1-1-1995

Making horticulture sustainable

Bob Paulin
Neil Clifton Lantzke
Ian McPharlin
Murray Hegney

Follow this and additional works at: http://researchlibrary.agric.wa.gov.au/journal_agriculture4

Part of the Environmental Monitoring Commons, Horticulture Commons, Soil Science Commons, and the Sustainability Commons

Recommended Citation

Available at: http://researchlibrary.agric.wa.gov.au/journal_agriculture4/vol36/iss2/2

This article is brought to you for free and open access by Research Library. It has been accepted for inclusion in Journal of the Department of Agriculture, Western Australia, Series 4 by an authorized administrator of Research Library. For more information, please contact jennifer.heathcote@agric.wa.gov.au, sandra.papenfus@agric.wa.gov.au.
IMPORTANT DISCLAIMER

This document has been obtained from DAFWA's research library website (researchlibrary.agric.wa.gov.au) which hosts DAFWA's archival research publications. Although reasonable care was taken to make the information in the document accurate at the time it was first published, DAFWA does not make any representations or warranties about its accuracy, reliability, currency, completeness or suitability for any particular purpose. It may be out of date, inaccurate or misleading or conflict with current laws, polices or practices. DAFWA has not reviewed or revised the information before making the document available from its research library website. Before using the information, you should carefully evaluate its accuracy, currency, completeness and relevance for your purposes. We recommend you also search for more recent information on DAFWA's research library website, DAFWA's main website (https://www.agric.wa.gov.au) and other appropriate websites and sources.

Information in, or referred to in, documents on DAFWA's research library website is not tailored to the circumstances of individual farms, people or businesses, and does not constitute legal, business, scientific, agricultural or farm management advice. We recommend before making any significant decisions, you obtain advice from appropriate professionals who have taken into account your individual circumstances and objectives.

The Chief Executive Officer of the Department of Agriculture and Food and the State of Western Australia and their employees and agents (collectively and individually referred to below as DAFWA) accept no liability whatsoever, by reason of negligence or otherwise, arising from any use or release of information in, or referred to in, this document, or any error, inaccuracy or omission in the information.
Contents

39 Making horticulture sustainable

46 Biotechnology – exposing the myths & realities

50 Sharing information benefits the meat industry

54 New Chief Executive Officer to take agriculture into the future

56 Breeding sheep for worm resistance

60 Benchmarks for the rangelands – mapping and assessing country types in the outback

66 Coming to grips with Eradu-patch of lupins
Making horticulture sustainable

Sweet crunchy carrots, luscious strawberries at very reasonable prices, crisp green vegetables – these are just a few of the horticultural products that Western Australians take for granted and eat almost every day. But is their future availability guaranteed as population grows, suburbia spreads and environmental concern increases?

The growth potential of horticulture in Western Australia and its ability to increase its share of the State’s agricultural earnings is widely recognised. The range of climatic conditions allows many annual crops, including vegetables, to be grown all year round and extends the production season for perennial crops, such as fruit, which expands marketing opportunities. Consequently, export growth is expected to double production within the next 15 to 25 years.

The growth potential is underscored by outstanding growth in vegetable exports, in particular carrots, cauliflowers and Chinese cabbage, and significant export opportunities for Pink Lady apples. Continued rapid growth in exports of wine and native cutflowers, and more recent developments with Redglobe table grapes and mangoes are also exciting.

In 1993-94, the value of Western Australian horticultural production was about $302 million. This represents about 15 per cent of the State’s total crop production value. Export earnings from this production was $105 million.

Nearly all of Australia’s exports of carrots, cauliflowers and Chinese cabbage come from Western Australia. This State also exports most of the wildflowers and more than half of the celery, lettuce, potatoes and strawberries.

However, these opportunities for horticultural growth in Western Australia are likely to be restricted within 10 to 15 years by a number of threats, the most important being limitations to the availability of land combined with water and suitable climate (see Table 1). Initially, these restrictions will be most likely to occur on the Swan Coastal Plain because of mounting competition for land and water resources in this region. Due to its climatic range, labour supply and the proximity to essential services
and facilities such as transport, storage, ports and airports, the Swan Coastal Plain is critical to the continued growth of horticulture in Western Australia.

Long-term security over the more productive horticultural land and water resources is therefore essential. To achieve this security, horticulture will need production methods that have minimal impact on the environment. The Department of Agriculture's programs are strongly focused on sustainable production, and these endeavours are supported by national research and development funding bodies, government agencies and private organisations. Whilst much of this work is currently focused on the Swan Coastal Plain, the outcomes will have statewide significance for Western Australian horticultural development.

Environmental issues were brought into focus in the late 1970s when algal blooms in the Peel-Harvey Estuary began to create strong public concerns. These blooms were primarily associated with increased phosphate levels in the estuary. While agriculture was the primary focus of the problem, horticulture was also implicated because of its relatively high phosphate use.

Concerns associated with horticulture have continued to grow. Increased nutrients, mainly phosphorus and nitrogen in coastal estuaries, wetlands and aquifers, have been the major issue.

**Recent initiatives**

The Department of Agriculture recognises that to maximise the development potential of horticulture, resources must be allocated and managed sustainably.

This supports the findings of a Select Committee report into the right to farm which has resulted in the recent government initiative to develop and implement a productive agricultural resource protection policy. This policy provides the framework for developing resource security for horticulture by clearly recognising that productive agricultural land and water resources are of strategic importance to Western Australia.

Following a recent study of issues facing horticulturalists on the Swan Coastal Plain, most State horticultural industry associations nominated representatives to a Horticultural Industry Sustainable Development (HISD) Working Party. This Working Party contributed to the recommendations contained in the final report on this study, *Horticulture on the Swan Coastal Plain – a study of grower concerns*.

The HISD Working Party will increase industry involvement in the Department of Agriculture's sustainable horticulture program. This includes a project funded by the National Landcare Program that aims to develop improved management practices in cooperation with the horticultural industry on the Swan Coastal Plain, and to monitor the impact of horticultural industries on the environment. The major components of this program are to:

- monitor phosphate and nitrogen management practices;
- improve management;
- develop codes of practice;
- address resource security;
- improve development approval processes.

**Monitoring phosphorus and nitrogen management practices**

High phosphorus concentrations in estuaries, rivers, lakes and wetlands cause algal blooms which have the potential to choke waterways, cause foul odours, and poison fish and other wildlife.

In most soils phosphorus fertiliser is held tightly or 'fixed' to iron and aluminium oxides, thus preventing leaching. Among the soils of the Swan Coastal Plain, there is no immediate risk of phosphorus
Phosphorus leached from fertilisers into surface water bodies may cause algal problems when concentrations exceed 0.1 parts per million (ppm). Nitrate-nitrogen concentrations above 10 ppm in drinking water can cause health problems in infants.

Leaching into the watertable on the reddish brown Spearwood sands or yellow Karrakatta sands. However, continued application above crop requirements, will eventually saturate this fixing capacity and phosphate will move down the soil profile. Ultimately, it will reach the watertable with the time taken depending on the application rate, soil type and depth to the watertable.

On the Bassendean sands, that contain very low levels of iron and aluminium oxides, phosphorus may be leached past the root zone and into the groundwater more quickly.

On heavier soils, phosphorus bound to soil particles may be carried from the property by run-off and enter waterways. This does not occur on sandy soil where there is no run-off.
The Department is working to establish the phosphorus pollution risk for different types of horticulture on a range of soil types with various depths to the watertable. In 1992 and 1993, the amount of phosphorus in drains leaving three properties on the Bassendean sands were measured (Table 2). The losses were far lower than those predicted by previous hypothetical studies. For example, the phosphorus loss rates for two sites were only slightly higher than those measured in many similar-sized catchments containing sheep and cattle grazing properties.

Another site represented the worst case scenario with a market garden on white sand which had a depth of less than 2 m to the watertable. The measured loss rate of 27 kg of phosphorus per hectare per year is not sustainable. It is important that horticultural expansion does not occur on similar properties, unless soil amendment or management practices can greatly reduce phosphorus loss.

The principal environmental concern from nitrogen is the contamination of drinking water and promotion of algal growth in salt water environments. In saline estuaries and shallow coastal waters, algal growth may be limited by nitrate rather than phosphate. Algae is implicated in killing sea grass because it excludes light.

Nitrates leach rapidly from all soils, and particularly from sandy soils because of their limited moisture and nutrient-holding capacity. High nitrate levels, often in excess of the World Health Organisation (WHO) limit of 10 ppm of nitrate-nitrogen, are commonly found in groundwater beneath horticultural properties on the Swan Coastal Plain.

Drinking water with nitrate levels exceeding this limit can cause methaemoglobinaemia, a brain disorder, which is especially serious in infants and may lead to death. It is therefore important that people who drink groundwater from private bores have the water analysed for nitrate-nitrogen.

In 1991, the Department of Agriculture conducted a survey of the nitrate-nitrogen concentrations in market gardeners' bores. Nitrate-nitrogen ranged from 0.02 to 88 ppm and on half the properties, levels exceeded the WHO limit. Soil type appeared to have no effect, however, levels were generally greater where the watertable was shallower and when gardens had been farmed longer.

### Table 2. Phosphorus loads leaving three horticultural catchments

<table>
<thead>
<tr>
<th>Site</th>
<th>Type of horticulture</th>
<th>Area of horticulture (ha)</th>
<th>Soil type</th>
<th>Phosphorus load (kg of P/ha/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Market gardens</td>
<td>140</td>
<td>Mixture of white and yellow sand and peaty soils</td>
<td>6 2.3</td>
</tr>
<tr>
<td>B</td>
<td>Orchard and vineyard</td>
<td>120</td>
<td>White sand with 2-5 m to watertable</td>
<td>3 1.6</td>
</tr>
<tr>
<td>C</td>
<td>Market garden</td>
<td>50</td>
<td>White sand with &lt;2 m to watertable</td>
<td>- 27</td>
</tr>
</tbody>
</table>

Initially the program focused on reducing phosphorus leaching into the Peel-Harvey Estuary, but more recently it has been expanded to include nitrogen, as well as phosphorus, over the entire Swan Coastal Plain. The program has several components including fertiliser and irrigation courses, soil testing on growers properties, demonstrating techniques to reduce nutrient leaching, evaluation of soil moisture sensors, evaluating the efficiency of commercial irrigation systems and surveys of fertiliser use.

The program is working to incorporate research findings that will reduce nutrient leaching into management practices on horticultural properties. This also involves the introduction of new technologies and methods that will refine fertiliser and irrigation management.

In developing better management practices, it is critical that there is recognition of the strong inter-relationship between fertiliser and irrigation. This was overlooked in the past, largely because we were not able to adequately study crop water use in the coarse sands.

Research programs now focus on nitrogen, phosphorus and irrigation management of horticultural crops. This work aims to reduce the nitrogen and phosphorus leaching into water systems, while maintaining economic production. Work so far has concentrated on vegetables, in particular cabbage, carrots, cauliflower, lettuce, onions and potatoes.
The Swan Coastal Plain is critical to the continued growth of Western Australia’s export carrot industry.

The early finding that the sandy soils differed in their ability to retain phosphorus, helped focus our thinking. It was thought that soil testing could be used as part of phosphorus management on the more phosphate retentive Spearwood and yellow Karrakatta sands.

Experiments created different levels of residual or ‘superbank’ phosphorus in the soil. Residual phosphorus as measured by soil test was then calibrated with crop yield (Figure 1). Finally the amount of applied phosphorus needed for maximum yield of the current crop at each soil test level was determined.

At high phosphorus soil test levels (i.e. more than 60 ppm for carrots) growers could reduce the phosphorus applied to the current crop so that it just matched what is removed (for carrots about 26 kg phosphorus/ha). This represents a large reduction as growers commonly apply set levels at 50 to 250 kg phosphorus/ha irrespective of residual phosphate in the soil.

On high phosphorus-fixing soils, placement is usually a more efficient application method than broadcasting. However, when banding was compared with broadcasting on the coastal sands, the results varied. With lettuce, carrots and cauliflowers there was no benefit from banding while in one experiment with onions, banding was superior. By contrast, banding of phosphorus on potatoes was inferior to broadcasting. Work is continuing to further examine the advantages and disadvantages of phosphorus placement.

The poorer Bassendean and Grey Phase Karrakatta sands of the coastal plain are only capable of retaining small quantities of phosphorus and are therefore not suitable for soil testing in their natural state.

Red mud/gypsum, the residue left when alumina is extracted from bauxite and modified with gypsum, can improve phosphorus retention in these poor soils. Results so far have shown that at least 120–250 t/ha of red mud/gypsum is needed to significantly improve their phosphorus retention to allow soil testing to be used. However, at these application rates, some yield reductions were recorded on some crops and consequently, no general recommendation can be made at present for the use of red mud/gypsum on vegetables. However, work is continuing to further develop the use of red mud/gypsum as part of vegetable production on the Bassendean sands.

Because sandy soils of the Swan Coastal Plain have little or no ability to retain nitrogen, large and frequent applications are used to maintain profitable production.

Applications of fowl manure before planting are common and the nitrogen contained is released over a four-week period after which very little is left in the crop root zone. Heavy applications can supply about 500 kg nitrogen/ha which is considerably higher than needed to meet crop demands during early growth. A large proportion of this pre-plant nitrogen is therefore wasted which can result in groundwater contamination.

Preliminary research has shown that pre-plant applications of nitrogen are unnecessary for crops such as lettuce, cabbage and potato, provided post-planting applications begin immediately after transplanting or just before crop emergence. Also, significant improvements in crop nitrogen use efficiency (that is kilograms of marketable yield from each kilogram of nitrogen applied) have been achieved by splitting post-planting nitrogen into small amounts applied daily rather than applying larger amounts weekly or fortnightly.

![Figure 1. The relationship between phosphorus soil test and yield of carrots (per cent of maximum). Vertical line indicates soil test level required for maximum yield.](image-url)
Irrigation management has a significant impact on crop nitrogen requirements. In particular, over-irrigation leads to excessive leaching and more nitrogen being required to maximise yields. Therefore, it is essential that irrigation and nitrogen management are in step.

Research effort is now concentrated on defining the nitrogen and water requirements of crops at each growth stage. The ultimate aim is to develop systems which apply water and nitrogen together in small, frequent amounts, sufficient to meet current crop demands. In this way, the quantity of soil nitrogen at any given time is minimised, reducing the potential for large quantities of nitrogen to be leached by heavy rain. Nitrogen leaching by excessive irrigation is also eliminated.

This new approach to nitrogen and irrigation management requires automatic irrigation system controllers, injectors and soil moisture monitoring devices. Low output drip and mini-sprinklers may be more appropriate than the high output, impact sprinkler systems now in use. At present, this technology is not widely used. Research is also continuing to identify how best to use it for a range of crops in commercial practice.

Improving the ability of coastal sands to hold water and nutrients will clearly benefit irrigation/nutrition management. Increasing the soil’s organic matter, together with sub-surface barriers such as polythene sheet or asphalt to reduce leaching are possibilities.

The feasibility of composting poultry manure is being investigated and its increased cost is likely to be offset by improved crop growth, better soil disease control, and fewer flies, in addition to benefits from improved soil water and nutrient holding ability.

Developing codes of practice

A horticultural code of practice detailing environmentally acceptable practices has been prepared for the Peel Catchment. The recently formed HISD Working Party is seeking to encourage individual industries to develop their own codes of practice.

Codes of practice are statements of the best, commercially viable management practices that will inform new entrants on acceptable farming practices; inform existing growers of management practices that reduce environmental impacts; are written by industry and therefore demonstrate their commitment to sustainable resource management; and allow risks associated with industry development to be assessed so that appropriate, consistent planning standards can be developed and applied.

Codes of practice reflect current knowledge and practice, and will therefore need to be revised as new knowledge comes to hand.

The Department of Agriculture, together with other resource management agencies, principally the Department of Environmental Protection, and members of the HISD Working Party are developing guidelines for the preparation of codes of practice. These guidelines will ensure that industry codes address the required issues.

Resource security

The recent study of growers’ concerns on the Swan Coastal Plain indicated that the availability of land with suitable water and climate was the major concern. Despite acknowledging the potential capital gains that can result from subdivision of their land, many growers also identified the need to protect resources for horticulture. Current planning processes were also criticised and zoning changes which create conflict and ultimately force growers to move were of particular concern.

The Department of Agriculture actively promotes the need for planning agencies to consider horticulture as a long-term rather than short-term land user. To achieve long-term security, planning agencies need to develop policies that will protect productive horticultural land. This is likely to require the establishment of precincts or zones, that are based on land capability, water availability, climate and other regionally significant factors (infrastructure, employment, tourism). These initiatives are strongly supported by the recently announced government policy to identify and protect productive agricultural resources.
The process of urbanising high quality horticultural land continues.

**Improve development approval processes**

Planned horticultural developments frequently experience lengthy delays in obtaining approval. These delays are expensive and can seriously jeopardise a project's success.

Improvements have been made which involve centralising aspects of the approval process, however this needs to be formalised and developed further. To complete assessments within acceptable time, applicants will have to provide appropriate information on their proposed developments and the referral process, within and between the agencies, needs to be streamlined.

Industry codes of practice on which acceptable management practices can be assessed, and the development of horticultural zones, based on land capability/suitability information, will also speed up assessment procedures.

**Conclusions**

It is critically important that horticulture is no longer regarded as a short-term land user. Government policy initiatives to protect productive agricultural land will lead to the overdue recognition within the planning process of the finite nature and strategic importance of horticultural resources.

An example is the export carrot industry which is centred on the Swan Coastal Plain. Currently worth $16.8 million a year, this industry has been growing by 10 to 15 per cent a year since the early 1980s. This growth can continue, providing the industry has access to the sandy soils and climate of the Swan Coastal Plain which enables high, year round production of exceptionally clean, well-shaped carrots.

Monitoring has clearly demonstrated that horticulture's potential environmental impact from fertiliser use is not as serious as previously indicated. Research and efforts to increase the use of soil phosphorus testing to determine fertiliser requirements will continue. Because nitrate nitrogen moves readily in all soils, particularly sands, greater effort is needed to improve irrigation management and minimise leaching of nitrogen and other mobile nutrients.

The potential for compost and other techniques to increase the water and nutrient holding capacity of sands is being recognised. Technology that enables the complex interactions between plant growth, irrigation and fertiliser use to be studied more effectively, will lead to much improved management practices for horticulture.

Codes of practice will be important for establishing long-term resource security because they make a public statement of horticultural management against which sustainability can be assessed. They will play an important role in developing planning controls for horticultural development and as statements of current best management they will enable clearer identification of future management research needs.

**Further reading**


Authors, **Bob Paulin** and **Neil Lantzke**, are from the Land Management Branch and **Ian McPharlin** and **Murray Hegney** are from the Horticultural Industries Branch in South Perth and can be contacted on (09) 368 3215.