of its members to raise awareness of the benefits of recycling organic resources.

It aims to act as an advocate for the wider organics resource recovery and beneficial reuse industries, and to represent their views in a constructive dialogue with policy makers. The Association envisages an industry in which best practice is shared, standards are maintained and surpassed, and a positive contribution to safeguarding the environment is made.

The Association consists of a national body represented by a Board. State divisions operate in defined geographical areas (e.g. states or territories of the Commonwealth of Australia), managing their operations relevantly to their region. The AORA Board provides coordination across the divisions and a means of addressing state and national matters, as well as being the administrative managers of the business.

W **www.aora.org.au**

VENUE

Hotel Jen by Shangri-La
159 Roma Street
Brisbane QLD 4000

Hotel Jen Brisbane is located on Roma Street in the heart of the CBD and adjacent to the Brisbane Transit Centre, the city's central transportation hub. Brisbane Airport is just 15kms away and accessible directly from the hotel property. Both the domestic and international airport terminals are serviced by the on-site "AirTrain" that makes travel to and from the hotel a seamless service.

The hotel features spacious and bright rooms with a host of thoughtful touches ranging from fast, free WiFi to espresso machines in every room.

CONFERENCE SECRETARIAT

For any enquiries about the conference program, sponsorship or trade displays Please contact Veronica Dullens on

ORGANISING COMMITTEE

- **Martin Tower**, AORA (Chair)
- **Colin Thun,** Wood Mulching Industries
- **Tim Richards,** Richgro
- **Peter Wadewitz,** Peats Soil and Garden Supplies
- **Veronica Dullens,** AIEN
- **Kay Reid,** AORA

AUDIENCE INTERACTION

At the conference we'll be using a system called Slido to provide an engaging experience between panel members and the audience.

Sponsored by:

STEINERT
MAGNETIC + SENSOR SORTING SOLUTIONS

Sli.do allows you to submit your questions and upvote the ones you like the most. Throughout the event, you will also be able to express your opinion by voting on live polls.

NATIONAL SPONSORS

AORA would like to acknowledge the following National Sponsors who play an active role in realising our vision:

Platinum Plus

BASF – We create chemistry

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KOMPTECH – Technology for a better environment

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HITACHI – Reliable solutions

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Vermeer
suez
SESL Australia
C·WISE Soil Carbon Solutions
Corporate Carbon Advisory
Australasian Bioplastics Association
WTT

SPONSORS + PARTNERS

AORA would like to acknowledge the generous support of our sponsors and partners:

GOVERNMENT PARTNER

Queensland Government

Proudly supported by the Queensland Government

Visit: **www.des.qld.gov.au**

The Department of Environment and Science recognises the enormous value a clean environment, innovative society and economy, and vibrant culture makes to our lives. As a diverse organisation, the department brings together the following key areas of work to achieve our objectives for a better Queensland.

Environment

- protecting and managing our parks, forests and the Great Barrier Reef for current and future generations
- enhancing Queensland's ecosystems
- protecting significant heritage places
- avoiding, minimising and mitigating impacts to the environment.

Science

- leading the development of science strategy for government
- delivering scientific expertise to protect and manage our environment and natural resource base
- supporting the development of Queensland's science sector.

Arts

- fostering a community of the arts and facilitating growth of the arts and cultural sector
- supporting arts and cultural growth through partnerships, programs and events
- investing in all levels of the arts and cultural sector
- growing Queensland's cultural reputation and cultural tourism offering.

GALA DINNER

HITACHI

Reliable solutions

Hitachi is a subsidiary of Hitachi Construction Machinery Co., Ltd (Japan) and part of the global and diversified Hitachi Ltd group.

Supported by over 50 years of excavator and wheel loader R&D experience, Hitachi delivers machinery sales and support to Australian customers across the mining, construction, quarry, forestry, material handling and recycling industries through a wholly-owned national branch network and a customer support centre operation 24 hours a day, 7 days a week.

Hitachi machine reliability is supported by an extensive service support network and genuine spare parts inventory within Australia that ensures maximum machine uptime.

Visit: **www.hitachicm.com.au**

GALA DINNER DRINKS

KOMPTECH

TECHNOLOGY FOR A BETTER ENVIRONMENT

Komptech is Australia's leading supplier of equipment for the treatment of green waste organics and biomass. With a focus on innovative technology, green efficiency, and quality, the product range includes over 30 machines that cover all key steps in modern waste handling: shredding, turning, separation, and biological treatment.

Visit: **www.elbquip.com**

SPONSORS + PARTNERS

SUPPORTING

C-Wise is a Western Australian owned company whose primary business is to improve soil health and productivity through the reuse of carbon. Our passion is the development of sustainable practices to achieve optimal soil performance for communities and industry. C-Wise fully embraces the economic, environmental and social responsibilities of sustainability.

Visit: **www.cwise.com.au**

GCM Enviro is the leading Australasian distributor for the latest in Waste Management Equipment, from Landfill Compactors, Shredders and Crushers through to state of the art Trommel Screeners, Windsifters and Compost Turners. They offer top quality equipment from world-renowned manufacturers including TANA, TERRA SELECT, BACKHUS, JENZ and ALLU.

Visit: **www.gcmenviro.com.au**

TECHNOLOGY

Achieve success by utilising STEINERT sorting & separation technologies to recover the valuable materials hidden in refuse.

Thanks to the application of a wide spectrum of methods, from traditional magnet separation to innovative sensor sorting technology, our solutions recover more value from your resources.

Visit: **www.steinert.com.au**

REUSABLE WATER BOTTLES

SUEZ makes the best use of water and waste by providing smart and reliable resource management solutions for towns, cities, businesses and industry. We're also the country's largest processor of urban generated food and garden organics, producing around 250,000 tonnes of high quality compost each year.

Visit: **www.suez.com.au**

DEMONSTRATION DAY

FOCUS enviro is a specialist provider of environmental equipment for the organics recycling industry. They offer lower-cost tailored solutions, from single equipment supply to complete integrated systems. Selected technologies include Shredders, Trommel screens, Air separators, Turners, Flip-flow screens, mulch colouring and FOGO systems to create and maximise value in organic recycling.

Visit: **www.FOCUSenviro.com.au**

LANYARDS

AgSight supports the Australian Compost Industry.

We market the SOLVITA™ Compost Maturity Test which improves the composting process, reduces costs and helps produce a compost that is fit-for-purpose.

AgSight works with scientists and industry to measure the benefits of compost to soil microbial activity and labile carbon and plant growth.

Visit: **www.agsight.com.au**

DEMONSTRATION DAY

Wednesday 2nd May 2018

SEE EQUIPMENT IN ACTION AT THE AORA EQUIPMENT DEMONSTRATION DAY

Sponsored by: FOCUS envi

All participants are required to wear long pants and steel capped safety boots. *Hard hats and safety vests will be provided along with lunch and morning tea. We recommend you bring a hat and water bottle.*

See grinders, screens, turners and other equipment in operation with live demonstrations and take the opportunity to see the equipment up close, compare different models and meet with suppliers all in the one place.

On display will be:

- Grinders and Shredders
- Screens
- Windrow Turners
- Loaders and Excavators
- Biodegradable plastic bag demonstration

Preliminary Timetable

0915	**Bus departs Hotel Jen**
1030	Morning tea
1045	Compostable bag demonstration
1100	Windrow Turners
1130	Screens and Loaders
1230	**Lunch**
1300	Excavators, Grinders and Other equipment
1430	Tour of new Tunnel Composting Construction (TBC)
1500	Opportunity to view equipment and meet with suppliers
1600	**Bus returns to Hotel Jen**
1700	Arrive Hotel Jen
1800	**Networking Function**

Note: this is a preliminary schedule and is subject to change.

KEYNOTE SPEAKERS

PROF RAMANI NARAYAN

University Distinguished Professor at Michigan State University in the Department of Chemical Engineering & Materials Science

Dr. Narayan has 153 refereed publications in leading journals to his credit, 28 issued patents, edited three books and one expert dossier in the area of bio-based polymeric materials. His research encompasses design & engineering of sustainable, biobased products, biodegradable plastics and polymers, biofiber reinforced composites, reactive extrusion polymerization and processing, studies in plastic end-of-life options like biodegradation and composting. His research involves developing carbon and environmental footprint of biobased and biodegradable plastics and products using biocarbon content analysis (ASTM D6866) and LCA (life cycle assessment) methodology.

PROF ANDY BALL

School of Science, RMIT University

Andy graduated from Liverpool University, UK in 1986 with a PhD in Microbiology. Following a three-year position as Senior Research Fellow at Liverpool University he took up a lectureship at the University of Essex, UK, becoming a Reader in 2000.

In 2005 Andy took up the position of Foundation Chair in Environmental Biotechnology at Flinders University. In 2012 Andy moved to RMIT University where he is the Founding Director of the Centre for Environmental Sustainability and Remediation.

Andy has headed the Microbial Life Group at RMIT since 1995. The molecular methods developed to monitor microbial communities in the natural environments are now used world-wide. Running parallel with these studies has been the development of biotechnological applications based on natural microbial communities.

PRELIMINARY PROGRAM

Thursday 3rd May 2018

0800 Registration, tea and coffee

OPENING PLENARY

0900	**Martin Tower** Executive Director, AORA	*Welcome and housekeeping*	
0910	**Tony Roberts** Deputy Director-General of Environmental Policy & Planning	*Official opening*	
0930	**Prof Ramani Narayan** Michigan State University (USA)	*KEYNOTE PRESENTATION: Certified Compostable Polymers and their role in organic diversion*	Designing single use disposable packaging and products for complete biodegradability-compostability offers an environmentally responsible end-of-life value proposition. However, much confusion, misuse, and misleading claims abound in the marketplace. This lecture discusses the science and issues surrounding biodegradability-compostability and the role certified compostable products play in enabling diversion of food and other biowastes from landfills or leakage into land and ocean environments.
1000	**Prof Andrew Ball** School of Science, RMIT University (VIC)	*Biosolids Contamination: Current and emerging Issues*	Environmental, food quality, and public health issues surrounding contaminants create barriers, real and perceived, to the reuse of biosolids, and thus inhibit the effective recycling of this valuable urban wastewater resource. Questions to be addressed in this presentation include how we can better understand the potential risk associated with these contaminants and what factors influence their presence in biosolids?

1030 Morning tea served in the Trade Exhibition

SOILS AIN'T SOILS

1100	**Dr Michael Crawford** CRC for High Performance Soils (NSW)	*The Soil CRC – what it means for the members of AORA*	The Cooperative Research Centre for High Performance Soils is bringing together scientists, industry and farmers to find practical solutions for Australia's underperforming agricultural soils. The Soil CRC is the biggest collaborative soil research effort in Australia's history, with 8 universities, 3 state govt agencies, 19 farmer groups and a range of industry partners.
1130	**Natalie Williams** Soils for Life (ACT)	*Synergies for Soils - Partnerships for the long term*	This presentation will explore the role that synergistic relationships play at a macro and micro level. The partnering of Soils for Life and AORA seems like a symbiotic relationship worth pursuing....just as soil bugs need each other to improve their overall effectiveness, so does organisational collaboration.
1200	**Dr Bronwyn Laycock** School of Chemical Engineering, UQ (QLD)	*Food Waste CRC and linkages with the recycled organics industry*	The Federal Government recently announced the success of the Fight Food Waste Cooperative Research Centre, a new $133 million 10 year initiative that brings together industry, government and research bodies to target food waste to improve the future sustainability and profitability of the Australian food industry. This talk will cover the planned research activities and their implications for the recycled organics industry.

1230 Lunch served in the Trade Exhibition

PATHOGENICITY AND DEGRADATION

1330	**Dr Muriel Lepesteur-Thompson** EPA Victoria (VIC)	*Inactivation of animal & human pathogens in compost: A review*	EPA Victoria has undertaken a literature review to identify pathogens of relevance in Australia and to understand what factors are influencing the inactivation or survival of pathogens during composting. This review susggested that other factors than time-temperature influenced pathogen inactivation, that could be better controlled to optimise sanitisation.
1400	**Lou Sherman** Scion (NZ)	*Biodegradable packaging innovation and the need for testing standards*	Biodegradable packaging materials offer new, more sustainable end of life opportunities for waste products, especially for food. This presentation will give an overview of recent compostable material developments, the international standards used to test compostability and Scion's new biodegradation facility.
1430	**Dr Ash Martin** Microbiology Laboratories Australia (SA)	*No Free Ride – How to avoid spreading plant pathogens via compost*	With increasing amounts of green organics and food organics being recycled comes increased risk of spreading plant pathogens to end users. Get the essential guide to these bad guys, how they live and what you can do to avoid giving them a free ride in your compost that will help you to minimise the risk to you and your customers.

1500 Afternoon tea served in the Trade Exhibition

COMPOST ADOPTION – HERE WE GO

1530	**John Logan**, Axiom Research & **Elisabeth Blik**, WildBlueGlobal (NSW)	*Growing markets for commercial compost in agriculture – Farmer insights*	Sustainability Victoria recently undertook social research with farmers to identify the opportunities and barriers of increasing recycled organics use in agricultural sectors in Victoria. This presentation will provide a summary of the results from qualitative depth interviews with major agricultural organisations and a quantitative survey of 450 farmers .
1600	**Brice Kaddatz**, Macadamia & Horticultural Services & **Susie Chapman,** Healthy Land and Water (QLD)	*Using compost in macadamia orchards*	Erosion and top soil loss causes significant detrimental effects including loss of soil function and soil health, agronomic, environmental burdens and clean-up costs. This paper will present findings from trials to assess the possibility of partially substituting mineral fertilizer with urban derived compost and Twin N, a microbial nitrogen fixing agent.
1630	**Nigel Blieschke** Torbreck Vintners (SA)	*Dealing with Vineyard Variability - Torbreck Vintners Case Study*	Torbreck Vintners is one of Australia's leading premium winemakers based at Marananga in the famed Barossa Valley. Through the use of organic compost and under vine mulches Torbreck are seeing improvements to wine quality, vine vigour, uniformity and yield. Nigel will present a number of vineyard case studies on the work he has undertaken.
1700	**Bill Grant** Blue Environment (VIC)	*Using compost to building and maintain creditable carbon under cropping systems*	This paper will discuss how composts can be used with other practice changes to build SOC levels to healthy levels, how landowners and composters might apply for Australian Carbon Credit Units under the ERF, and the sorts of levels of creditable carbon that might be achieved under different situations.

1730 Close Day 2

1900 GALA DINNER

Friday 4th May 2018

0800 Registration, tea and coffee

LESSONS FROM THE PAST AND FOR THE FUTURE

0900	**Dr Darren Perrin** Ricardo (UK)	*An insider's perspective of industry developments in the UK over the last decade*	The collection of Organics from household waste in the UK and how it is treated has evolved significantly over the past two decades influenced by policy, regulatory and market drivers. Kerbside food waste collection systems and Anaerobic Digestion technologies are now common place across the UK. As we enter an era of Circular Economy, the value of food waste as energy or product is currently debated. This paper will talk through the journey of the UK over the past two decades and identify lessons/ experiences which could inform the current debates in Australia.
0930	**Matthew Warnken** Corporate Carbon (NSW)	*New Agricultural Systems Method for Soil Carbon: Increased opportunities for recycled organics to create carbon credits*	The new Emissions Reduction Fund methodology is a potential gamechanger for mainstreaming the creation of soil carbon credits from agriculture and the use of recycled organics is recognised as an eligible new management activity. Embracing the complexity of auditable soil measurement represents a significant opportunity to map soils and track beneficial changes over time.
1000	**Johannes Biala**, CROWN, **Peter Wadewitz**, AORA & **Dr Georgina Davis**, Qld Farmers Federation (QLD)	*CROWN – Facilitating and supporting the organics recycling supply chain*	This talk will outline the visions DES, the University of Queensland and the Queensland Farmers' Federation have for CROWN and how future cooperation between state and local Governments, the organics recycling industry, the agricultural / horticultural sector, and CROWN, will be able to significantly advance organics recovery and value-adding in Queensland.

1030 Morning tea served in the Trade Exhibition

CLEAN IN - CLEAN OUT

1100	**Kurt Palmer** STEINERT Australia (VIC)	*Removing contamination from organics*	Steinert are pleased to announce it now has a cost-effective solution for the removal of non-organic material from your input stream. This presentation will explain the technical capabilities of the technology, showcase practical applications and include a short case study on an organic composting plant in Germany already using the technology to increase the value of their finished product from their tunnel facility and reduce the load of contamination in their oversized fraction.
1130	**Sean Galdermans** WTT Australia (NSW)	*Tailor made cost effective recycling solutions for the Australian market*	This presentation focusses on the different products/methods engineered in-house at WTT as they relate to organics recycling. We will explain and showcase a couple of WTT's flagship facilities across the globe that combine dry-Anaerobic and Aerobic treatment to extract biogas, which can be upgraded to natural gas or electricity while creating an AS standard compliant quality compost.
1200	**Amanda Kane** NSW Environment Protection Authority (NSW)	*To line or not to line? Learnings from the roll out of 500,000 kerbside organics services*	Over past four years, 42 councils in NSW have introduced new, or improved existing, kerbside collections services for food and garden waste. Funded through the waste levy, the $18 million awarded for collections so far has given NSW an unprecedented insight into the multiple ways local government can roll out a kerbside organics service and what works best. EPA organics manager Amanda Kane will present on the findings of an in-depth analysis of all the new services, commissioned by the EPA earlier this year.

1230 Lunch served in the Trade Exhibition

NEW THINGS COMING

1330	**Ross Fox** Fishburn Watson O'Brien Lawyers (NSW)	*Balancing risk and liability - lessons from the AORA NSW experience with financial guarantees*	Many jurisdictions around Australia now require processing facilities to be provide financial guarantees to secure environmental obligations against default. However, the NSW experience has shown that the organics recycling industry is being unfairly treated in comparison to the risks it presents. This presentation will explain how they are calculated, opportunities to reduce your exposure and take control of the negotiation.
1400	**Tim Richards** Richgro Garden Products (WA)	*Anaerobic Digestion – Closing the loop on foodwaste recycling*	Richgro's anaerobic digestion plant diverts food waste from landfill, depackages food waste to remove contamination, digests the food and creates methane which in turn runs a generator to produce electricity, the spent digestate is then added to compost piles. The plant has been operating free from the grid since 2015 with excess power going back into the grid. The power is stable and most importantly it is renewable.
1430	**Declan McDonald** SESL Australia (VIC)	*Composting Carp - A strategy to manage 1M dead fish!*	The National Carp Control Program aims to remove about 1,000,000 tonnes of carp from inland waterways. A wide range of commercial strategies to dispose of dead fish have been proposed, however these will not be able to manage the volumes of fish predicted to be removed from waterways at highly diverse locations. On-farm composting as a model has been shown to have merit with a trial commencing in May 2018.
1445	**Peter Wadewitz** AORA	*Wrap up discussion and closing remarks*	

1500 Conference close

SOCIAL FUNCTIONS

NETWORKING FUNCTION

Join us after the Demonstration Day for an evening of drinks, canapes and networking with the exhibitors, speakers, sponsors and other attendees.

Date: Wednesday 2 May 2018

Time: 6.00 – 8.00pm

Venue: Trade Exhibition Area (Level 5, Hotel Jen)

Dress: Casual

Tickets: Included in full registrations or optional event for $100. Please indicate on the registration form if you wish to attend this function and the ticket will be added to your invoice.

GALA DINNER

AORA invites all conference attendees to add the Gala Dinner to their calendar. It will be a fantastic opportunity for industry professionals to come together in a more relaxed setting and engage in the type of networking that is vital to furthering the recycled organics industry.

Sponsored by:

Date: Thursday 3 May 2018

Time: 7.00pm – late

Venue: Jen Ballroom 3 & 4 (Level 5, Hotel Jen)

Dress: Business/Smart Casual

Tickets: Included in full registrations or optional event for $175. Please indicate on the registration form if you wish to attend this function and the ticket will be added to your invoice Table's of eight are also available for $1260.

ACCOMMODATION

Hotel Jen is pleased to offer the following special rates for delegates attending the AORA 2018 Annual Conference.

Please note these rates are available until 2 April 2018, after which, rooms can be booked at the best available rate of the day.

Room Type	Daily Room Rates
Deluxe Single / Twin Rooms (Run of house)	• $160.00 per room, per night • $170.00 per room, per night inclusive of full buffet breakfast for one • $190.00 per room, per night inclusive of full buffet breakfast for two
Executive Room	• $210.00 per room, per night • $220.00 per room, per night inclusive of full buffet breakfast for one • $240.00 per room, per night inclusive of full buffet breakfast for two

To book please contact the hotel's reservations department directly using the following email and contact numbers:

Hotel Jen Brisbane
Ph +61 7 3238 2202
Fax +61 7 3238 2288
Email groupres.hjbb@hoteljen.com

The in-house reservation department is open Monday to Friday from 8:30 a.m. to 4:00 p.m (AEST).

GENERAL INFORMATION

HOW TO REGISTER

Registration can be completed through either the online booking process (requires payment by credit card) or using the fax/mail back form.

Online Registrations
Visit the conference website www.aoraconference.com.au. The process takes approximately 5 minutes. We accept Visa, MasterCard, AMEX and Diners.

Fax/Mail Back Registrations
You can use the registration form included in this brochure or visit www.aoraconference.com.au to download a copy of the form. If registering a group please ensure that each delegate completes a registration form individually.

Conference registrations cannot be shared. Strictly one delegate per registration only.

GROUP DISCOUNTS

Discounts apply for groups of 5 or more (5% discount) or 10 or more (10% discount) delegates from the same organisation who register at the same time.

PAYMENT

Registration will not be confirmed until payment is received in full

All fees are in Australian Dollars $AUD and are inclusive of 10% Goods and Services Tax (GST)

For cheque payments please make cheques out to 'Australian Organics Recycling Association'

DRESS CODE

The dress standard for the event is business/smart casual including sessions and evening functions.

CANCELLATIONS

Cancellation of your registration must be advised in writing to info@aoraconference.com.au. Cancellations received on or before 13 April 018 will receive a full refund less a $165 administration fee, cancellations received after this date will not receive a refund, however, we will accept delegate name changes at any time leading up to the event

PRIVACY

In registering for this event relevant details may be incorporated into a delegate list for the benefit of all delegates (name, organisation and title) and may be made available to parties directly related to the event including AORA and sponsors (subject to conditions). If you do not wish to be included in the delegate list, please email info@aoraconference.com.au.

PARKING

A discounted rate of $36.00 per day is available subject to availability at Secure Parking on evels 3 and 4 of the hotel building. Entry is via the hotel side entrance all the way up the ramp (159 Roma Street, Brisbane).

Guest must obtain the parking ticket dispensed on arrival to the car park and go to reception on ground level to have their car parking tickets validated prior to departure.

'Club Secure' also offers special deals for online booking visit www.secureparking.com.au for further information and rates.

DISCLAIMER

Every effort has been made to present all the information contained in this brochure as accurately as possible. The organisers reserve the right to change, without notice, any or all of these details.

INSURANCE

Registration fees do not include insurance of any kind. It is strongly recommended that all delegates take out their own travel and medical insurance before attending the event. AORA will not take any responsibility for any participant failing to insure.

PHOTOGRAPHY/RECORDING

By registering for the AORA 2018 Annual Conference you consent and grant permission to AORA, its agents and others working under its authority, to take and to have full and free use of video/photographs containing your image/likeness. These images and recordings may be used for promotional, news, online/multimedia, research and/or educational purposes by and for AIEN. Copies of the event photographs will be made available to the attendees after the event.

CONTACT

If you have any questions about the event, registration or AORA please contact:

Australian Organics Recycling Association

2018 ANNUAL CONFERENCE

Recycled Organics - The Circular Economy in Action

australian organics recycling association

REGISTRATION FORM

2 - 4 May 2018 • Hotel Jen • 159 Roma St, Brisbane City
Australian Organics Recycling Association Ltd • ABN 17 158 519 736

DELEGATE INFORMATION

Title ☐ Mr ☐ Ms ☐ Dr ☐ Prof ☐ Cr

Given Name

Surname

Position

Organisation

Postal Address

City

State

Postcode

Phone

Mobile

Fax

Email

Dietary/Special Requirements (please specify)

What sector of the industry do you work in?

☐ Compost Producer ☐ Equipment Supplier
☐ End-User ☐ Local Govt
☐ Consulting ☐ State/Federal Govt
☐ Soil Scientist ☐ Academia/Research
☐ Other

PAYMENT

TERMS AND CONDITIONS

- Registration will not be confirmed until payment is received in full
- All fees are in Australian Dollars $AUD and are inclusive of 10% Goods and Services Tax (GST)
- For cheque payments please make cheques out to 'Australian Organics Recycling Association'
- Cancellation of your registration must be advised in writing to admin@aora.org.au.
- Cancellations received on or before 13 April 2018 will receive a full refund less a $165 administration fee, cancellations received after this date will not receive a refund, however, we will accept delegate name changes at any time leading up to the event (differences in registration fees may be applicable). Non-payment does not constitute cancellation.

Payment Method ☐ Credit Card ☐ EFT ☐ Cheque

CREDIT CARD PAYMENT

Card Type ☐ Visa ☐ MasterCard ☐ AMEX

Card Number

Expiry Date CCV

Cardholder Name

Signature

REGISTRATION

PLEASE INDICATE YOUR SELECTION(S) BELOW

All amounts include GST. Early registration discounts end 10 April 2018. Late registration fees apply from 25 April 2018.

FULL REGISTRATION

☐ Includes:
- 1 x Demonstration Day Ticket (Wed 2 May)
- 1 x Networking Function Ticket (Wed 2 May)
- Day Registration (Thu 3 May)
- 1 x Gala Dinner Ticket (Thu 2 May)
- Day Registration (Fri 4 May)
- Access to conference papers

	MEMBER	NON MEMBER
Early	$1,099	$1,299
Standard	$1,174	$1,374
Late	$1,249	$1,449

OR SELECT YOUR ITEMS INDIVIDUALLY

DAY REGISTRATION - THURSDAY

☐ Includes:
- Day Registration (Thu 3 May)
- Access to conference papers

	MEMBER	NON MEMBER
Early	$375	$575
Standard	$450	$650
Late	$525	$725

DAY REGISTRATION - FRIDAY

☐ Includes:
- Day Registration (Fri 4 May)
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Barossa Seminar and Site Tour: Increased vineyard productivity through application of compost

Thursday 26th April 8am – 12pm.

This seminar and site tour shows what's possible with good organics management in the vineyard in lifting yields and improved consistency. The latest soil monitoring and application techniques will also be presented.

- Michael Eyres and Ed Scott of Field Systems Australia and Oli Madgett of Platfarm will describe precision compost application and demonstrate their application at Torbreck using recent soil mapping and other testing undertaken by Nigel. An examination and description by Michael of the residual and commercial effects of organic carbon at depth using soil pit evaluation will also be an opportunity to discuss potential carbon sequestration opportunities for wine grape growers, which AORA seeks to facilitate.

- Site tour with Nigel Blieschke, Viticulturist at Torbreck Vintners. Nigel will describe the benefits to his vineyards achieved by applying compost over the last three years, techniques he has used to monitor soil health and in applying compost to achieve his success. Results have included increased microbial activity in soil and overcoming soil variability, which have in turn resulted in significant water savings and increases in yield.

- Opportunities to meet SA Australian Organics Recycling Association Processing Members and learn more about their products and services. Growers can continue to liaise with SA AORA branch through a Community of Practice and receive guidance on best practice for compost application. A case study will be developed based on Nigel's experience as well as gauging need for other resources to assist the regions growers in monitoring and lifting soil carbon.

EVENT DETAILS

When: Thursday 26th April 8am – 12pm.

Where: Starting in the CWA Hall 70 Murray Street, Tanunda for presentations, morning tea and opportunity to meet Processing AORA Memebrs (8am – 10:15am) then site visit at Torbreck Vintners, Barossa Valley, 348 Roenn Feldt Road, Marananga (10:30am – 12pm)

Cost: $25 AORA Members and $35 Non-Members. A cap of 40 in order to make things manageable and safe during the site tour. Please RSVP to Uma via who will send a booking and payment link

Event Sponsor

SA AORA Branch kindly acknowledge the support of National Landcare, Regional Landcare and the Adelaide Mount Loft Ranges Natural Resource Management Board, AMLR NRM Board which has enabled this event and subsequent case study and engagement with Growers possible.

SA AORA Branch would also like to thank andacknowledge Barossa Grape and Wine Association for their promotion of the event and assisting by hiring the seminar venue. Also thanks to Nigel of Torbreck Vineyards for a wonderful morning tea sourced locally.

Australian Government | National Landcare Program | Regional Landcare Facilitator | Government of South Australia – Adelaide and Mount Lofty Ranges Natural Resources Management Board

BAROSSA GRAPE & WINE | TORBRECK BAROSSA VALLEY

AORA Platinum Plus Sponsor BASF We create chemistry | eco VIO

AORA Platinum Sponsor KOMPTECH TECHNOLOGY FOR A BETTER ENVIRONMENT

Viticulture

Organic Matter for Water Saving

It's no surprise that more and more growers are investigating the use of compost mulches in their vineyards, with conservative estimates of irrigation savings between 20 -30% when mulch s used. In some cases, water saving can be as high as 70%!

Compost mulches conserve soil moisture by preventing evaporation. Direct sunlight can heat the soil, and with warm air moving across the soil surface, moisture is drawn up from the soil and evaporates. Even a shallow layer of mulch on top of the soil can slow down this process and conserve soil moisture.

This results in the need for less irrigation – an outcome that will benefit every grower. Compost mulches are a great option to conserve soil moisture and potentially decrease irrigation, while at the same time maintaining and even increasing crop yields.

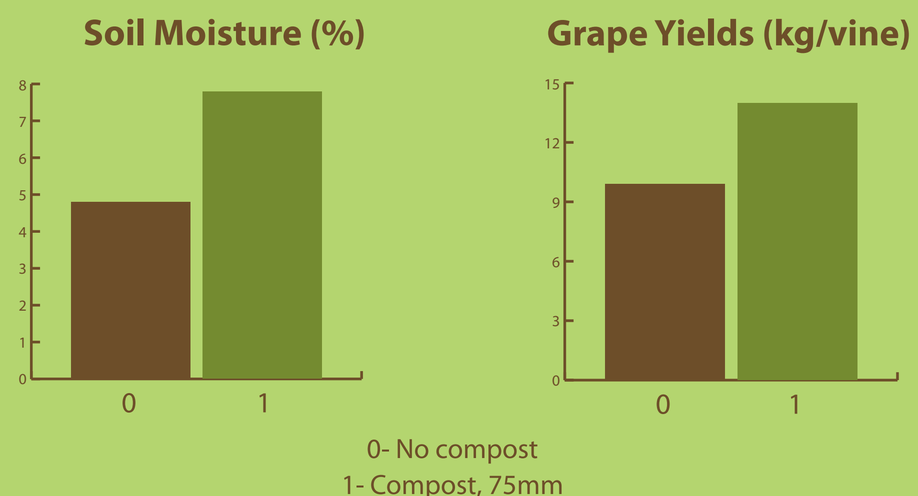
Australian researchers estimate potential irrigation savings of 20-30% with the use of a coarsely textured compost mulch

Achieving Water Savings

The first step in achieving water savings is to choose the right compost mulch for your property (see Choosing the Right Compost). Fully composted materials have been shown to be effective, but pasteurised materials can also provide substantial benefits.

In general, coarse mulch grades with woody particles are the best to use for water saving. Current recommended application rates for coarse mulches are between 50-75mm deep, and 40cm wide under vine. This type of compost application (at 50mm) can be expected to provide you with significant water savings for two – four years.

High rates of fine composts should be avoided as they can hold moisture and prevent water from moving into the soil. A deep layer of fine particle compost can also encourage root growth in the mulch. An application rate of 25mm for fine compost mulches may be appropriate, but never apply at rates greater than 50mm.



Soil moisture and grape yields after compost mulch application
Cabernet sauvignon, McLaren Flat, S.A.

Making the most of compost mulch

To get the most out of your compost application it is essential that good irrigation management is in place. Monitoring soil moisture and understanding soil water availability will allow you to adjust your irrigation schedules to suit the needs of the crop and help maximise the benefits of your compost. This is especially important to maintain yields, particularly where a mid-row cover crop or sward is used. As well as irrigating less throughout the season, applying compost mulches can also delay the need for irrigation, often postponing the first irrigation application by a month, or one-two irrigations depending on soil type and management factors.

Good irrigation management practices will enable you to determine when you need to begin irrigating as well as how often.

Compost mulches can also be targeted to specific areas within a single irrigation block to address soil water variability. Compost has also been used successfully in this way to ameliorate the effects of salinity. Vines in areas of high salinity responded to a greater extent to remediation than vines in areas of low salinity. Applying compost in a blanket manner may not be the best approach for your block, and soil variability should be taken into account.

Advantages of mulches

Short-term

Immediate and substantial water savings

Long-term

- Increase soil capacity to capture and store water
- Increased yields
- Moderate soil moisture and temperature fluctuations
- Reduced farm management costs
- Improved soil structure and decreased erosion

Additional benefits

Water saving is a key reason to use compost mulches, but there are also other significant gains to be made by mulch application.

Compost mulches supply additional nutrients to the soil, which can decrease the need for fertiliser. Nitrogen and phosphorous become available slowly from the mulch over a period of years, but some nutrients like potassium move readily from the compost into the soil. As up to 85% of potassium can move into the soil it is important that fertiliser programs are adjusted to account for this. This can be easily achieved using a nutrient calculator **www.recycledorganics.com/product/agriculture/mulchnutcalc/mulchnutrcalc.htm**.

Young vines in particular can benefit from compost mulches. As well as saving water, compost mulches can increase the growth rate of young vines by moderating the fluctuations in soil moisture and temperature. This enables young vines to increase growth and also provides them with the ability to withstand periods of extreme stress. Field trials showed that young vines were able to support twice as many

of compost mulching

bunches through to harvest when compost mulch was applied. With extreme environmental fluctuations becoming more common, compost mulches can give young vines a significant advantage.

Other long term benefits include:

- Increasing yield
- Reduce risk of crop failure – by moderating soil moisture and temperature fluctuations
- Reduce farm management costs - less need for herbicide and fertiliser applications
- Increased water filtration – reduces pooling of water and evaporation, reduced run-off and nutrient loss
- Supplying nutrients to soil – N and P slowly, Potassium more quickly (refer to 'Fact Sheet - Compost and Nutrients')
- Salinity management (ref compost for managing salinity)
- Increased biological activity
- Reduced soil strength
- Preventing erosion

Saving Water and Saving Money

A recent cost benefit analysis using yield data from vines in South Australia showed that compost mulch applied at 10 and 50mm gave strong returns on the initial investment. When mulch was applied to 50mm depth (at $24.50/m), an average of $2.60 was returned on a $1 investment!

Saving 20-30% of your irrigation as well as providing a range of additional benefits – compost mulch can significantly improve your vineyard operation.

Benefit cost (dollars returned for each dollar invested) analysis for compost mulch application to McLaren Vale vineyards (South Australian Centre for Economic Studies, 1999).

Site	Compost Mulch Depth	
	10mm	50mm
McLaren Vale – Cabernet Sauvignon	8.85	2.27
Willunga – Shiraz	4.27	1.69
McLaren Flat – mature Cabernet Sauvignon	6.47	3.86
McLaren Flat – young Cabernet Sauvignon	n.d.	2.19

Case Study 1:
Vineyard With Variable Soils

A grower operates a large vineyard area which straddles hills, creek lines, rocky outcrops and areas of variable soil type and depth. The irrigation system has been designed in large blocks which do not allow for the highly variable vineyard conditions. The grower is concerned that in order to get enough water to areas on lighter soils and rocky areas on rises, other areas in the same block with heavier, deeper soils are being overwatered, compromising yield and quality.

The grower would like to reduce vineyard variability, and decides that mulching areas of lighter, shallower soil could reduce the need for frequent irrigation, saving water and allowing better management of grape quality. Using satellite imagery of the vineyard, the grower identifies a block with areas of low and high vine vigour, and correlates the information with on-ground knowledge of the vineyard conditions. Areas to be mulched are identified and the lineal metres of vine row to be treated are estimated.

The grower works closely with the compost processor to choose a material with a high proportion of coarse, woody material, and arranges an experienced contractor to undertake the spreading. Extra soil moisture meters are installed in the mulched and unmulched areas for fine-tuning of irrigation scheduling, enabling maximum benefit to be achieved from the mulch. Next growing season, the grower uses satellite imagery to confirm the effects of the mulching strategy, and plan for mulching of the next block.

Case Study 2:
Large Vineyard, Irrigation Dependent

A vineyard manager oversees a large company vineyard that is dependent on river-water for irrigation. Recent new plantings have ensured that the maximum possible area of land is used to make the most of the water allocation. But pressure on the water source resulted in the allocation being cut by over 30%.

The manager now has to decide whether to sacrifice the yield on entire vineyard blocks to ensure the survival of vines, or find a way to reduce irrigation.

The manager decides to try mulching and determines that a coarse grade of green-organics compost will provide the right physical and chemical properties for water-saving. The coarse, open texture of the compost will allow transmission of rainfall and irrigation to the soil surface and along with the relatively-low nutrient content, will discourage root growth in the mulch. The woody fraction will persist on the soil for some years to assist in achieving good value from a single application.

The manager works closely with the compost processor to ensure that an acceptable grade and quality of material will be supplied and arranges to access to specialised spreading machinery.

The vineyard has extensive moisture monitoring equipment and after application, the irrigation team undertake a period of daily monitoring and review of soil moisture to ensure that the irrigation schedule will be optimally adapted to achieve maximum value from the compost mulch.

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the resource for compost users

Agronomic and Sustainability Outcomes from Compost Application in South Australian Citrus Orchards

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Keywords: compost, soil amendment, biological control

Abstract

SARDI has undertaken trials with compost mulch, grape marc and animal manure at sites on three citrus orchards in South Australia for a number of years. The trials were established to evaluate the potential of soil amendments as part of an integrated management program for Kelly's citrus thrips (KCT). Experimental sites were designed to obtain best possible data for pest management within budget limitations, subsequently, the agronomic and environmental data were in some cases restricted to one site and selected representative treatments. A range of data were collected, including fruit yields, and fruit, soil, leaf, and water quality measures and biological changes, and the potential for water savings assessed. The field trials involved application of various rates of compost to crops, ranging from 40-200 m^3 ha^{-1} for compost mulch, 100-200 m^3 ha^{-1} for grape marc, and 10-40 m^3 ha^{-1} for animal manure. The recycled green waste and composted animal manure have provided significant pest management and agronomic benefits through suppression of KCT and improved yield and fruit size. There were considerable economic net benefits from every type of trial application to citrus at both sites over the four year period assessed. For example, for every dollar invested in an application of 40 m^3 ha^{-1} compost mulch at Loxton North, a return of about $ 5 dollars was realised. Returns ranged from $ 1.91 to 4.96. There also is the benefit of improved water efficiency that could provide significant cost savings. The longevity of these benefits remains unknown and is currently being evaluated. Whilst the grape marc treatments improved yields, and are cheaper than the composted green waste, the level of suppression of KCT was not as good as that provided by the compost, and the increased acidity that resulted from the high phosphate levels associated with the grape marc treatments could result in reduced quality. It seems that higher levels of application for compost mulch create more overall benefits in terms of fruit quality and tree health.

INTRODUCTION

Soil-dwelling predatory mites were identified as potential biological control agents of Kelly's citrus thrips (KCT), a soil pupating species (Colloff et al., 2003; Baker et al., 2004; Barbour, 2003). Generally, where population densities of predatory mites are high the emergence of adult KCT from the soil is reduced by >50%. A survey of soil from 13 citrus orchards conducted in the South Australian Riverland area demonstrated that predatory mite abundance is positively correlated with soil organic carbon (SOC) levels.

Research on Southern Australian farms highlights that SOC is one of the major limiting factors on biological processes in the soil that are critical for the maintenance of soil and plant health (Lawrence and Gupta, 2009). Further on farm benefits of increasing soil carbon include improvements in soil structure, biodiversity, cation exchange, and reduced bulk density, and it is also source of plant nutrients (Reeves, 1997). SOC also improves the cycling on nutrients in the soil and improves the availability of the nutrients to plants (Weil and Magdoff, 2004). Humic substances have also been reported to act as plant stimulants and to improve the ability of plants to access minerals, such as iron, that can often be unavailable to plants in soils with low SOC (Chen et al., 2004). SOM increases the availability of water to plants by improving infiltration, improved water holding capacity through absorption and through formation and stabilisation of soil aggregates (Weil and Magdoff, 2004).

As a result of the movement toward low-till and no-till practices in broadacre agriculture there has been a large number of studies into the effect of increased soil carbon and broadacre crops, however, there appears to be limited information on the yield effect of increased and long term fate of SOC in irrigated orchard crops.

In addition to improving KCT biological control, this research project was designed to quantify the crop yield and quality and environmental (e.g., water savings) benefits that had been observed in preliminary experiments where composts were applied to citrus trees. Soil amendments applied to citrus orchards as part of a series of trials to evaluate the potential for increasing KCT pupal mortality by increasing the population densities of soil dwelling predatory mites were assessed for agronomic effects such as yield, water use efficiency and nutrient availability.

MATERIALS AND METHODS

The trials were established in October 2006 in a 'Valencia' orange orchard at Loxton Research Centre (LRC), Loxton, SA and in a navel orange orchard at Loxton North (LN), SA respectively. Both of these orchards were approximately 20 years age, irrigated by under canopy sprinkler and managed conventionally. The trial design at LRC consisted of four tree plots laid out in a four-replicate, randomized block design. The treatments at the LRC ('Valencia') trial consisted of five rates of composted green organics CGO (40, 80, 120, 160 and 200 m^3 ha^{-1}), two rates of aged grape marc GM (100 and 200 m^3 ha^{-1}) and four rates of composted dairy manure DM (10, 20, 30 and 40 m^3 ha^{-1}), and an untreated control. At LN the treatments, applied to the four tree plots replicated six times, were CGO (40, 120 and 200 m^3 ha^{-1}), grape marc (200 m^3 ha^{-1}), animal (dairy) manure (40 m^3 ha^{-1}) and an untreated control. Treatments were applied only once at the commencement of the experiment.

The CGO supplied by Jeffries Group is a blend of lawn clippings, branches, and garden prunings mixed with timber waste in pallets, crates and boxes. The CGO has 40+% organic carbon with a carbon/nitrogen ratio of approximately 12:1 and has a pH of around 8. The GM was aged for two years. The soil amendments were concentrated under the canopy of the trees with no amendment applied to the mid-rows. The CGO and GM were applied evenly across the entire canopy, whereas the DM was banded along the tree drip line. The GM had the highest organic matter content, whereas the composted dairy waste had the highest total nitrogen and phosphorous content.

Fruit Yield, Quality and Size

Yield data from the LRC was a direct measure of total yield gathered from each tree at harvest. LN is a commercial orchard, and it was not possible to take total yield per tree at harvest; therefore, a relative estimate of yield (fruit density) was calculated by counting the number of fruit in four (50×50 cm) randomly-selected quadrats per tree, and multiplying this fruit number estimate by the mean weight per fruit of a 16 fruit sample randomly picked from that tree. One quadrat was selected from a random point between 1-2 m height on each of the four sides of the tree; the fruit sample was picked randomly from around the tree between 1-2 m height. Fruit quality data was measured by sampling 4 fruit from each tree at LN and 10 from each tree at LRC, analysis was carried out at the ACML laboratories at LRC. Titratable acidity of the juice was measured as described by Iland et al. (2000). °Brix was measured using an Atago hand-held refractometer, with readings adjusted for temperature. pH was determined using a TPS AQUA CPAH meter, calibrated at pH 4 and 7 prior to use. Diameter and rind thickness were measured using a Sontax electronic digital calliper.

Fruit size was measured by sampling 5 fruit from each tree at LN and 5 (2009) or 10 (2007 and 2008) from each tree at LRC; fruit was measured at SARDI Waite campus laboratories or ACML laboratories at LRC.

Soil Moisture and Water Quality

In the first years of the trial (2006-2008) water moisture levels for control and high rate compost treated trees were monitored using SM 200 probes (Delta-T services, Cambridge England) at a single depth of 10-15 cm.

Soil water quality was measured during the final 12 months of the project using Solu-samplers (Sentek Sensor Technologies, Adelaide, Australia) placed at depths of 25, 50 and 100 cm. After irrigation a vacuum was created in each Solu-Sampler using a 50 ml syringe, after 24 h water samples were taken from each solu-sampler by syringe, placed in 70 ml sample vials, and frozen until they were analysed by SARDI Soil and Water Laboratories.

Leaf Nutrient Samples

On 3 March 2009 (3^{rd} year), 40 leaves (10 per tree) were taken from each plot and analysed by ACML Laboratories, (plant trace elements by Acid Digest Plant, total nitrogen by Dumas method (LECO) and plant chloride by Coulometric analysis and ICP analysis). This sample was possibly confounded by an application of foliar nutrients approximately 3 weeks prior to sampling.

Benefit Cost Analysis

The benefit cost analysis (BCA) took into consideration increases (or decreases) in yield in each trial plot as compared to the control plot in each field site. Other savings quantified in the BCAs include herbicide and fertilizer savings, with additional costs of harvesting the fruit included. The BCA was assessed for a 5 year period using the 4 years data available and estimating the fifth year. The soil amendments were all applied and costed in the first year only. A discount rate of 7% was used.

RESULTS

Loxton North 'Navel' Oranges

Agronomic data collected in from the 'Navel' orange trial at Loxton North included fruit density, average fruit weight, yield per m^2 of canopy and diameter of fruit. The average weight of fruit harvested from trees receiving the soil amendments was greater than fruit from control trees for all years (Table 1). Average fruit density was not significantly different in 2007, but was higher on treated trees in 2008, 2009 and 2010 than control trees except for the 40 m^3 ha^{-1} CGO in 2008. As a result of increased weight and density, the total yield harvested per m^2 was significantly higher on trees that were treated with the soil amendments than control trees. For each of the composted amendments the diameter of navel oranges harvested from these treated trees was significantly greater than for fruit harvested from control trees. The three year average diameter was greatest for the 200 m^3 ha^{-1} application rate (80.8 mm) and lowest for the fruit from control trees (75.7 mm) (Table 1).

Loxton Research Centre, 'Valencia' Oranges

The yield response in the 'Valencia' trees treated with the various soil amendments at LRC were varied in 2007; the only significant yield increases occurred in plots where the two highest rates of compost and three rates of animal manure were applied (Table 2). However, in the second year yields for each of the soil amendment treatments were significantly higher than for control trees. The diameters of the 'Valencia' oranges harvested from trees treated with the composts were not significantly different to those of fruit harvested from control trees. The majority of 'Valencia' oranges harvested in the Riverland are processed for juice and therefore total yield is more important than fruit size.

Fruit Quality

A series of quality parameters, including Brix, juice titratable acidity, rind thickness and fruit colour, were measured at both orchards in both 2007 and 2008. There were no significant differences in rind thickness or fruit colour of fruit harvested from trees treated with the soil amendments or the untreated control. However, in 2008 juice extracted from fruit harvested from trees at both trial sites treated with GM had a significantly higher titratable acidity than juice from fruit harvested from other treated trees. The °Brix was not significantly different in 2008 and while the Brix/acid ratio of fruit from the GM treated plots was acceptable from both sites in both years, it was lower, and therefore less favourable, than that of fruit from control trees or those treated with other soil amendments.

Soil Moisture Levels

Soil moisture sensors placed at a depth of 10-15 cm at the LRC trial site during 2006-08 showed that soil moisture levels were consistently higher under trees treated with the highest rate of CGO to control trees. In fact the soil moisture levels at the end of an irrigation cycle under trees treated with 200 m^3 ha^{-1} CGO still exceeded the maximum soil moisture level of the untreated control trees achieved immediately following irrigation.

Nutrition

Another factor that could be contributing to increased plant health and yield as a result of these soil amendment treatments is nitrogen. All trees in the LRC experimental area received two applications of urea each year; however, the soil under trees that received compost amendments had significantly higher levels of nitrogen. The CGO that was applied to the trees had a nitrogen composition of 2.2% and this appears to have been retained in the top 5 cm of the soil profile. This suggests that applications of synthetic sources of nitrogen, such as urea, could be reduced, or ceased completely, where soil amendments have been added.

Late in 2008 more detailed analysis of the movement of soil water and associated nutrients and salts was commenced using Solu-samplers placed at depths of 25, 50 cm and 1.0 m at the LRC trial site. Analysis of the first samples detected significant differences in some mineral components of the water collected from the Solu-samplers. Nitrogen levels were clearly higher at all depths in samples taken from under trees treated with the soil amendments compared with those taken from under control trees. Phosphate levels were also significantly higher in samples taken from under trees treated with GM compared with control trees or trees treated with CGO. This trend was also evident in leaf samples taken in February 2009, and may explain the lower pH of juice from fruit harvested from trees treated with grape marc amendments.

Soil Water Quality

The EC values of the water samples analysed from the LRC trial site were not significantly different at 25 cm or at 1.0 m among samples collected from treated plots or untreated controls. However, there was a trend that the EC water from samples of soil water collected from under trees that had been treated with CGO and GM amendments were higher than samples from control soils. At 50 cm and 1.0 m depth the EC of water samples taken from soil where the CGO had been added at 200 m^3 ha^{-1} was significantly higher than either control samples or samples taken from soil with CGO at 120 m^3 ha^{-1}. There are some anomalous results (e.g., compost 120 m^3/ha December 31 to January 21) these short term significant changes in EC are associated with smaller than usual samples being extracted from the individual Solu-samplers for that treatment. In some cases, e.g., CGO 200 m^3 ha^{-1} 50 cm, no water sample can be drawn from one or more of the replicated Solu-samplers possibly confounding results. This indicates that single data points from these results should be treated with caution and long term averages are more reliable indicators of EC of soil water.

The pH of soil water collected using Solu-samplers was not significantly different across treatments applied to orchard soils after two years. However, the pH of soil water from trees treated with 200 m^3/ha GM was generally lower than from samples from under control trees. Samples taken from soil treated with the CGO at 120 and 200 m^3 ha^{-1} were slightly higher than control samples.

The concentration of SO_4 in the samples taken from the Solu-samplers under trees was significantly higher at 50 cm depth for the 200 m^3/ha CGO treatment compared to the control. Likewise samples from under trees with GM had higher SO_4 at a depth of 1 m. Concentrations of NO_3 were higher in samples taken from Solu-samplers under all trees treated with soil amendments. Chloride concentrations were generally higher from samples taken from under trees receiving 200 m^3/ha CGO and 200 m^3/ha GM than in samples taken from control trees. The phosphate levels in samples from control trees and those treated with CGO were not significantly different; however, levels in samples from trees treated with GM were significantly higher at 25 and 50 cm depths.

Leaf Nutrient Samples

There was no significant statistical difference, at 5% confidence, in the concentration of nitrogen, sodium, iron, magnesium, copper or chlorine in the leaf samples taken from trees treated with the various composted soil amendments. There were however significant differences in levels of chloride, calcium, phosphate and potassium.

Benefit Cost Analysis

There were considerable quantitative economic net benefits from every type of soil amendment applied to citrus at these two trial sites over the five year period accessed. We used the actual figures for four years (with a four year mean used in the fifth year). For example, an application of 40 m^3 ha^{-1} compost mulch at LN provided a BCR of 4.96, indicating that for every dollar the grower invested, they had a return of about $ 5 dollars over a 5 year period. Returns ranged from $ 1.91 to 4.96 (Table 3).

DISCUSSION

Fruit density (oranges/m^2) at the LN orchard in 2007 was not significantly different between trees treated with composted soil amendments and control trees; this is most likely due to fruit having set prior to application of the soil amendments. In 2008 and 2009 fruit density was higher on trees treated with the composted soil amendments than untreated control trees indicating improved tree health and vigour resulting from the treatments. An increase of 5-7 mm in fruit diameter that resulted from most of the soil amendments adds to the value of fresh fruit destined for high-value markets.

Yield increase for the 'Valencia' oranges at LRC was not significant in 2007. However, in 2008 increases in 'Valencia' yield ranged from 30% for trees treated with the 40 m^3 ha^{-1} CGO to 130% for the 40 m^3 ha^{-1} DM. There was a positive linear correlation between the rate of CGO added and yield increase for three seasons at LN and two seasons at LRC. When fruit size and yield gains are combined, net return increases are substantial, even before any pest management benefit is realized. In 2009 the yields from trees treated with composted soil amendments was lower than from untreated control trees this is thought to be related to the higher yields in 2008 in combination with limited irrigation due to water restrictions in place in 2009. 2010 yields, particularly for LRC, were significantly lower than other years due to a 14-day heatwave over the flowering and fruit set period, however, the trees that had been treated with composted soil amendments appear to have been buffered from the losses to some extent.

The increase in yield and fruit size achieved on trees treated with composted soil amendments could be attributable to a range of factors, including improvements to soil structure, cation exchange, reduced bulk density, increased plant nutrient availability and humic substances acting as plant stimulants (Reeves, 1997; Weil and Magdoff, 2004). However, it is most likely that in these trials the increased availability of soil moisture was the major contributing factor. Improved nitrogen levels in the soil were also likely to have been an important driver for yield increases, although there was no significant difference in nutrient levels in leaves in 2009.

The results from soil, soil water and leaf analysis testing indicate that in most instances there were no long term detrimental effects associated with the application of these soil amendments. However, EC levels in water samples taken from the highest application rate of CGO and the GM were elevated and could potentially be of concern. In these cases the samples collected from the Solu-sampler were of lower volume than other samples, and while concentration of ions may be higher in the solution, actual concentrations in the soil may be no higher than in control samples. This needs further investigation.

Also, the high levels of NO_3 at 0.5 and 1.0 m depth associated with the CGO and grape marc treatments could be the result of concentration of nutrients in lower water volumes or it may indicate that some nitrates from these treatments are moving through the soil profile into the water table. If the latter is the case there is some potential for environmental pollution, and applications of mineral N may need to be reduced where grape marc and CGO is applied as a soil amendment.

At current compost decomposition rates it appears that the higher application rates of compost are likely to provide benefits for at least five years and possibly as long as 8-10 years. It is expected that subsequent applications of compost could be at lower rates due to retention of some organic carbon in the soil profile. The longer than expected life of the CGO in particular and lower subsequent application rates may improve the BCA calculated in this research. Further monitoring of the sites will give a better indication of the time between applications and whether subsequent applications at lower rates will maintain the fruit yield and size benefits and the IPM benefit achieved with the original applications.

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Tables

Table 1. Four year average yield from 'Navel' orange trees (kg/m^2 quadrat (kg m^2)) of canopy at Loxton North treated with composted soil amendments expressed as a % of yield harvested from untreated control trees. Average yield and average yield of control are 4 year average. Compost is composted recycled green waste at 40, 120 or 200 m^3 ha^{-1}: animal is composted dairy waste at 40 m^3 ha^{-1}: marc is composted grape marc 200 m^3 ha^{-1}.

	2007	2008	2009	2010	Average yield (kg/m^2 quadrat)	Average % of control
Control	100.0	100.0	100.0	100.0	5.4	100
Animal 40	105.0	128.8	113.5	119.3	6.2	116.3
Compost 40	111.7	116.8	114.7	126.3	6.3	117.6
Compost 120	116.9	143.4	124.5	129.8	6.9	128.1
Compost 200	125.7	162.9	121.1	114.0	6.9	128.7
Mark 200	125.5	151.3	118.7	128.1	6.9	129.3

Table 2. The yield of 'Valencia' orange fruit yield recorded for soil amendment treatments from 2007 to 2010, recorded as a % of untreated control at Loxton Research Centre. NB. The untreated control yields were 13 t ha^{-1} (2007) and 29.5 (2008) 38.9 (2009) and 1.3 (2010). There was no significant difference in pre-treatment (2006) yields.

	2007	2008	2009	2010	Average yield (kg/tree)	Average % of control
Control	100.0	100.0	100.0	100.0	51.7	100.0
Compost 40	119.9	150.3	106.4	153.6	64.5	124.4
Compost 80	120.5	180.8	99.5	302.8	69.7	132.2
Compost 120	113.4	205.8	82.3	313.3	69.6	131.9
Compost 160	126.6	199.4	82.5	317.6	69.7	131.8
Compost 200	116.5	229.5	97.5	353.4	78.3	148.2
Animal 10	121.0	202.6	54.4	396.9	63.6	118.6
Animal 20	123.2	230.8	89.1	487.2	78.2	145.7
Animal 30	91.7	145.2	71.2	493.2	55.6	101.2
Animal 40	63.1	150.0	31.9	595.2	45.5	79.6
Grape 100	89.9	199.6	92.4	657.7	72.0	130.7
Grape 200	86.8	233.5	90.5	776.9	78.5	141.5

Table 3. Five year BCAs for Citrus Orchard Trial Applications. Loxton Research Centre (LRC) Loxton North (LN) Benefit cost ratio (BCR) Net present value (NPV) ($ Australian).

	LRC			LN	
	BCR	NPV $		BCR	NPV $
Compost 40	3.21	10,137	Compost 40	4.96	13,228
Compost 120	2.21	11,495	Compost 120	3.14	15,517
Compost 200	1.91	13,114	Compost 200	2.17	11,729
Mark 200	2.36	13,284	Mark 200	3.32	15,049
Animal 10	3.72	12,372			
Animal 40	2.96	4,154	Animal 40	4.75	9,836

SOUTH AUSTRALIAN
CENTRE FOR ECONOMIC STUDIES
ADELAIDE & FLINDERS UNIVERSITIES

Benefit Cost Analysis of Composted Organic Mulch in Horticultural Industries:

Vines — Cherries — Almonds
Pears — Citrus

and

Potatoes — Capsicums — Carrots — Flowers

Final Report

Prepared for:

Waste Management Committee

Prepared by:

The SA Centre for Economic Studies

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Contents

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Executive Summary

Since 1997 the CSIRO has undertaken field trials with 'green-organics' compost, derived from municipal green wastes (leaves, lawn clippings and prunings) in nine horticultural crops, namely: vines; cherries; potatoes; capsicums; pears; carrots; almonds; flowers and citrus. The Centre for Economic Studies was commissioned by WMC to analyse the results of these trials to estimate the economic benefits that potentially could be derived from applications of compost.

The purpose of the trials differed for each crop. The objectives ranged from exploring the potential for water saving, to looking for improvements in produce or soil quality, to aiding in the establishment of young trees and vines.

The results must be considered as indicative only, given the lack of statistical significance between the control and compost applications in most of the crop trials.

The field trials involved application of various rates of compost to crops, ranging from 10 mm to 150 mm. Some crops had a mix of coarse and fine compost applied at a cost of $24.50 per cubic metre (includes the total cost of the compost and its delivery, application and spreading), while other crops had a very fine compost applied at a cost of $29.00 per cubic metre (includes application and spreading). Applied as a surface mulch, the higher compost rates are expected to have a life span of 5 years; and the lowest compost rate of 10 mm is expected to have a life expectancy of 2 to 5 years, and 3 years was assumed for the benefit cost analyses (BCAs).

There were significant economic benefits from the application of compost that could not be included or quantified in the BCAs, namely water, herbicide and fertiliser savings.[1] CSIRO's experience suggests that there is the potential for large water savings in horticultural crops using compost, easily up to 30 per cent for some crops. Shown in Table I are the average water needs for most of the horticultural crops in question and the potential for water savings (in kilolitres) from 10 to 30 per cent reduction total water use.

Potential water cost savings from the application of compost are shown in Table II, with the cost of the mulch per hectare shown in Table III.

The BCAs took into consideration increases (or decreases) in yield and changes in quality (and hence effects on revenue received) from the control treatment and the compost treatments. It is important to note that not all benefits could be quantified, hence a summary of qualitative factors is also presented in the results.

[1] These potential savings could not be included in the analyses because production inputs were not varied during the course of the trials, therefore to include them in the analyses with yield increases or decreases is misusing the data.

Table I
Water Use for Various Horticultural Crops

Crop	Indicative irrigation water requirements Kilolitres per hectare per year (per crop if more than one crop is possible in a year)	Average Water Use	Potential Water Savings (Kilolitres)		
			10%	20%	30%
Almonds	5,500-7,500	6,500	650	1,300	1,950
Vines*	5,000-6,000	5,500	550	550	550
Flowers	4,000-8,000	6,000	600	1,200	1,800
Potatoes	4,000-7,000	5,500	550	1,100	1,650
Carrots	4,000-5,000	4,500	450	900	1,350
Capsicums	3,000-5,000	4,000	400	800	1,200

Note: *In the Barossa, supplementary irrigation of vines is based on an irrigation application rate of 1,000 kL/Ha.
Source: Water Reticulation Systems Virginia

Table II
Water Cost Savings for the Nine Horticultural Crops Studied

Horticultural Crop	Cost Per Hectare*	Potential Savings		
		10 %	20 %	30 %
Vines	$334	$33	$67	$100
Cherries	$150	$15	$30	$45
Potatoes	$138	$14	$28	$41
Capsicums	$3,200**	$320	$640	$960
Pears	$10,731**	$1,073	$2,146	$3,219
Carrots	$450	$45	$90	$135
Almonds	$524	$52	$105	$157
Flowers	$3,750*	$375	$750	$1,125
Citrus	$317	$32	$63	$95

Note: * The cost per hectare is derived from estimates of average gross margins produced by PIRSA for various crops. Hence — the water cost represents the average cost incurred for producing a hectare of each horticultural crop. Estimates were derived from PIRSA for all crops.
** Average costs per hectare were not available for these crops, hence figures denote the annual cost of water hectare/year. Hence — the water cost represents the average cost incurred for producing the various horticultural crop on that hectare over a year's time period.
Source: PIRSA 1999, The Grower 1999, SACES 1999.

Table III
Mulch Costs for the Nine Horticultural Crops Studied

Horticultural Crop	Cost Per Hectare
Vines	$24.50
Cherries	$24.50
Potatoes	$29.00
Capsicums	$29.00
Pears	$24.50
Carrots	$29.00
Almonds	$24.50
Flowers	$29.00
Citrus	$37.50

Source: CSIRO

Results

Vines

Composted mulch was applied to vines in McLaren Vale, Willunga and McLaren Flat (both mature and young vines) at depths of 10 mm, 50 mm and 150 mm, and at a cost of $24.50 per cubic metre. Strong economic returns were obtained for all 10 mm and 50 mm applications in the various regions, however the 150 mm mulch application was generally not economic. The BCA's indicated that for every dollar invested by growers in McLaren Vale in the 10 mm mulch they would receive $8.85 in return, Willunga growers $4.27 in return and McLaren Flat growers $6.47 for their mature vines.

Water availability is a key issue for grape growers, and the potential for water savings to be derived from compost mulch is a significant benefit in terms of costs and improvements in the management of their vines. Growers could save up to $100 per hectare in water costs.

Growers are not only seeking ways of saving water, to enable them to continue to operate under proposed water allocation limits, by more efficiently managing their irrigation. With the water available to the grower, it may not be possible to supply the water demand of vines during times of extreme stress. The use of a compost mulch can reduce fluctuations in soil moisture and temperature, reducing the impact of extreme stress on vine performance.

The most significant economic impact of the use of compost mulch on the production of grapes is the potential to improve conditions for the establishment of young vines, giving growers more options for management of early training, pruning, harvest and quality. With more options to manage the growth of young vines, growers have opportunities to reduce establishment costs and lessen the time for the vineyard to achieve economic yields.

Cherries

Composted mulch was applied to cherries in Forreston at depths of 10 mm, 20 mm and 70 mm, at a cost of $24.50 per cubic metre. Very strong economic returns were obtained for the 10 mm mulch scenario, indeed, this was the trial that had the highest benefit cost ratio from all the horticultural crop trials. For every dollar invested by growers in the 10 mm mulch they received $73.78 in return. This benefit was a direct consequence of the grower receiving higher prices for the improvements in cherry size. The 20 mm mulch did not have any economic return while the 70 mm provided a moderate return.

By applying composted mulch, cherry growers could save up to $45 per hectare in water costs.

The application of a compost mulch can reduce fluctuations in soil temperature and moisture, and encourage extension of the root-zone and more efficient use of nutrients. The addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration, and reduced run-off further optimising water-use. There has been effective suppression of weeds at this site, which has aided in the non-chemical control of weeds.

The increase in cherry size was of considerable benefit, with the grower noting that the picking costs and time for larger cherries are the same or lower than the costs for smaller cherries.

Almonds

Composted mulch was applied to almonds in Willunga at depths of 10 mm, 50 mm and 150 mm, at a cost of $24.50 per cubic metre. All rates provided negative economic returns.

Given the importance of water availability to almond growers, the water savings of compost mulch provide a considerable benefit. Growers could save up to $157 per hectare in water costs.

The moderated soil moisture and temperature conditions beneath a surface mulch allows extension of the root-zone, and more efficient use of nutrients. Suppression of weeds may reduce the need for herbicides. The addition of organic matter to soils has additional benefits, with increased water holding capacity, increased rainfall infiltration, and reduced run-off further optimising water-use.

The most significant economic impact of the use of compost mulch in the production of almonds is the potential to improve conditions for the establishment of young trees, giving growers more options for management of early training and pruning.

Pears

Composted mulch was applied to pears in Coromandel Valley at depths of 10 mm, 50 mm and 150 mm, and at a cost of $24.50 per cubic metre. Strong economic returns were obtained for the 10 mm and 150 mm mulch scenarios, with the 10 mm mulch providing the highest return with $5.30 for every dollar invested. The 50 mm mulch did not have any economic return.

By applying composted mulch, pear growers could save up to $3,200 hectare/year in water costs.

The trial was established in 1997 in an orchard in which the trees had not established as quickly as expected; after five years they had not reached the top of the trellis. This limited the options for the grower to train and prune the trees to achieve optimal production. Within six weeks of compost mulch application, growers reported obvious responses in growth, and after three months, shoot length in the mulched trees extended well beyond the upper trellis wire.

Application of a compost mulch can reduce soil moisture and temperature fluctuations and allows extension of the root-zone, with more efficient use of nutrients and other soil-applied amendments. Suppression of weeds may reduce the need for herbicides. The addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration and reduced run-off, further optimising water-use.

Citrus

Composted mulch was applied to citrus at Waikerie at depths of 10 mm, 50 mm and 150 mm, and at a cost of $37.50 per cubic metre. The additional delivery costs added to the overall cost of the mulch. Negative economic returns were obtained for all mulch scenarios.

By applying composted mulch, citrus growers could save up to $95 per hectare in water costs.

Water is not expensive in the Riverland irrigation areas, and growers are not seeking to save irrigation to reduce costs. However, the availability of water and the times of access to irrigation may be restricted, and long intervals between irrigations can lead to plant stress and potentially, yield loss. Application of a compost mulch can conserve moisture and reduce soil moisture and temperature fluctuations between irrigations, and provide a 'buffer' during hot weather conditions.

Potatoes

Compost was soil incorporated prior to potato planting in the Northern Adelaide Plains at rates of 10 mm, 25 mm and 75 mm, at a cost of $29.00 per cubic metre. There was little economic return achieved from the potato trials, with the 20 mm compost providing a return of $1.30 for every $1 invested. The 75 mm compost did not have any economic return.

By applying composted mulch, potato growers could save up to $41 per hectare in water costs.

There were significant changes in soil properties, with organic carbon levels increased by over 40% under the highest rate of compost. A shift towards neutral pH altered the availability of nutrients in the soil, with the grower noting that he would be able to reduce his use of fertilisers. The addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration and reduced run-off, further optimising water-use.

Capsicums

Compost was soil incorporated prior to capsicum planting in the Northern Adelaide Plains at rates of 10 mm, 25 mm and 75 mm, at a cost of $29.00 per cubic metre. Moderate economic returns were obtained for the 10 mm and 20 mm compost trials, with the 20 mm compost having the largest return as every dollar invested by growers meant they received $2.60 in return. The 75 mm compost trial did not have any economic return.

By applying mulch, capsicum growers could save up to $960 hectare/year in water costs.

There were significant changes in soil properties, with a five times increase in soil organic carbon levels under the highest rate of compost, and a shift towards neutral soil pH. Fifty per cent higher soil moisture was recorded during the growing season, under the highest rate of compost. These results demonstrate the potential for altering irrigation and fertiliser inputs, and achieving more efficient use of water and nutrients.

Carrots

Compost was soil incorporated prior to carrot planting in the Northern Adelaide Plains at rates of 10 mm, 25 mm and 75 mm, and at a cost of $29.00 per cubic metre. All provided negative economic returns, however it is important to note that these results are based on only one harvest.

By applying composted mulch, carrot growers could save up to $135 per hectare in water costs.

There were significant changes in soil properties, with a substantial increase in soil organic carbon levels, a shift towards neutral pH, higher soil moisture, and reduced run-off. The change in soil pH altered the availability of nutrients in the soil, with the grower noting that he would be able to reduce his use of fertilisers.

The addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration, and reduced run-off, further optimising water-use. For these reasons, the grower is now committed to a program of soil improvement, through addition of organic matter.

Flowers

Compost was incorporated into soil prior to planting *Lisianthus* in Northern Adelaide Plains at depths of 25 mm and 75 mm, at a cost of $29.00 per cubic metre. Very strong economic returns were obtained from the 25 mm compost, with growers receiving $24.16 for every dollar they invested, however the 75 mm compost proved to not be economic.

By applying composted mulch, flower growers could save up to $1,125 hectare/year in water costs.

There were significant changes in soil properties, with a substantial increase in soil organic carbon levels, higher soil moisture, and a shift towards neutral pH which altered the availability of nutrients in the soil.

The addition of organic matter to soils has additional benefits, with increased water holding capacity, increased rainfall infiltration, and reduced run-off further optimising water-use. For these reasons, the grower is committed to a program of soil improvement, through addition of organic matter.

Average Costs of Fruit and Vegetable Growers in South Australia and Summary

The costs for fruit and vegetable agricultural industries in South Australia are shown in Table B.7 in Appendix B. The cost share of irrigation (between 1994-95 to 1996-97) for fruit and vegetable producers is considerably higher (10 and 3 percent respectively) than the overall average for all agricultural industries (which was 2 per cent).

The five highest costs incurred by vegetable producers in 1996/97 were for crop and pasture chemicals (22 per cent); fertiliser and soil conditioners (20 per cent); seed, seedlings and plants (19 per cent); marketing expenses (11 per cent); and fuel and lubricants (7 per cent). In comparison, water rates and drainage charges in 1996-97 represented 4 per cent of total expenses for vegetables.

The application of compost to horticultural crops can be expensive, even though compost only needs to be applied around once every three to five years. The actual share of compost of total variable cost will vary considerably, depending on the type of crop and depth application. The share of compost costs could be extremely large[2], hence it is essential that growers are assured that they are receiving economic returns above what they are investing.

The Centre's economic analyses suggest that on the whole the quantitative benefits from lower rates of compost applications outweigh the costs associated with the compost for most horticultural crops. In addition, growers obtain considerable other benefits that have not been quantified, but such benefits include water savings, increased flexibility with water management and soil improvements.

2 Crops that have small total variable costs per hectare (such as potatoes and carrots) will share a larger burden of the compost cost.

1. Introduction

The Waste Management Committee commissioned the Centre to undertake benefit cost analysis of results from field trials on the application of composted 'green-organics' in nine horticultural crops. These horticultural crops included:

- Vines;
- Cherries;
- Potatoes;
- Capsicums;
- Pears;
- Carrots;
- Almonds;
- Flowers; and
- Citrus.

The field trials were undertaken by CSIRO, beginning in October 1997 and finishing in June 1999.

This study is to assist in the market development process for the use of composts made from green waste, and quantifies the costs and benefits involved with the application of composted green waste. The Waste Management Committee asked the Centre wherever possible to quantify the following costs and benefits:

Costs

- Price of the product;
- Application rates;
- Cost of spreading;
- Reapplication frequency; and
- Costs and benefits.

Costs and Benefits

- Yields and yield quality;
- Water conservation;
- Weed control; and
- Soil quality.

2. Methodology

In conducing the benefit cost analyses, the Centre has used the Federal (Department of Finance 1991) and South Australian (Department of the Treasury 1990) Guidelines.

Benefit cost analysis (BCA), an economic analysis tool for decision making project evaluation was chosen as the most appropriate economic method to use. The following section provides a description of BCA and its objectives.

2.1 Benefit Cost Analysis

Benefit cost analysis is used to determine whether a project/programme is justified on economic grounds.

BCA is a widely used tool for comparing alternative courses of action by reference to the *net benefits* that they produce, and comparing a base case (no change) with the proposed option.

An important feature of the analysis is that costs and benefits are, as far as possible, expressed in money and hence are directly comparable with one another. Because a dollar available for spending (or investing) today is more valuable than a dollar that won't become available until a later period, it is necessary to discount future benefits and costs so they are comparable with current benefits and costs.

A benefit-cost ratio (BCR) provides an indication of the result achieved from a particular activity. For example, a benefit cost ratio above one indicates that a positive economic return was achieved, and a benefit cost ratio below one indicates that a negative economic return resulted.

BCR's for multiple projects can be compared to determine which project has a higher economic return relative to the others with higher BCR's indicating higher return.

2.2 Assumptions made within the Benefit Cost Analyses

The following assumptions were made in the BCAs of results from field trials:

- benefits and costs were assumed to accrue over the life of the compost;
- generally, averages of revenue for the crops were used for the years where no harvest data was available;
- there were generally three compost scenarios considered in the trials, ranging from 10 mm to 150 mm for all crops that had the available data, and they were compared against the base case scenario (or 'No Compost' scenario);
- compost costs were incurred in the first year for each scenario. For the 10 mm compost application, it was assumed that the compost would have a life expectancy of three years, and in the 50 mm and 150 mm compost scenarios the life expectancies were assumed to be 5 years;

- for all crops the BCAs were recalculated using the standard errors to estimate the difference in benefits from the average;
- most of the cost information was based on PIRSA's estimates of typical growers experience for the horticultural crops in question. Information was also obtained from the ABS on estimates of South Australian fruit and vegetable producers costs and from The Grower magazine (1999);
- water cost savings have been estimated at a potential saving of between 10 to 30 per cent; and
- analysis was conducted on the total benefits and costs occurred per hectare of horticultural crop.

The results of the economic analyses for each horticultural crop trial are presented in Sections 3 to 10.

3. Vines

Benefit cost analysis was conducted on field trials undertaken by the CSIRO on a variety of vineyard locations and grape varieties. Analysis was conducted on the following:

- McLaren Vale: Cabernet Sauvignon grapes;
- Willunga: Shiraz grapes;
- McLaren Flat: Cabernet Sauvignon grapes (mature vineyards);
- McLaren Flat: Cabernet Sauvignon grapes (young vineyards); and
- All Region Average: Cabernet Sauvignon and Shiraz grapes (average of all vine data provided).

The compost mulch applied to vines was a mix of coarse and fine compost, at a cost per cubic metre of $24.50, which included application and spreading.

3.1 Vine Results

Benefit cost ratios (BCRs) were estimated for each region and rate of compost mulch. Benefits were calculated using three different values of benefits: (1) the average of the yield for each vineyard; (2) the increase in the yield mean taking into consideration its standard error; and (3) the decrease in the yield mean taking into consideration its standard error.

It is important to note that not all the benefits of compost mulch application are included in the benefit cost analysis. There are two main sources of benefits that have not been included in the analysis below, they are water and herbicide savings. The reason why these benefits were not included in the BCAs is because the field trials did not alter any level of inputs that were utilised in the production of the grapes.[3] Instead, potential water savings for the compost mulch scenarios has been used to estimated a cost savings that could be achieved through a reduction in water use.[4] The trials were established in 1996 to demonstrate to growers the potential for more efficient management of irrigation, in a region where water availability was an increasing concern.

The BCAs did not account for the quality of grapes produced under compost mulched and normal conditions. The differences in quality between the scenarios and the base case were within the limits acceptable to the winemaker, and did not affect the price received per tonne.

The benefit cost ratios obtained are in Table 3.1, and the present values of total benefits and costs are in Table 3.2.

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3 If the water levels had been changed to reflect the various moisture conditions under the compost mulch applications, then it is not likely that the same yield per hectare would have been obtained. Assuming water savings within the BCA and using the yield numbers for the compost mulch scenarios would have confounded the results. The same issue is applicable to herbicide (or fertiliser) savings.

4 There has not been enough research to suggest potential herbicide savings.

Table 3.1
Benefit Cost Ratios of Compost Mulch Application for Vines

Location	Mulch Scenario - Benefit Cost Ratio		
	10 mm	**50 mm**	**150 mm**
Mean Yield			
McLaren Vale - Cabernet Sauvignon	8.85	2.27	-0.13
Willunga - Shiraz	4.27	1.69	0.72
McLaren Flat - mature - Cabernet Sauvignon	6.47	3.86	1.29
McLaren Flat - young - Cabernet Sauvignon	n.a	2.19	0.24
All Region Average - Cabernet Sauvignon & Shiraz mature only	8.79	2.60	1.04
Yield with Higher Standard Error			
McLaren Vale - Cabernet Sauvignon	8.99	3.60	-0.16
Willunga - Shiraz	4.27	1.69	0.72
McLaren Flat - mature - Cabernet Sauvignon	6.47	3.68	1.24
McLaren Flat - young - Cabernet Sauvignon	n.a	2.19	0.24
All Region Average - Cabernet Sauvignon & Shiraz	8.83	2.55	1.01
Yield with Lower Standard Error			
McLaren Vale - Cabernet Sauvignon	8.72	3.57	-0.10
Willunga - Shiraz	4.27	1.69	0.72
McLaren Flat - mature - Cabernet Sauvignon	6.47	3.71	1.24
McLaren Flat - young - Cabernet Sauvignon	n.a	2.19	0.24
All Region Average - Cabernet Sauvignon & Shiraz	8.67	2.56	1.03

Note: The BCAs of young vines were estimated for a period of 4 years only.
Source: SACES.

The BCAs show that there were significant quantitative benefits to be derived from applying the compost mulch to vines. Appendix A provides the details of the assumptions, and an example of the BCA.[5]

5 A detailed BCA spreadsheet has only been provided for the one vine scenario.

Table 3.2
Present Values of Total Benefits and Costs of Compost Mulch Application for Vines

Location	10 mm		50 mm		150 mm	
	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)
Mean Yield						
McLaren Vale - Cabernet Sauvignon	7,156	809	9,171	4,043	-1,616	12,128
Willunga - Shiraz	3,453	809	6,851	4,043	8,720	12,128
McLaren Flat - mature - Cabernet Sauvignon	5,228	809	15,587	4,043	15,685	12,128
McLaren Flat - young - Cabernet Sauvignon	n.a	n.a	13,306	6,076	2,947	12,128
All Region Ave. - Cabernet Sauvignon & Shiraz	7,109	809	10,522	4,043	12,560	12,128
Yield with Higher Standard Error						
McLaren Vale - Cabernet Sauvignon	7,265	809	14,549	4,043	-1,980	12,128
Willunga - Shiraz	3,453	809	6,851	4,043	8,720	12,128
McLaren Flat - mature - Cabernet Sauvignon	5,228	809	14,891	4,043	14,990	12,128
McLaren Flat - young - Cabernet Sauvignon	n.a	n.a	13,306	6,076	2,947	12,128
All Region Ave. - Cabernet Sauvignon & Shiraz	7,141	809	10,324	4,043	12,235	12,128
Yield with Lower Standard Error						
McLaren Vale - Cabernet Sauvignon	7,047	809	14,418	4,043	-1,252	12,128
Willunga - Shiraz	3,453	809	6,851	4,043	8,720	12,128
McLaren Flat - mature - Cabernet Sauvignon	5,228	809	14,997	4,043	15,096	12,128
McLaren Flat - young - Cabernet Sauvignon	n.a	n.a	13,306	6,076	2,947	12,128
All Region Ave. - Cabernet Sauvignon & Shiraz	7,012	809	10,362	4,043	12,527	12,128

Note: The BCAs of young vines were estimated for a period of 4 years only.
Source: SACES

3.1.1 McLaren Vale Cabernet Sauvignon Vines

The BCR for applying a 10 mm compost mulch at McLaren Vale is 8.85.[6] This indicates for every $1 spent on applying 10 mm of compost mulch, the grower receives $8.85 in return. The BCR of applying a 50 mm compost mulch to mature vines over a 5 year

[6] The analysis presented was calculated using the mean of the yields. Taking into consideration the standard error of the yields, the BCR for the 10 mm compost mulch ranged from 8.72 to 8.99 for the lower and higher SE respectively.

period to the same vineyard was estimated to be 2.27[7], and -0.13[8] for the 150 mm compost mulch application.

3.1.2 Willunga Shiraz Mature Vines

The BCR of applying a 10 mm compost mulch in Willunga to a hectare of Shiraz mature vines over a 3 year period was estimated to be 4.27. The BCR of applying a 50 mm compost mulch to mature vines over a 5 year period to the same vineyard was estimated to be 1.69, and 0.72 for the 150 mm compost mulch application.

3.1.3 McLaren Flat Cabernet Sauvignon Vines

The BCR of applying a 10 mm compost mulch in McLaren Flat to a hectare of Cabernet Sauvignon mature vines over a 3 year period was estimated to be 6.47. The BCR of applying a 50 mm compost mulch to mature vines over a 5 year period to the same vineyard was estimated to be 3.86,[9] and 1.29 for the 150 mm compost mulch application.

3.1.4 McLaren Flat Cabernet Sauvignon Young Vines

The BCR of applying a 50 mm compost mulch in McLaren Flat to a hectare of Cabernet Sauvignon young vines over a 4 year period was estimated to be 2.19, and 0.24 for the 150 mm compost mulch application.

3.1.5 Average of Vineyard Results

The average of all the vineyard results was calculated. It must be understood that these figures do not represent the average representation for the region. The BCR of applying a 10 mm compost mulch in to the McLaren Vale Region a hectare of Cabernet Sauvignon/Shiraz mature vines over a 3 year period was estimated to be 8.79[10]. The BCR of applying a 50 mm compost mulch to mature vines over a 5 year period to the same vineyard was estimated to be 2.60[11], and 1.04[12] for the 150 mm compost mulch application.

3.2 Potential Water Savings

As commented previously, water savings were not included in the BCA analyses. However, it is very probable that there are significant water savings to be made with the application of compost mulch. The availability of water and its cost is most likely going to be a major constraint for growers in the near future. Therefore, any production processes that will help growers conserve on water will be valued highly.

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7 Taking into consideration the standard error, the BCR for the 50mm compost mulch ranged from 3.57 to 3.60 for the lower and higher SE respectively.

8 Taking into consideration the standard error, the BCR for the 150 mm compost mulch ranged from -0.10 to - 0.16 for the lower and higher SE respectively.

9 Taking into consideration the standard error, the BCR for the 50 mm compost mulch ranged from 3.68 to 3.71 for the lower and higher SE respectively.

10 Taking into consideration the standard error, the BCR for the 10 mm compost mulch ranged from 8.67 to 8.83 for the lower and higher SE respectively.

11 Taking into consideration the standard error, the BCR for the 50 mm compost mulch ranged from 2.55 to 2.56 for the lower and higher SE respectively.

12 Taking into consideration the standard error, the BCR for the 150 mm compost mulch ranged from 1.01 to 1.03 for the lower and higher SE respectively.

Based on CSIRO experience, it is probable that there are potential water savings of 10 to 30 per cent that can be saved with the application of compost mulch.[13] Average cost of irrigation for growers in McLaren Vale was used to estimate the potential water cost savings that could be made. Irrigation does represents approximately 11.6 per cent of total variable costs for vineyards in McLaren Vale. Table 3.3 illustrates the potential savings to be derived from the compost mulch application.

Table 3.3
Water Savings for Vine Growers in McLaren Vale*

Current Cost Per Hectare ($)	**Water Savings**		
	10 Per Cent	**20 Per Cent**	**30 Per Cent**
	Potential Savings ($)		
334	33.40	66.80	100.20

Note: * Water costs represent water and irrigation costs.
Source: PIRSA.

Potentially, growers could be saving up to $100 per hectare in water savings, on top of the benefits cited previously.

3.3 Economic Qualitative Benefits

Grower interest in the potential for using compost as a mulch undervine to conserve water led to the establishment of trials in the McLaren Vale region in 1996, to demonstrate the potential for more efficient management of irrigation and weed suppression.

Growers are not only seeking ways of saving water, to enable them to continue to operate under proposed water allocation limits, by more efficiently managing their irrigation. With the water available to the grower, it may not be possible to supply the water demand of vines during times of extreme stress. The use of a compost mulch can reduce fluctuations in soil moisture and temperature, reducing the impact of extreme stress on vine performance.

The moderated moisture and temperature conditions beneath a surface mulch may encourage extension of the root-zone, and more efficient use of nutrients. Suppression of weeds may reduce the need for herbicides. The addition of organic matter to soils has additional benefits, with increased water holding capacity, increased infiltration, and reduced run-off further optimising rainfall interception.

The most significant economic impact of the use of compost mulch on the production of grapes is the potential to improve conditions for the establishment of young vines, giving growers more options for management of early training, pruning, harvest and

13 Larger applications of compost mulch will of course save the grower more water. However, as there is no research that defines this the Centre has considered the water savings to be constant across mulch applications.

quality. With more options to manage the growth of young vines, growers have opportunities to reduce establishment costs and lessen the time for the vineyard to achieve economic yields.

3.4 Summary

Overall — taking into consideration the variations in the yields — the compost mulch scenarios provided substantial economic benefits (in both qualitative and quantitative terms) in vines in the McLaren Vale region. However, it is important for the estimates of benefits presented here to be considered as indicative, because not all of the differences in compost mulch yield means were statistically significant from the control/base case.

4. Cherries

Benefit cost analysis was conducted on field trials undertaken by the CSIRO in Forreston in 1998 and 1999.

The compost mulch applied to cherries was a mix of coarse and fine compost, at a cost per cubic metre of $24.50, which included application and spreading.

4.1 Cherry Results

Benefit cost ratios (BCRs) were estimated for yields of each rate of compost mulch, and took into consideration the standard error.

Once again, not all the benefits of compost mulch application are included in the benefit cost analysis. Namely water and herbicide/fertiliser savings have not been estimated. The trials were established to demonstrate the potential for more efficient use of water and nutrients.

An improvement in quality was considered in the benefit cost analysis for cherries. As cherry prices depend considerably on the size of the cherries, the field trial data included a breakdown of the percentage of cherries in each category of size (four categories in all). The grower also provided information on the prices they received for the cherries in those size categories.

The benefit cost ratios obtained are in Table 4.1, and the present value of total benefits and costs are in Table 4.2.

Table 4.1
Benefit Cost Ratios of Compost Mulch Application for Cherries

Location	Compost Mulch Scenario - Benefit Cost Ratios		
	10 mm	20 mm	70 mm
Mean Yield			
Forreston	73.78	0.13	2.10
Yield with Higher Standard Error			
Forreston	74.91	0.56	2.25
Yield with Lower Standard Error			
Forreston	72.65	-0.29	1.95

Source: SACES.

Table 4.2
Present Values of Compost Mulch Application for Cherries

Location	10 mm		20 mm		70 mm	
	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)
Mean Yield						
Forreston	82,080	1,112	688	5,246	33,073	15,738
Yield with Higher Standard Error						
Forreston	83,340	1,112	2,919	5,246	35,427	15,738
Yield with Lower Standard Error						
Forreston	80,821	1,112	-1,543	5,246	30,718	15,738

Source: SACES.

4.1.1 Quantitative Economic Benefits

Like the vine analysis, the BCRs of the trials of compost mulch in cherry orchards indicated that there are diminishing returns to increased depth of mulch application. There are larger net benefits to be derived from the 20 mm compost mulch than the 70 mm mulch.

Considerably high benefits were derived from the 20 mm compost mulch application in the Forreston orchards. The BCR was a huge 73.8[14], indicating that for every dollar invested the grower received $73.80 in return. This was driven in part by the increase in yield, but also the increase in the larger size of cherries (hence more money was received per kilogram).

No significant increase in yield with the 50 mm compost mulch harvest meant that there were very low returns. The BCR was 0.13[15] in the 50 mm scenario and 2.10[16] in the 70 mm scenario.

4.1.2 Potential Water Savings

The Centre has used the average cost of irrigation for cherry growers in South Australia to estimate the potential water cost savings that could be made. For cherry growers, water is not a large cost. It represents approximately 0.5 per cent of their total variable costs. The savings for cherry growers is shown in Table 4.3.

14 Taking into consideration the standard error, the BCR for the 20 mm compost mulch ranged from 72.7 to 74.9 for the lower and higher SE respectively.
15 Taking into consideration the standard error, the BCR for the 50 mm compost mulch ranged from -0.3 to 0.6 for the lower and higher SE respectively.
16 Taking into consideration the standard error, the BCR for the 70 mm compost mulch ranged from 2.0 to 2.3 for the lower and higher SE respectively.

Table 4.3
Potential Water Cost Savings for Cherry Growers

Current Cost Per Hectare $	Water Savings		
	10 Per Cent	20 Per Cent	30 Per Cent
	Potential Savings ($)		
150	15.00	30.00	45.00

Source: PIRSA.

Potentially, growers could be saving up to $45 per hectare in water savings, on top of the other benefits cited previously.

4.1.3 Qualitative Economic Benefits

The field trial under cherries was established in 1997 to demonstrate alternatives for optimising production in a commercial orchard. The grower was seeking to minimise his use of chemical fertilisers and pesticides, and provide optimal soil conditions for the production of cherries.

The application of a compost mulch can reduce fluctuations in soil temperature and moisture, and encourage extension of the root-zone and more efficient use of nutrients. The addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration, and reduced run-off further optimising water-use. There has been effective suppression of weeds at this site, which has aided in the non-chemical control of weeds.

Herbicide costs represent approximately 2.5 per cent of cherry growers total variable costs.

The increase in cherry size was of considerable benefit, with the grower noting that the picking costs and time for larger cherries are the same or lower than the costs for smaller cherries.

Overall — taking into consideration the variations in the yields — the compost mulch scenarios provided substantial economic benefits in cherries. However, it is important for the estimates of benefits presented here to be considered as indicative, because not all of the differences in compost mulch yield means were significant from the control/base case.

5. Almonds

Benefit cost analysis was conducted on field trials undertaken by the CSIRO on mature almond trees in Willunga, with harvests in 1997, 1998 and 1999.

The grade of compost mulch applied to almonds was a mixture of coarse and fine material, at a cost per cubic metre of $24.50, which includes the cost for delivery, application and spreading.

5.1 Almond Results

Compost mulch applications in Willunga on young almond trees had spectacular effects on growth. Indeed, the trial had to be discontinued as the grower insisted on mulching all his younger almond trees. It was therefore not possible to conduct a benefit cost analysis on younger almond trees given the lack of comparative data, however there is substantial anecdotal evidence that it is economic to apply compost mulch to young almond trees.

Once again, not all the benefits of compost mulch application are included in the quantitative benefit cost analysis. Namely water and fertiliser savings have been excluded due to lack of information. The initial trials in Willunga were established to look at the potential for saving water, and the grower did substantially reduce the water input.

The benefit cost ratios obtained are in Table 5.1, and the present values of total benefits and costs are in Table 5.2.

Table 5.1
Benefit Cost Ratios of Compost Mulch Application for Almonds

Location	Compost Mulch Scenario - Benefit Cost Ratio		
	10 mm	50 mm	150 mm
	Mean Yield		
NAP	-5.81	-1.46	-0.59

Source: SACES

Table 5.2
Present Values of Compost Mulch Application for Almonds

Location	10 mm		50 mm		150 mm	
	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)
	Mean Yield					
NAP	-996	172	-1,144	784	-1,353	2,303

Source: SACES.

5.1.1 Quantitative Economic Benefits

There was no quantitative economic benefits that could be identified from the application of compost mulch. All mulch scenarios had negative economic returns.

Results showed indications of a positive yield trend in the deeper compost mulch applications on a yield per basal area of trunk basis. However, these results were not statistically significant.

5.1.2 Potential Water and Fertiliser Savings

Water costs represent a, significant proportion of total costs for almond growers, at approximately 12 per cent of their total variable costs. Table 5.3 illustrates the potential savings that could be derived from mulch application.

Table 5.3
Water Savings for Almond Growers

Cost per Hectare	Water Savings		
$	10 Per Cent	20 Per Cent	30 Per Cent
	Potential Savings Per Year ($)		
524	52	105	157

Source: PIRSA

Potentially, growers could be saving up to $150 per hectare in water costs.

There may be some potential savings in herbicide costs from the application of 150 mm compost mulch[17]. This deep mulch appeared to be effective in controlling weeds, but the scale of this potential saving would be very low as herbicide costs only make up 1 per cent of total variable costs for almond growers.

5.1.3 Qualitative Economic Benefits

Grower interest in the potential for using compost as a mulch to conserve water and more efficiently manage irrigation led to the establishment of trials at Willunga in 1996, to demonstrate the potential for more efficient management of irrigation, nutrition, soil, orchard establishment, and weed suppression.

Almond growers were seeking ways of not only saving water, to enable them to continue producing under proposed water allocation limits, but also to more efficiently manage their irrigation. Growers were keen to test the effectiveness of compost mulch in saving water.

[17] Almond growers herbicide the entire orchard well before harvest to ensure a 'clean' surface to harvest from. Use of compost mulch may not impact on this practice.

The moderated soil moisture and temperature conditions beneath a surface mulch allows extension of the root-zone, and more efficient use of nutrients. Suppression of weeds may reduce the need for herbicides. The addition of organic matter to soils has additional benefits, with increased water holding capacity, increased rainfall infiltration, and reduced run-off further optimising water-use.

The most significant economic impact of the use of compost mulch in the production of almonds is the potential to improve conditions for the establishment of young trees, giving growers more options for management of early training and pruning.

Overall the compost mulch scenarios provided no quantitative economic benefits for almond growers. Again, caution is urged given the previous comments about tree sizes, and the fact that the mean yield of mulched trees was not significantly different from the control/base case.

6. Pears

Benefit cost analysis was conducted on a trial undertaken by the CSIRO in Coromandel Valley in 1998 and 1999. Two harvests of lemon bergamot pears were obtained.

The compost mulch applied to pears was a mix of coarse and fine compost at a cost per cubic metre of $24.50, which included delivery and application/spreading.

6.1 Pear Results

Once again, not all the benefits of compost mulch application are included in the quantitative benefit cost analysis. Namely water and herbicide savings have been excluded. The trials were established to demonstrate the potential for more efficient use of water and nutrients, and to increase the options available to the grower to manage the growth and training of the trees.

Table 6.1 illustrates the benefit cost ratios obtained, and Table 6.2 the present value of total benefits and costs.

Table 6.1
Benefit Cost Ratios of Compost Mulch Application for Pears

Location	Compost Mulch Scenario - Benefit Cost Ratio		
	10 mm	50 mm	150 mm
Mean Yield			
Coromandel Valley	5.32	-0.34	2.29

Source: SACES.

Table 6.2
Present Values of Compost Mulch Application for Pears

Location	10 mm		50 mm		150 mm	
	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)
Mean Yield						
Coromandel Valley	3,257	613	-1,034	3,063	21,054	9,188

Source: SACES.

6.1.1 Quantitative Economic Benefits

The quantitative economic net benefits from the application of compost mulch to pears were the second largest after cherries and vines.

An application of 10 mm compost mulch in Coromandel Valley provided a BCR of 5.32[18], indicating that there was a very small, positive return for every dollar the grower invested.

The 50 mm mulch application had negative economic returns, with a BCR of -0.3, but the 150 mm scenario showed strong economic returns again with a BCR of 2.3.

6.1.2 Potential Water and Fertiliser Savings

Water costs represent a reasonably significant proportion of total costs for fruit growers, pear growers spend approximately $10,731 hectare annually on water and irrigation. Table 6.3 illustrates the savings that could be made under a mulch application.

Table 6.3
Water Savings for Pear Growers

Total Cost Hectare/Year $	Water Savings		
	10 Per Cent	20 Per Cent	30 Per Cent
	Potential Savings Per Year $		
10,731	1,073	2,146	3,219

Source: PIRSA.

Potentially, growers could be saving up to $3,000 hectare/year in water savings, on top of the other benefits cited previously.

There is expected to be potential savings in fertiliser and herbicide costs, although at this stage it is impossible to quantify the exact amount. Nevertheless, these potential savings would not be minimal as chemicals represent 11 per cent of fruit producers total variable costs and fertilisers represent around 9 per cent.

6.1.3 Qualitative Economic Benefits

The trial under pears was established in response to grower interest in the potential for compost mulch to aid in more efficient management of plant growth, irrigation, nutrition and weed suppression.

The trial was established in 1997 in an orchard in which the trees had not established as quickly as expected; after five years they had not reached the top of the trellis. This limited the options for the grower to train and prune the trees to achieve optimal production. Within six weeks of compost mulch application, growers reported obvious responses in growth, and after three months, shoot length in the mulched trees extended well beyond the upper trellis wire.

Application of a compost mulch can reduce soil moisture and temperature fluctuations and allows extension of the root-zone, with more efficient use of nutrients and other soil-applied amendments. Suppression of weeds may reduce the need for herbicides. The

[18] The BCRs did not change with the application of higher and lower standard errors.

addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration and reduced run-off, further optimising water-use.

Overall, the compost mulch scenarios provided substantial economic benefits for pear growers.

7. Citrus

Benefit cost analysis was conducted on trials undertaken by the CSIRO in Waikerie in 1998 and 1999. Two harvests of Pasin Navel oranges were obtained.

The compost mulch applied to pears was a mix of coarse and fine compost at a cost per cubic metre of $37.50, which included delivery and application/spreading. The additional delivery cost for the mulch increased its overall cost.

7.1 Citrus Results

Once again, not all the benefits of compost mulch application are included in the quantitative benefit cost analysis. Namely water and herbicide savings have been excluded. The trials were established to demonstrate the potential for more efficient use of water and nutrients in the establishment of a young orchard.

Table 7.1 illustrates the benefit cost ratios obtained, and Table 7.2 the present value of total benefits and costs.

Table 7.1
Benefit Cost Ratios of Compost Mulch Application for Citrus

Location	Compost Mulch Scenario - Benefit Cost Ratio		
	10 mm	50 mm	150 mm
Mean Yield			
Waikerie	-3.04	-5.96	-4.42

Source: SACES.

Table 7.2
Present Values of Compost Mulch Application for Citrus

Location	10 mm		50 mm		150 mm	
	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)
Mean Yield						
Waikerie	-455	150	-4,249	713	-9,440	2,138

Source: SACES.

7.1.1 Quantitative Economic Benefits

There was no quantitative economic net benefits from the application of compost mulch to citrus.

An application of 10 mm compost mulch in Waikerie provided a BCR of -3.04[19], indicating that for every dollar the grower invested, they had a negative return of about $3 dollars.

Deeper mulch applications had even more negative returns.

7.1.2 Potential Water and Fertiliser Savings

Water costs represent a reasonably significant proportion of total costs for fruit growers, citrus growers spend approximately $317 per hectare on water and irrigation. Table 7.3 illustrates the savings that could be made under a mulch application.

Table 7.3
Water Savings for Citrus Growers

Per Hectare Cost	Water Savings		
$	10 Per Cent	20 Per Cent	30 Per Cent
	Potential Savings Per Hectare ($)		
317	31.70	63.40	95.10

Source: PIRSA

Potentially, growers could be saving up to $95 per hectare in water savings, on top of the other benefits cited previously.

There is expected to be potential savings in fertiliser and herbicide costs, although at this stage these savings have not been quantified. These potential savings would not be minimal as chemicals represent 11 per cent of fruit producers total variable costs and fertilisers represent around 9 per cent.

Nevertheless, these potential savings would not be minimal as chemicals represent 11 per cent of fruit producers total variable costs and fertilisers represent around 9 per cent.

7.1.3 Qualitative Economic Benefits

Water is not expensive in the Riverland irrigation areas, and growers are not seeking to save irrigation to reduce costs. However, the availability of water and the times of access to irrigation may be restricted, and long intervals between irrigations can lead to plant stress and potentially, yield loss. Application of a compost mulch can conserve moisture and reduce soil moisture and temperature fluctuations between irrigations, and provide a 'buffer' during hot weather conditions.

The moderated soil conditions under a compost mulch can allow extension of the root-zone, with more efficient use of nutrients and other soil-applied amendments. Suppression of weeds may reduce the need for herbicides. The addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration and reduced run-off, further optimising water-use.

[19] The BCRs did not change with the application of higher and lower standard errors.

Overall — taking into consideration the variations in the yields — the compost scenarios provided negative economic benefits in citrus. However, it is important for the estimates of benefits presented here to be considered as indicative, because not all of the differences in compost yield means were statistically significant from the control/base case.

8. Potatoes

Benefit cost analysis was conducted on a field trial undertaken by the CSIRO in Northern Adelaide Plains in 1998. Only one harvest was obtained.

The compost applied to the soil was a very fine compost, at a cost per cubic metre of $29.00, which includes the cost to the grower to apply and spread the compost.

8.1 Potato Results

Once again, not all the potential benefits of compost application are included in the benefit cost analysis. Namely water and fertiliser savings have been excluded because that information was not available.

An improvement in quality was considered in the benefit cost analysis. As potato prices depend on grade, the field trial data included a breakdown of the amount of premium and seconds potatoes. The grower also provided information on the prices expected for the potatoes in those grades.

The other main benefit not considered from compost application was the improvement in soil conditions. The trial was established in conjunction with the Northern Adelaide Plains Landcare Group to demonstrate ways for growers to achieve their aims of increasing soil organic matter, improving soil structure, and more efficient use of nutrients.

The benefit cost ratios obtained are in Table 8.1, and the present values of total benefits and costs are in Table 8.2.

Table 8.1
Benefit Cost Ratios of Compost Application for Potatoes

Location	**Compost Scenario - Benefit Cost Ratios**		
	10 mm	**25 mm**	**75 mm**
Mean Yield			
NAP	0.97	1.29	-0.25
Yield with Higher Standard Error			
NAP	0.98	1.33	-0.29
Yield with Lower Standard Error			
NAP	0.95	1.25	-0.22

Source: SACES

Table 8.2
Present Values of Compost Application for Potatoes

Location	10 mm		25 mm		750 mm	
	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)
Mean Yield						
NAP	2,801	2,900	9,336	7,250	-5,543	21,750
Yield with Higher Standard Error						
NAP	2838	2,900	9,640	7,250	-6,276	21,750
Yield with Lower Standard Error						
NAP	2,764	2,900	9,032	7,250	-4,810	21,750

Source: SACES.

8.1.1 Quantitative Economic Benefits

The quantitative economic benefits from the application of compost were considerably smaller for potatoes than in vines or cherries. However, the limited availability of data (one harvest only) must be taken into consideration in viewing these results.

An application of 10 mm of compost in Virginia provided a BCR of 0.97[20], indicating that there was a very small, negative return for every dollar the grower invested.

The 25 mm compost application had stronger economic returns, the BCR was 1.29[21] and -0.25[22] in the 75 mm scenario.

8.1.2 Potential Water and Fertiliser Savings

The average cost of irrigation for potato growers in South Australia was used to estimate the potential water cost savings that could be made. For potato growers, water is not a large cost. It represents approximately 3.3 per cent of their total variable costs. The savings in potato growers is shown in Table 8.3.

Table 8.3
Water Savings for Potato Growers

Current Cost Per Hectare $	Water Savings		
	10 Per Cent	20 Per Cent	30 Per Cent
	Potential Savings ($)		
1,138	14.00	28.00	41.00

Source: PIRSA.

20 Taking into consideration the standard error, the BCR for the 10 mm compost ranged from 0.95 to 0.98 for the lower and higher SE respectively.

21 Taking into consideration the standard error, the BCR for the 25 mm compost ranged from 1.25 to 1.33 for the lower and higher SE respectively.

22 Taking into consideration the standard error, the BCR for the 75 mm compost ranged from -0.22 to -0.29 for the lower and higher SE respectively.

Potentially, growers could be saving up to $41 per hectare in water savings, on top of the often benefits cited previously.

The improvement in soil conditions may imply a reduction in the rate of fertiliser to be applied (currently or in the future). It is not possible to suggest a range of potential savings (further research would be required), suffice to say that fertilisers represent a considerable amount of total variable costs for vegetable producers, almost 20 per cent, hence any savings made in fertiliser costs would not be trivial.

8.1.3 Qualitative Economic Benefits

The trial was established in conjunction with the Northern Adelaide Plains Landcare group, to address the group's aims of increasing soil organic carbon levels, improving soil structure, and achieving more efficient use of nutrients and water.

There were significant changes in soil properties, with organic carbon levels increased by over 40 per cent under the highest rate of compost. A shift towards neutral pH altered the availability of nutrients in the soil, with the grower noting that he would be able to reduce his use of fertilisers. The addition of organic matter to soils has additional benefits, with increased water-holding capacity, increased rainfall infiltration and reduced run-off, further optimising water-use.

Overall — taking into consideration the variations in the yields — the compost scenarios provided modest economic benefits in potatoes. However, it is important for the estimates of benefits presented here to be considered as indicative, because not all of the differences in compost yield means were statistically significant from the control/base case.

9. Capsicums

Benefit cost analysis was conducted on a field trial undertaken by the CSIRO in the Northern Adelaide Plains in 1998. Only one harvest of capsicums was obtained.

The compost applied to capsicums was a very fine compost, at a cost per cubic metre of $29, including the cost of the grower applying and spreading the compost.

9.1 Capsicum Results

Once again, not all the benefits of compost application are included in the quantitative benefit cost analysis. Namely water and fertiliser savings have been excluded because this information was not available.

The main benefit not considered from compost application was the improvement in soil conditions. The trial was established in conjunction with the Northern Adelaide Plains Landcare Group to demonstrate ways for growers to achieve their aims of increasing soil organic matter, improving soil structure, and more efficient use of nutrients.

Table 9.1 illustrates the benefit cost ratios obtained, and Table 9.2 the present value of total benefits and costs.

Table 9.1
Benefit Cost Ratios of Compost Application for Capsicums

Location	Compost Scenario - Benefit Cost Ratio		
	10 mm	25 mm	75 mm
Mean Yield			
NAP	2.08	2.59	0.43

Note: Benefit cost ratios do not vary allowing for higher and lower standard errors.
Source: SACES

Table 9.2
Present Values of Compost Application for Capsicums

Location	10 mm		25 mm		75 mm	
	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)	PV Benefits ($)	PV Costs ($)
Mean Yield						
NAP	6,020	2,900	18,812	7,250	9,406	21,750

Note: Benefits and costs do not vary allowing for higher and lower standard errors.
Source: SACES

9.1.1 Quantitative Economic Benefits

The quantitative economic benefits from the application of compost were smaller for the capsicum than for vines or cherries, but larger than in potatoes. The availability of data (one harvest only) must also be taken into consideration in viewing these results.

An application of 10 mm compost in the Northern Adelaide Plains provided a BCR of 2.1[23], indicating that for every dollar the grower invested in the compost she/he received a return of $2.10.

The 25 mm compost application had stronger economic returns, the BCR was 2.6 but there was no economic return in the 75 mm scenario with a BCR of 0.43.

9.1.2 Potential Water and Fertiliser Savings

The average cost of irrigation for capsicum growers in South Australia was used to estimate the potential water cost savings that could be made. For vegetable growers, water is not a large cost. It represents approximately 3.3 per cent of their total variable costs.[24] Table 9.3 illustrates the savings.

Table 9.3
Water Savings for Capsicum Growers

Total Annual Cost Hectare ($)	**Water Savings**		
	10 Per Cent	**20 Per Cent**	**30 Per Cent**
	Potential Savings $		
3,200	320	640	960

Source: PIRSA.

Potentially, growers could be saving up to $960 hectare year in water savings, on top of the other benefits cited previously.

The improvement in soil conditions may imply a reduction in the rate of fertiliser to be applied (currently or in the future). It is not possible to suggest a range of potential savings (further research would be required), suffice to say that fertilisers represent a considerable amount of total variable costs for vegetable producers, almost 20 per cent, hence any savings made in fertiliser costs would not be trivial.

9.1.3 Qualitative Economic Benefits

The trial under capsicums was established in conjunction with the Northern Adelaide Plains Landcare group, to address the group's aims of increasing soil organic carbon levels, improving soil structure, and achieving more efficient use of nutrients and water.

23 Taking into consideration the standard errors, the BCRs for all scenarios did not change.
24 The Centre did have figures on the use of water by glasshouse capsicum producers, who spend approximately $3,200 hectare/year on water and power.

There were significant changes in soil properties, with a five times increase in soil organic carbon levels under the highest rate of compost, and a shift towards neutral soil pH. Fifty per cent higher soil moisture was recorded during the growing season, under the highest rate of compost. These results demonstrate the potential for altering irrigation and fertiliser inputs, and achieving more efficient use of water and nutrients.

Overall — taking into consideration the variations in the yields — there is good indication the compost scenarios of 10 mm and 25 mm provided economic benefits in capsicums.

10. Carrots

Benefit cost analysis was conducted on a field trial undertaken by the CSIRO in the Northern Adelaide Plains in 1997. Only one harvest of carrots was obtained, hence the BCAs have limited application.

The compost applied to carrots was a very fine compost, at a cost per cubic metre of $29.00, which includes the cost for the grower to apply and spread the compost.

10.1 Carrot Results

Benefit cost ratios (BCRs) were estimated for each compost application, taking into consideration the yields standard error.

Once again, not all the benefits of compost application are included in the quantitative benefit cost analysis. Namely water and fertiliser savings have been excluded due to lack of information.

The main benefit not considered from compost application was the improvement in soil conditions. The trial was established in conjunction with the Northern Adelaide Plains Landcare Group to demonstrate ways for growers to achieve their aims of increasing soil organic matter, improving soil structure, and making more efficient use of nutrients.

The benefit cost ratios obtained are in Table 10.1, and the present values of total benefits and costs are in Table 10.2.

Table 10.1
Benefit Cost Ratios of Compost Application for Carrots

Location	Compost Scenario - Benefit Cost Ratio		
	10 mm	25 mm	75 mm
Mean Yield			
NAP	0.16	0.00	-0.97

Source: SACES

Table 10.2
Present Values of Compost Application for Carrots

Location	10 mm		25 mm		75 mm	
	PV Benefits $	PV Costs $	PV Benefits $	PV Costs $	PV Benefits $	PV Costs $
Mean Yield						
NAP	467	2,900	0	7,250	-21,152	21,750

Source: SACES

10.1.1 Quantitative Economic Benefits

Taking into consideration that there was only one field trial for carrots, there was no indication of quantitative economic benefits to be derived from the application of compost.

An application of 10 mm compost in Virginia provided a BCR of 0.16[25], indicating that there were no economic returns.

The 25 mm compost application had zero economic returns with a BCR of 0 and -0.97 in the 75 mm scenario.

10.1.2 Potential Water and Fertiliser Savings

As commented previously, water savings were not included in the BCA analyses.

The cost of irrigation and water for carrot growers in South Australia was used to estimate the potential water cost savings that could be realised. Water costs represent a small proportion of total costs for carrot growers, at approximately 5 per cent of their total variable costs. The savings are shown in Table 10.3.

Table 10.3
Potential Water Savings for Carrot Growers

Cost Per Hectare ($)	Water Savings		
	10 Per Cent	20 Per Cent	30 Per Cent
	Potential Savings Per Hectare ($)		
450	45	90	135

Source: PIRSA.

Potentially, growers could be saving around $130 per hectare in water costs.

There is expected to be some potential savings in fertiliser costs (but not herbicide costs). Fertilisers represent around 5 per cent of carrot growers total variable costs.

10.1.3 Qualitative Economic Benefits/Costs

The quality of carrots depends on the amount which are forked and bent. It was found that higher rates of compost resulted in a significantly higher percentage of carrots which were forked. There was a general increasing trend with the percentage of carrots forked and bent with higher rates of compost, but most were not statistically significant. These results suggest the possibility that the grower may receive less money per crop with higher rates of compost given the higher percentage of forked and bent carrots.

The trial was established in conjunction with the Northern Adelaide Plains Landcare group, to address the group's aims of increasing soil organic carbon levels, improving soil structure, and achieving more efficient use of nutrients and water.

25 The BCRs did not change taking into consideration the standard error.

The moderated soil moisture and temperature conditions beneath a surface mulch allows extension of the root-zone, and more efficient use of nutrients. Suppression of weeds may reduce the need for herbicides. The addition of organic matter to soils has additional benefits, with increased water holding capacity, increased rainfall infiltration, and reduced run-off further optimising water-use.

The most significant economic impact of the use of compost mulch in the production of almonds is the potential to improve conditions for the establishment of young trees, giving growers more options for management of early training and pruning.

The compost scenarios evaluated did not show any indication of quantitative economic benefits in carrots.

11. Flowers — *Lisianthus*

Benefit cost analysis was conducted on a field trial undertaken by the CSIRO in the Northern Adelaide Plains on *Lisianthus* in early 1998. There were seven harvests of flowers obtained over a period of around three weeks. Because data is from only one trial, the BCAs have limited application.

The compost applied to flowers was a very fine compost, at a cost per cubic metre of $29.00, which includes the cost for the grower to apply and spread the compost.

11.1 *Lisianthus* Results

Once again, not all the benefits of compost application are included in the quantitative benefit cost analysis. Namely water and fertiliser savings have been excluded because that information was not available.

The main benefit not considered from compost application was the improvement in soil conditions. The trial was established in conjunction with the Northern Adelaide Plains Landcare Group to demonstrate ways for growers to achieve their aims of increasing soil organic matter, improving soil structure, and more efficient use of nutrients.

The benefit cost ratios obtained are in Table 11.1, and the present values of total benefits and costs are in Table 11.2.

Table 11.1
Benefit Cost Ratios of Compost Application for Flowers

Location	Compost Scenario - Benefit Cost Ratio	
	25 mm	75 mm
	Mean Yield	
NAP	24.16	-13.63

Source: SACES

Table 11.2
Present Values of Compost Application for Flowers

Location	25 mm		75 mm	
	PV Benefits $	PV Costs $	PV Benefits $	PV Costs $
		Mean Yield		
NAP	176,334	7,300	- 298,412	21,900

Source: SACES

11.1.1 Quantitative Economic Benefits

The quantitative economic benefits from the application of compost were considerably variable in the flower crops.

An application of 25 mm compost in Evanston Gardens provided a BCR of 24.16[26], indicating that there was a very large, positive return for every dollar the grower invested.

Interestingly, because of the lower yields in the 75 mm compost application, it had negative economic returns with a BCR of -13.6.

11.1.2 Potential Water and Fertiliser Savings

The average cost of irrigation for flower growers in South Australia was used to estimate potential water cost savings. Water costs represent a small proportion of total costs for flower growers, at approximately 2 per cent of their total variable costs. Table 11.3 illustrates the potential savings to be made from the mulch.

Table 11.3
Water Savings for Flower Growers

Total Annual Cost ($)	Water Savings		
	10 Per Cent	20 Per Cent	30 Per Cent
	Potential Savings Per Year ($)		
3,750	375	750	1,125

Source: PIRSA.

Potentially, growers could be saving up to $1,000 per annum in water savings.

Savings may also be derived from a reduction in fertiliser costs. Fertiliser costs represent approximately 3 per cent of flower growers total variable costs.

11.1.3 Economic Qualitative Benefits

The trial was established in conjunction with the Northern Adelaide Plains Landcare group, to address the group's aims of increasing soil organic carbon levels, improving soil structure, and achieving more efficient use of nutrients and water.

There were significant changes in soil properties, with a substantial increase in soil organic carbon levels, higher soil moisture, and a shift towards neutral pH which altered the availability of nutrients in the soil.

The addition of organic matter to soils has additional benefits, with increased water holding capacity, increased rainfall infiltration, and reduced run-off further optimising water-use. For these reasons, the grower is committed to a program of soil improvement, through addition of organic matter.

Overall the compost scenarios provided substantial benefits in flowers. Benefits must be considered as indicative only.

26 The BCRs did not vary taking into consideration the higher and lower standard errors.

Further Reading

Trials of 'green-organics' compost derived from collections of garden prunings, clippings and leaves have been undertaken in horticultural crops across Australia. Results from these trials are reported in the proceedings of the International Composting Conference, Melbourne 1998 and the Compost in Horticulture Seminar, Perth 1999. Results from CSIRO trials have been widely reported in grower journals and at industry conferences.

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Appendix A
Assumptions/Calculations Used Within The BCAs

No Mulch Application	Vines - Average 1st Harvest	Vines - Average 2nd Harvest	Vines - Average 3rd Harvest
Benefits			
Yield (kg/vine)	7.90	11.23	8.97
Standard error	0.83	1.13	0.97
Yield (kg/vine) (+SE)	8.73	12.37	9.93
Yield (kg/vine) (-SE)	7.07	10.10	8.00
Yield/ha	13.04	18.54	14.80
Yield/ha (+SE)	14.41	20.41	16.39
Yield/ha (-SE)	11.66	16.67	13.20
Price received $	1504.00	1504.00	1504.00
Revenue $	19604.64	27876.64	22251.68
			15.455
Av. Revenue over the Harvests $			23244.32
Revenue $ (+SE)	21,702	30,713	24,633
Av. Revenue over the Harvests $			25,773
Revenue $ (-SE)	17,559	25,087	19,836
Av. Revenue over the Harvests $			20900.9
Water cost savings $	0.00	0.00	0.00
Total Benefits	19,605	27,877	22,252
Av. Total Benefits over the Harvests $			23244.32
Total Benefits (+SE)	21,702	30,713	24,633
Av. Total Benefits over the Harvests $			25,773
Total Benefits (-SE)	17,559	25,087	19,836
Av. Total Benefits over the Harvests $			20,901
Costs			
Cubic metres of compost/ha	0	0	0
Cost per cubic metre $	24.5		
Cost of compost annually/ha $	0.00	0.00	0.00
Labour: casual & permanent $	220	220	220
Irrigation	334	334	334
Herbicide costs for weeds $	110	110	110
Herbicide costs for pests $	328	328	328
Fertilisers $	306	306	306
Pruning $	250	250	250
Harvesting costs $	682	682	682
Plants and soil preparation $	0	0	0
Machinery operating costs $	390	390	390
Other Costs (seeds & seedlings, Freight costs, and Other costs) $	257	257	257
Total Costs	2,877	2,877	2,877

Applying Compost Mulch **10 mm Application Scenario**	**Vines - Average** **1st harvest**	**Vines - Average** **2nd Harvest**	**Vines - Average** **3rd Harvest**
Benefits			
Yield (kg/vine)	8.51	11.52	11.26
Standard error	0.83	1.13	1.00
Yield (kg/vine) (+SE)	9.3	12.7	12.3
Yield (kg/vine) (-SE)	7.7	10.4	10.3
Yield/ha	14.05	19.01	18.58
Yield/ha (+SE)	15.42	20.88	20.23
Yield/ha (-SE)	12.67	17.14	16.93
Price received $	1,504.00	1504.00	1,504.00
Revenue $	21,127	28,588	27,887
Av. Revenue over the Harvests $			25,869
Revenue $ (+SE)	23,195.	31,401	30,364
Av. Revenue over the Harvests $			28,321
Revenue $ (-SE)	19,059	25,776	25,410
Av. Revenue over the Harvests $			23,416
Water cost savings $	0.00	0.00	0.00
Total Benefits	21,127	28,588	27,887
Av. Total Benefits over the Harvests $			25,869
Total Benefits (+SE)	23,195	31,401	30,364
Av. Total Benefits over the Harvests $			28,321
Total Benefits (-SE)	19,059	25,776	25,410
Av. Total Benefits over the Harvests $			23,416
Costs			
Cubic metres of compost/ha	33		
Cost per cubic metre $	24.50		
Cost of compost annually/ha $	808.50		
Labour: casual & permanent $	220	220	220
Irrigation	334	334	334
Herbicide costs for weeds $	110	110	110
Herbicide costs for pests $	328	328	328
Fertilisers $	306	306	306
Pruning $	250	250	250
Harvesting costs $	682	682	682
Machinery operating costs $	390	390	390
Other Costs (seeds & seedlings, Freight costs, and Other costs) $	257	257	257
Total Costs	3,686	2,877	2,877

Applying Compost Mulch	**Vines - Average**	**Vines - Average**	**Vines - Average**
50 mm Mulch Application	**1st harvest**	**2nd Harvest**	**3rd Harvest**
Benefits			
Yield (kg/vine)	8.20	12.80	10.03
Standard error	0.83	1.13	0.97
Yield (kg/vine) (+SE)	9.0	13.9	11.0
Yield (kg/vine) (-SE)	7.4	11.7	9.1
Yield/ha	13.53	21.12	16.555
Yield/ha (+SE)	14.91	22.99	18.15
Yield/ha (-SE)	12.16	19.25	14.96
Price received $	1504.00	1504.00	1504.00
Revenue $	20,349	31,765	24,899
Av. Revenue over the Harvests $			25,671
Revenue $ (+SE)	22,417	34,577	27,298
Av. Revenue over the Harvests $			28,097
Revenue $ (-SE)	18,281	28,952	22,500
Av. Revenue over the Harvests $			23,244
Water cost savings $	0.00	0.00	0.00
Total Benefits	20,349	31,764	24,899
Av. Total Benefits over the Harvests $			25,671
Total Benefits (+SE)	22,417	34,577	27,298
Av. Total Benefits over the Harvests $			28,097
Total Benefits (-SE)	18,281	28,952	22,500
Av. Total Benefits over the Harvests $			23,244
Costs			
Cubic metres of compost/ha	165	0	0
Cost per cubic metre $	24.5		
Cost of compost annually/ha $	4042.50		
Labour: casual & permanent $	220	220	220
Irrigation	334	334	334
Herbicide costs for weeds $	110	110	110
Herbicide costs for pests $	328	328	328
Fertilisers $	306	306	306
Pruning $	250	250	250
Harvesting costs $	682	682	682
Machinery operating costs $	390	390	390
Other Costs (seeds & seedlings, Freight costs, and Other costs) $	257	257	257
Total Costs	**6,920**	**2,877**	**2,877**

Applying Compost Mulch 150 mm Mulch Application	Vines - Average 1st harvest	Vines - Average 2nd Harvest	Vines - Average 3rd Harvest
Benefits			
Yield (kg/vine)	8.00	11.90	11.80
Standard error	0.83	1.10	0.97
Yield (kg/vine) (+SE)	8.8	13.0	12.8
Yield (kg/vine) (-SE)	7.2	10.8	10.8
Yield/ha	13.20	19.64	19.47
Yield/ha (+SE)	14.58	21.45	21.07
Yield/ha (-SE)	11.83	17.82	17.88
Price received $	1504.00	1504.00	1501.00
Revenue $	19,853	29,531	29,225
Av. Revenue over the Harvests $			26,205
Revenue $ (+SE)	21,921	32,261	31,619
Av. Revenue over the Harvests $			28,602
Revenue $ (-SE)	17,785	26,801	26,830
Av. Revenue over the Harvests $			23,808
Water cost savings $	0.00	0.00	0.00
Total Benefits	19,853	29,531	29,224
Av. Total Benefits over the Harvests $			26,205
Total Benefits (+SE)	21,921	32,261	31,619
Av. Total Benefits over the Harvests $			28,602
Total Benefits (-SE)	17,785	26,801	26,830
Av. Total Benefits over the Harvests $			23,808
Costs			
Cubic metres of compost/ha	495		
Cost per cubic metre $	24.5		
Cost of compost annually $	12127.50		
Labour: casual & permanent $	220	220	220
Irrigation $	334	334	334
Water costs $	334	334	334
Herbicide costs for weeds $	110	110	110
Herbicide costs for pests $	328	328	328
Fertilisers $	306	306	306
Pruning $	250	250	250
Harvesting costs $	682	682	682
Machinery operating costs $	390	390	390
Other Costs (seeds & seedlings, Freight costs, and Other costs) $	257	257	257
Total Costs	**15,005**	**2,877**	**2,877**

Benefit Cost Analysis for Vines for All Regions and Grape Varieties

Benefit cost analysis of Organic Mulch in Wine Industry	**All Regions**						
Discount rate	7%						
Mean of yields	**Cabernet Sauvignon and Shiraz Grapes**						
Year	***1999***	***2000***	***2001***	***2002***	***2003***	**Sum**	
Discount factor	1.000	0.935	0.873	0.816	0.763		
Base Case Benefits	19,605	27,877	22,252	23,244	23,244	**116,222**	
Organic Mulch Benefits 10 mm	21,127	28,588	27,887			**77,602**	
Organic Mulch Benefits 50 mm	20,349	31,764	24,899	25,671	25,671	**128,354**	
Organic Mulch Benefits 150 mm	19,853	29,531	29,224	26,205	26,205	**131,018**	
Difference - 10 mm	1,522	711	5,635				
Difference - 50 mm	744	3,888	2,647	2,426	2,426		
Difference - 150 mm	248	1,654	6,973	2,960	2,960		
Non-use benefits ?							
Total benefits - 10 mm	1,522	711	5,635			**7,869**	
Total benefits - 50 mm	744	3,888	2,647	2,426	2,426	**12,132**	
Total benefits - 150 mm	248	1,654	6,973	2,960	2,960	**14,796**	
PV total benefits - 10 mm	1,522	665	4,922			**7,109**	
PV total benefits - 50 mm	744	3,633	2,312	1,981	1,851	**10,522**	
PV total benefits - 150 mm	248	1,546	6,090	2,417	2,259	**12,560**	
Base Case Costs	2,877	2,877	2,877	2,877	2,877	**14,385**	
Organic Mulch Costs - 10 mm (reapplication every 3 years)	3,686	2,877	2,877			**9,440**	
Organic Mulch Costs - 50 mm	6,920	2,877	2,877	2,877	2,877	**18,428**	
Organic Mulch Costs - 150 mm	15,005	2,877	2,877	2,877	2,877	**26,513**	
Total costs - 10 mm	809	-	-			**809**	
Total costs - 50 mm	4,043	-	-	-	-	**4,043**	
Total costs - 150 mm	12,128	-	-	-	-	**12,128**	
PV Total costs - 10 mm	**809**	**-**	**-**	**-**	**-**	**809**	
PV Total costs - 50 mm	4,043	-	-	-	-	**4,043**	
PV Total costs - 150 mm	12,128	-	-	-	-	**12,128**	
						8.79	**10 mm BCR**
						2.60	**50 mm BCR**
						1.04	**150 mm BCR**

Appendix B
Water In South Australia

B.1 An Overview of Water Issues in Australia

Agriculture is the largest sectoral water user in Australia. Agriculture consumes more than 70 per cent of the country's stored water (including groundwater). As a proportion of land area, irrigation appears insignificant. Australia's 2.5 million hectares of irrigated crops and pastures are less than one half of 1 per cent of the total agricultural land and about 12 per cent of the total area of crops and pastures. In terms of value of production, however, irrigation is hugely important. The value of irrigated production fluctuates between 25 and 30 per cent of Australia's gross value of agricultural output (Cape, 1997; 1998).

Almost all fruits and vegetables are produced with some form of irrigation. Irrigation supports all rice production, and most dairy and cotton as well as significant amounts of soybeans and sugar. Its contribution to meat, cereal, pulse and oilseed production is relatively minor (DPIE, 1996).

Irrigated crops vary greatly in areas irrigated, water used, and production values. In the Southern Murray–Darling Basin, citrus, grapes and other horticulture account for 16 per cent of total water use and more than 50 per cent of total gross margin. Rice accounts for 25 per cent of total water use, but only 8 per cent of total gross margin (Hall et al. 1994).

Water costs make up a very small proportion of production costs. For vegetables, water accounts for only one per cent of average cash costs; for fruits, it represents about four per cent (IC, 1993). A long standing controversial aspect of irrigation in Australia is the low value crops that are grown. Irrigation land use is dominated by pastures and other low value crops. For example, rice and pasture return only $0.09 per kilolitre of water used while fruits, vegetables and wine grapes return from $1.00 to $5.00 per kilolitre of water used.

Many crops grown are of low value in relation to their water requirements — although major export earners (Meyer 1992). A common conclusion of agricultural water use studies over the years has been that the price of water has not been a critical factor in the choice of crop (Smith, 1998) nor the choice of irrigation technology.

Table B.1 illustrates the percentage of production attributable to irrigation in four states and in Australia as a whole. Within South Australia, the main crops requiring irrigation include vegetables, fruit, grapes, pastures and milk respectively.

Table B.1
Percentage Of Production Attributable To Irrigation - 1990

Crop	Queensland	NSW	Victoria	SA	Australia
Rice	100	100	0	0	100
Apples	97	97	97	97	97
Citrus	95	95	95	95	95
Pears	95	95	95	95	95
Apricots	100	90	100	95	92.9
Vegetables	96	81	83	96	91
Grapes	99.2	85.9	94.5	81.3	88.5
Peaches	87	87	87	87	87
Cotton	80	80	0	0	80
Maize	6	89	0	0	70.1
Oilseeds	50	65.5	95	7	65.8
Milk	33	47	47	51	44
Pastures	0.8	50.3	5.6	54.5	19.8
Sheep	1	20	5	1	6.6
Wool	1	7	2	0.5	3.2
Cereals	5.2	6.9	0.2	0	2.1
Wheat	0	5	0	0	1.2
Barley	1.5	6.2	0	0	1.2
Cattle	0.5	0.5	0.3	0.3	0.4

Source: Australian Irrigation Council, Melbourne

B.2 Water Sources and Use in South Australia

South Australia has 3,300 million KL of available water. Table B.2 illustrates that just less than half of the State's water supplies is subterranean. South Australia is dependent upon groundwater for much of its irrigated agriculture, and a high proportion of irrigation occurs outside of the Riverland (Thomson, 1997). These groundwater resources are most often aquifers.

With limited possibilities for expanding supplies, the continued expansion of irrigated agriculture in South Australia is dependent on sustainable demand management practices. Table B.3 presents an overview of the State's water use, indicating that irrigation accounts for 71 per cent of total water use.

Table B.2
Water Source In South Australia

Source	Gigalitres
Groundwater	1,400
Re-claimed	50
Murray	1,050
Streams & Dams	800
Total	**3,300**

Source: Thomson (1997)

Table B.3
Water Use In South Australia

Use	Gigalitres
Irrigation	1,000
Domestic	250
Industry	100
Rural	50
Total	**1,400**

Source: Thomson (1997)

Irrigated agriculture plays an important economic role in South Australia's economy. With a total farmgate value in the mid 1990s of $530 million, irrigated agriculture represents 25 per cent of total agricultural production in the State.

Much of this irrigation is for low value production. In South Australia, some 20 per cent of the irrigators, use around 70 per cent of the water on 50 per cent of the land to produce less than 10 per cent of value of irrigated agriculture (Thomson, 1997).

The main regions of irrigated agriculture in South Australia and their values are shown in Table B.4.

Table B.4
Irrigated Agriculture In South Australia

Region	$Million	Hectares
Barossa	**17.9**	**4,430**
Riverland	225.6	25,028
Lower Murray	32.9	11,219
North Adelaide Plains	**41.0**	**2,951**
Central Mt Lofty Ranges	61.1	5,345
Southern Vales	23.3	3,234
Upper South East	41.4	24,614
South East Coast	11.8	9,984
Lower South East	42.9	10,885
Total SA	**497.9**	**97,690**

Source: Thomson (1997)

Table B.5 indicates irrigation water requirements of various crops. Pastures are the crops requiring the largest amount of water, followed by almonds and flowers. Herbs require the least amount of water.

Table B.6 details the value of irrigated produce for South Australia and Australia as a whole our ten main crops. Grapes have the highest irrigation value, followed by vegetables, milk and other fruit.

Table B.5
Irrigation Water Required For Various Crops

Crop	Indicative irrigation water requirements Kilolitres per hectare per year (per crop if more than one crop is possible in a year)
Lucerne	8,000-10,000
Almonds	5,500-7,500
Olives	5,000-6,500
Onions	5,000-6,000
Vines*	5,000-6,000
Flowers	4,000-8,000
Potatoes	4,000-7,000
Cereal Crops	4,500-6,000
Lettuce	4,000-6,000
Carrots, parsnips and turnips	4,000-5,000
Cauliflower, cabbage or broccoli	4,000-5,000
Celery	3,000-5,000
Capsicums	3,000-5,000
Herbs (including parsley)	1,000-2,000
Tomatoes	200-280 per 150m2 glasshouse
Cucumbers	120-170 per 150m2 glasshouse

Note: * In the Barossa, supplementary irrigation of vines is based on an irrigation application rate of 1,000 kL/Ha.
Source: Water Reticulation Systems Virginia

Table B.6
Value Of Irrigated Produce In SA 1995-96

Commodity	South Australia $ millions	Australia $ millions
Cereals	n.a.	60.5
Cane	n.a.	1,319.6
Cotton	n.a.	964.5
Rice	n.a.	213.2
Pastures & Grasses	27.5	119
Apples	28.8	281.2
Other Fruit	134.9	892.6
Milk	170.2	2,965.3
Vegetables	219.2	1,461.7
Grapes	331.8	675.1
Total	**912.4**	**8,952 .7**

Source: ABS Rural Survey

B.3 Water Resources and Use in the Northern Adelaide Plains

The Northern Adelaide Plains (NAP) region has been included in this report because of the importance of the sector in vegetable producing. Water resources in the area have always been limited and controversial, hence any potential saving in water and its costs would be considerably welcome.

Most water in the NAP is obtained using groundwater from two aquifers within the region. All users are required to have a license. Before the implementation of the *Water Resources Act 1997*, water users were not charged.[27]

In 1998, the local licensed water allocation was 26,500 ML per annum, with an average use of only 17,000 ML because of the limited supply available (NABCWMB 1998). Estimates in 1995 placed the sustainable yield of water in the NAP at about 6,000 ML per annum (SACES 1995). It is currently estimated that the current annual allocation is more than 3 times the amount which is annually recharged into the aquifers.

Within the NAP, use of groundwater over the years has resulted in an increase in salinity of about 5 mg/L per annum (SACES 1995). A 1996 study identified a number of other issues related to water availability and management issues in the Barossa and NAP (Patrick 1996). These include:

- water availability is a barrier to economic development;
- the groundwater system is operating under severe stress, the sustainable rate of use has been exceeded for many years;
- water quality has deteriorated;
- water pressure in the confined aquifer has dropped;
- treated effluent is a relatively undeveloped and untried resource;
- allocations are three times the sustainable limit; and
- some areas remain prone to flooding.

The data in Table B.4 (from the mid 1990s) suggest that the NAP and Barossa regions together account for 12 per cent of the value of South Australia's irrigated production (SA's total production was approximately $498 million) and 7.5 per cent of the irrigated area (where SA's total irrigated area was 97,690 hectares, and NAP's and Barossa's total irrigated area was 7,381 hectares).

B.4 Expenses Incurred by South Australian Fruit and Vegetable Producers

Table B.7 illustrates the cost and share of expenses for fruit and vegetable agricultural industries in South Australia. The average cost share of irrigation (between 1994-95 to 1996-97) for fruit and vegetable producers is considerably higher (10 and 3 percent respectively) than the overall average for all agricultural industries (which was 2 percent).

The five highest costs incurred by vegetable producers in 1996/97 was for crop and pasture chemicals (22 per cent); fertiliser and soil conditioners (20 per cent); seed, seedlings and plants (19 per cent); marketing expenses (11 per cent); and fuel and lubricants (7 per cent). In comparison, water rates and drainage charges in 1996-97

[27] Pumping coats have been estimated at 6-7 cents per kilolitre and water used beyond the quota is charged at mains-water rates. Average annual fees to renew water licenses and monitor water meters was approximately $192 (Government Gazette 1997). It is hoped that all will be replaced by December 1999, so the meter rent will not apply beyond 1999.

represented 4 per cent of total expenses for vegetables.

Table B.7
South Australian Costs For Fruit And Vegetable Agricultural Industries

Item *Industry*	**1994-95** ***($'000)***	**1995-96** ***($'000)***	**1996-97** ***($'000)***	**1994-95** %	**1995-96** %	**1996-97** %
Payments for Crop and Pasture chemicals						
Fruit	10,358	9,718	13,453	12.0	10.4	11.2
Vegetable	9,973	8,375	12,582	12.2	13.6	22.4
Payments for fertiliser and soil conditioners						
Fruit	5,349	8,034	12,964	6.2	8.6	10.8
Vegetable	11,975	12,316	10,939	14.7	20.0	19.5
Payments for seed, seedlings and plants						
Fruit	4,813	4,546	9,994	5.6	4.9	8.3
Vegetable	11,782	8,492	10,588	14.4	13.8	18.9
Other crop and pasture expenses						
Fruit	4,180	1,341	2,537	4.8	1.4	2.1
Vegetable	607	776	2,004	0.7	1.3	3.6
Contract payments for work on crops and pastures						
Fruit	11,730	20,542	22,350	13.6	21.9	18.6
Vegetable	6,534	1,365	2,773	8.0	2.2	4.9
Rates paid to Vermin and weed authorities						
Fruit	27	59	140	0.0	0.1	0.1
Vegetable	0	2	1	0.0	0.0	0.0
Water rates and drainage charges						
Fruit	6,540	10,894	14,760	7.6	11.6	12.3
Vegetable	1,827	1,069	2,317	2.2	1.7	4.1
Land tax & land rates						
Fruit	2,831	4,944	5,185	3.3	5.3	4.3
Vegetable	1,699	1,193	1,449	2.1	1.9	2.6
Other rates taxes & licences						
Fruit	824	1,440	1,748	1.0	1.5	1.5
Vegetable	265	383	346	0.3	0.6	0.6
Electricity & gas charges						
Fruit	5,611	6,232	8,380	6.5	6.7	7.0
Vegetable	3,425	3,664	3,059	4.2	6.0	5.5
Payment fuels & lubricants						
Fruit	9,117	6,700	9,267	10.5	7.2	7.7
Vegetable	7,999	7,755	3,638	9.8	12.6	6.5
Marketing expenses						
Fruit	25,102	19,224	19,274	29.0	20.5	16.1
Vegetable	25,465	16,058	6,372	31.2	26.1	11.4
Total Expenses						
Fruit	86,482	93,674	120,052	100.0	100.0	100.0
Vegetable	81,551	61,448	56,068	100.0	100.0	100.0

Source: ABS, Selected Financial Statistics, South Australia