Requirements for survival in Australian horticulture

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Summary

Horticulture is a highly intensive form of agriculture and requires many inputs. Virtually all the horticultural crops grown in Australia have been introduced and, initially, they were grown as close as possible to population centres. As essential starting point for efficient horticulture is to grow the individual crops in environments to which they are specifically suited. As well, variety improvement by breeding is required to develop cultivars which give high yields, resistance to local diseases and produce of acceptable quality.

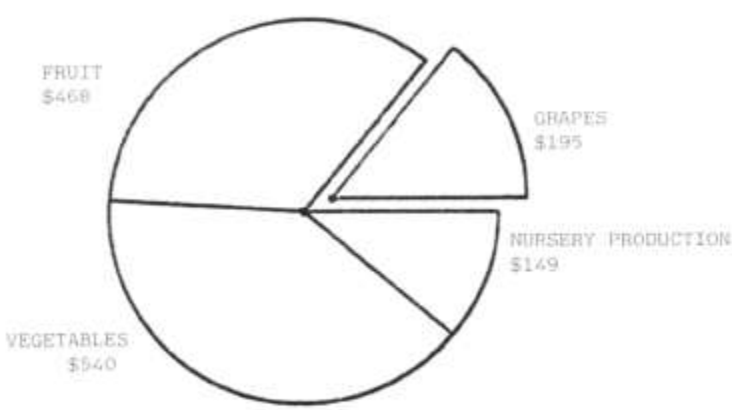
Australia, in contrast to the USA, the EEC and almost every other major horticultural nation, does not have access to a plentiful, cheap, agricultural labour force. Accordingly, the mechanisation of critical production steps such as harvesting, pruning, processing etc., is virtually essential, except for high-value specialist crops.

It seems clear that the production levels of a number of horticultural crops in Australia will need to be adjusted to meet the size of the local market. Some crops that are specially suited to growing in Australia and those for which we have developed labour-saving technologies may find limited export markets. Research findings which should contribute to the survival of crops such as citrus, peaches and grapevines will be discussed.

Introduction

Horticulture in Australia consists of many individual industries, ranging from commercial fruit and vegetable production to cut flowers and nursery sales. In total, the industry was valued in excess of $1300 million in 1980/81 (Figure 1). Horticulture is an intensive form of agriculture and is carried out on relatively small farms, mainly sited on fertile soils with access to irrigation. Relatively high inputs of labour, fertilizers, agricultural chemicals and a range of post-harvest treatments are required. In the case of fruit, many crops are produced on perennial plants and there can be a long lead time between planting the crop and producing saleable fruit.

Figure 1. Australian horticulture - gross value of production ($m) 1980-81



From: Aust. Bureau Stats. (1982) (1).

Historically, a number of the horticultural industries of Australia have developed close to markets and, in some instances, in environments unsuitable to the varieties grown. Examples of this are the mangoes grown in the wet coastal areas north and south of Brisbane, where high rainfall has caused severe anthracnose problems with the susceptible varieties which are grown; the West Indian limes south of Brisbane which were decimated by tristeza virus in the 1960's, and the oranges produced in metropolitan Sydney where yields were little more than half those of the MIA or Murray regions. Despite problems of low production, many 'hobby' and fringe city farms persist because of tax-free profits derived from the escalation of property values.

Owing to the relatively small population in Australia and the small rate of increase, there is little scope for large increases in Australian consumption for most horticultural crops. In the case of fruit, the domestic market has traditionally been supplied with pome fruits, citrus, stone fruits and grapes and, with time, these can expect to have increasing competition from tropical and so-called 'new' crops such as litchi, custard apples, mango, sapodilla, carambola, rambutan, mangosteen and durian. Many of these crops are now being grown in limited quantities and more people are becoming interested in new taste experiences.

The future of the export market depends on several factors, including the cost of production in relation to that of competing countries, relative exchange rates, transport costs, relative wage structures and the extent of government support.

Apart from political lobbying, factors open to modification by the horticulturist include increased productivity, lower labour costs and increased efficiency of irrigation and pest and disease control. Increased productivity may be achieved by such means as choice of cultivar, the use of high density plantings, the use of dwarfing rootstocks and crop-regulating sprays. Labour costs can be reduced by increasing the use of mechanical pruning and harvesting machinery, by a higher capital investment in more efficient irrigation and drainage, and by a greater use of biological control for insect pests. Some fungal, nematode and bacterial diseases can to a great extent be avoided by breeding resistant varieties.

There is increasing public awareness of quality aspects and greater sophistication of markets. High quality produce is more in demand and, to avoid waste, second-grade produce will need to be increasingly marketed as by-products. Examples of this are in the citrus and pineapple industries, where juice sales are as important as the sales of fresh fruit. However, because of our low population, our domestic market is too small to support major horticultural development schemes even though we have the climate and the land to produce a greater quantity and a wider range of fruit and nut crops than at present. This is particularly so in Northern Australia, where it is possible to produce species that are well known in South-east Asia. We are well placed to supply out-of-season produce to relatively close and very large markets.

Transport costs - both internal and for shipping - are an increasing strain on our ability to compete on overseas markets. Dried or concentrated products have a decided advantage in this respect because of their high value-to weight ratio. Dried fruits, nuts such as pistachio and macadamia, and citrus juice concentrate are good examples.

To succeed on export markets, Australian horticultural products will need to be of high quality, have a low cost of production and have a high value-to weight ratio.

The aim of this review is to discuss some of the recent research findings that should contribute to the survival of some of our fruit crops. Examples will be drawn from citrus, peaches and grapevines.

Citrus

The citrus industry in Australia was valued at $118.5 million in 1980-81. It is our third largest fruit industry next to grapes and pome fruit but, com pared with these crops, over 90% of the crop is sold on the domestic market (2). Productions in regions such as the MIA, Riverland and Sunraysia com pares favourably with average production in California and Florida (Table 1), whereas yields in coastal regions of NSW around Gosford are nearly half those of the main inland producing areas (Table 2). Average yields per tree for Brazil are about the same as those in the better areas of Australia. World production of citrus is increasing faster than demand and USA is currently the largest producer. However, Brazil, which is not expected to reach peak production until the late 1980's, will then become the leading producer. Table 3 lists the production, up to 1981, of major exporting countries. Australia's annual production is less than 5% of that of either the USA or Brazil. Accordingly, in high crop years these two countries can be faced with disposing of a surplus in excess of the total Australian production.

Per capita consumption of citrus in Australia is less than that in USA (Table 4), but it is increasing in Australia with an increase in juice consumption. In order to compete successfully, even on the domestic market, producers must lower their production costs.

Table 1. Mean yields of oranges in Australia and USA (tonnes/ha)

Region		Yield
Australia[1]		
Valencias	NSW	24.9
	Victoria	19.6
	South Australia	26.0
USA[2]		
California Valencias		24.1
Florida round oranges		25.7

[1]From Aust.BAE (1978) (3)
[2]From Rock, R.C. and Platt, R.G. (1977) (4)

Table 2. Effect of region on orange production (1976-77 and 1977-78) (tonnes/ha)

Region		Yield
NSW -	Lower and Mid Murray	23.1
	MIA	22.1
	Coastal	13.8

From NSW Division of Horticulture (1979) (5)

Table 3. Orange production of the major exporting countries (000 metric t)

	1969-70*	1979#	1980#	1981#
USA	7,734	8,502	10,985	9,434
Brazil	3,010	8,154	8,936	8,864
Spain	1,850	1,633	1,730	1,650
Israel	894	959	897	898
South Africa	547	579	565	569
Australia	266	399	403	385

*From Commonwealth Secretariat (1972) (6)
#From " " (1981) (7)

Table 4. Citrus consumption per head of population

USA	53 kg
Israel, Lebanon	> 45 kg
Australia[1], Greece, Cyprus, Argentina	35 to 40 kg
Western Europe, Canada	≈ 20 kg
Turkey, Morocco, South Africa	≤ 12 kg

From Wolf, J. (1975) (8)
[1]From Korallis, A.C. (1982) (2)

Increased production of citrus, particularly in the early years, can be achieved by high-density plantings and by the use of dwarf trees either by rootstocks or by infecting susceptible rootstocks with mild strains of the viroid disease exocortis (Table 5).

Table 5. Effect of high density planting and dwarf trees on orange yields (9 years from planting)

	Non-dwarf	Non-dwarf	Dwarf	Dwarf*
Spacing (m)	6.7 x 6.7	6.7 x 3.3	5.2 x 2.3	4.5 x 2.3
Trees per ha	223	452	836	966
Yield (tonnes/ha)	67	133	146	176

From Bevington, K.B. (1977) (9)
*Estimated value based on preliminary yield data from wider spacing.

Labour costs can be reduced by the increased use of mechanisation such as hedge rowing of the trees. This not only controls tree size but can help to overcome biennial bearing. Minimum tillage of orchards is commonly practised and recent advances by entomologists have led to the increased use of bio logical control measures to reduce the need for chemical sprays. The development of salt-tolerant citrus rootstocks is required for economic citrus growing in the Murray Valley.

Although methods for the mechanical harvesting of citrus are under investigation, it will probably be some time before the methods involving tree shakers or the removal of fruit by air blasting will be used commercially (10,11). Research on this topic in the USA is now limited because of the continued availability of Mexican labour.

Quality aspects are particularly important in the citrus industry. For example, there is now a world demand for loose-skinned cultivars of citrus. At the same time the use of orange juice is increasing, while that of whole oranges is decreasing. Over the past 3 years in Australia juice sales have increased from 50 to 60% of the total crop, and fresh fruit sales have correspondingly decreased from 50 to 40% (2). Juice has the added advantage of being suited to transport in frozen concentrated form without loss of quality.

It is relevant here to mention that grapefruit produced around Broome in WA lack the bitterness of those produced in southern Australia. With better and cheaper transport, the greater availability of refrigerated transport, and better technology for storage, e.g. shrink wrapping following a fungicidal wax, this area could supply fruit to southern markets. Northern Australia might also prove suitable for a citrus juice industry based on mid- season sweet oranges such as is used in Florida, because of the ready availability of salt-free water and suitable climate and soils.

<u>Peaches</u>

The Australian peach industry depends very largely on exports - less than 50% in 1980 but around 75% in 1970. In recent years exports to the UK have decreased from about 80 kt in the early 1970's to about 20 kt in 1977, owing to the phasing out of preferential tariffs when the UK joined the Common Market. Other factors affecting this reduction were changes in the exchange rate and inflation relative to South Africa and USA, our main competitors in Europe, and increases in freight and shipping costs.

Future prospects will be even more competitive because the Canadian government is considering removing tariff preference, Italy is to introduce production subsidies for domestic producers and California is providing an export subsidy scheme.

Mean yields of Victorian canning peaches of 15.1 tonnes/ha (12) compare unfavourably with the 33.6 tonnes/ha for standard peaches reported for California by Hansche and Beres (13). However, Smith and Challen (14) report, in a paper concerned with the effect of virus diseases on yield, that standard peaches in the Goulburn Valley can produce crops of 35.4 tonnes/ha, so high average yields are obtainable (Table 6).

Table 6. Effect of peach rosette and decline induced by prune dwarf and Prunus necrotic ringspot virus on yield of Golden Queen peaches (planting density 289 trees ha-l)

	Tonnes ha^{-1}
Uninfected	35.4
Trees with symptoms for 1st season	11.9
Trees with symptoms for 2nd season	5.8

From Smith, P.R. and Challen, D.H. (1977) (14)

Table 7. Effect of high density planting, dwarf trees and Tatura trellis on peach yields

		Planting density (trees ha^{-1})	Yield (tonnes ha^{-1}) Year 2	3	4
California[1]	Standard	270	1	7	13
	Dwarf	1,250	9	12	59
		2,500	17	36	69
		3,750	31	52	74
Victoria[2]	Tatura trellis	1,668	24	45	88
		2,222	28	47	86
		3,334	31	48	81

[1]From Hansche, P.E. and Beres, W. (1980) (13)
[2]From Chalmers et al. (1978) (15)

Recent research has shown that peach yields can be greatly increased by high density planting and by the use of dwarfing scions, as shown in Table 7. Dwarf trees have advantages with reduced pruning requirements, elimination of ladder operations and greater accessibility to disease control sprays, as well as higher yields and precocity. Tatura trellis systems are expensive to install and maintain, but have even higher cropping potential (up to 80 tonnes/ha). Both systems rely on a high plant density for early high yields per hectare.

Viticulture

Grapes are quantitatively the leading fruit crop in Australia, production being split about 0.57:1 between drying grapes and grapes for wine. Relatively few table grapes are grown in Australia because the local demand for this crop is low, possibly because, in general, the quality is low. Currently, attempts are being made to develop nearby markets in places such as Hong Kong, Singapore, Kuala Lumpur, Indonesia, Fiji and, eventually, Japan. We have the advantage with this crop of having a different season from Northern Hemisphere exporters such as the USA.

About 75 percent of Australia's wine grapes and almost all our dried raisins are grown under irrigation in warm areas along the Murrumbidgee, Murray and Swan Valleys. The areas we use for raisin production are not as reliably hot as the central valley of California, but are satisfactory provided drying emulsions are used to accelerate desiccation. Australian grapevines are relatively free of damaging diseases and pests, as attacks by severe fungus diseases such as Downy Mildew (Plasmapara viticola) and by the grape louse (Phylloxera vasotrix) are rare. Also the range is not as widespread and the severity of infection from virus and virus-like graft-transmissible diseases not as damaging as in most other grape-growing countries, mainly because rootstocks which commonly carry these diseases have not been used extensively in Australia.

Despite these advantages, the profitability of export dried grapes in Australia will depend on maximising the production of both existing and new varieties and on reducing labour inputs through the mechanisation of some aspects of both harvesting and pruning.

Although a substantial local industry now exists for wine, exports are limited. It is difficult to see this situation altering significantly, as wine from the well-established 'wine countries' of the EEC, such as France, Germany, Italy and Spain, is competitive in price compared with Australian wine on most world markets. As well, to be competitive, export Australian wine has to conform to well-established European quality standards.

Improved Cultivars and Rootstocks:

Cultivar improvement covering the selection of high-yielding clones of established varieties, and the breeding of new varieties specifically suited to Australian conditions, will play an increasingly important role in our viticulture. Clonal selection of improved lines has already played an important role and a range of drying and wine grape clones that give higher yields are now available and are used extensively by the industry.

As well, two new drying grapes have been released by CSIRO for further testing (16,17). The first of these is a black grape, the Carina, which when dried gives a product similar to the Zante currant. This variety arose from a cross of Shiraz by Sultana, and has good rain damage resistance and gives yields some 20 to 30 percent higher than the Zante currant. In some years the calyptras do not fall freely from Carina flowers, which are female and require cross pollination. Growth regulator sprays of GA-CCC are routinely required to promote good yields of even-sized fruits (16).

A white grape known as Merbein Seedless, arising from a cross of Planta Pedralba by Sultana, was released in 1981. This has some rain-damage resistance and also withstands summer heat-waves. Table 8 provides experimental data showing that, over four seasons, the yield of Merbein Seedless was almost double that of unselected Sultanas, while the yield of clonal H5 Sultanas was 15% more than unselected Sultanas.

Table 8. Yield comparisons between vines of unselected Sultana, selected clone H5 and the new variety Merbein Seedless (kg/vine)

Year	Unselected Sultana	Sultana Clone H5	Merbein Seedless
1979	11.5	16.0	33.0
1980	20.0	20.3	24.7
1981	14.1	17.4	31.4
1982	17.6	18.2	30.4
Means:			
kg/vine fresh	15.8	18.0	29.9
t/ha fresh	18.9	21.5	35.7
t/ha dry	4.5*	5.1	8.2

*computed value

Large increases in the yield of Sultana vines can be achieved by grafting them to vigorous rootstocks based on Vitis champini. The most successful of these stocks is known as Ramsey or Salt Creek, which is both tolerant of the rootknot nematode (Meloidogyne javanica) and of salt (NaCl), which can be present to harmful levels in many Australian soils and irrigation waters (18,19). Table 9 gives yield data for Sultana vines on their own roots or grafted on to Ramsey stocks. On narrow trellises (0.3m wide) these rootstocks gave yield increases of about 30% and on wide (1.2m wide) trellises they ranged between 13 and 20%.

Table 9. Fresh yield (t/ha^{-1}) of Sultana vines (seasons 1970-72). Own- rooted (OR) or grafted on to Ramsey nematode-resistant rootstock (G), trained on 0.3m or 1.2m T-trellis to 9, 14 or 19 canes (adapted from May et al. 1973 (20))

No. of canes	Trellis width			
	0.3m		1.2m	
	OR	G	OR	G
9	20.4	26.7	30.6	34.5
14	20.8	28.5	34.0	39.3
19	24.1	31.2	33.6	40.6

New wine grape varieties bred for Australian conditions will eventually play an important role in our hot irrigation districts. They promise to give high yields and, more importantly, balanced musts with good acid levels. The black variety Tarrango produces a red wine for early consumption which is low in tannin and which does not require wood ageing, while two high-yielding white varieties, Goyura and Tulillah, may become important components of blends used for the production of cask wines. A yet-unreleased white (code MR38-13) variety, which has a distinct Traminer character, also shows considerable promise. In trials, this hybrid is giving yields up to the order of 40 tonnes/hectare. Table 10 gives some yield comparisons between established winegrape varieties and some of CSIRO's new varieties. It is recognised that the rate of adoption of new winegrape varieties will be slow as there are well-entrenched quality factors with respect to wine. For example, the leading winegrape of Germany is now Milner-Thurgau; this was a 'new' variety bred in 1882!

Table 10. A. Production at harvest 1982 (t/ha^{1}) of winegrape varieties released by CSIRO (16) and pruned by different methods. B. Average production (t/ha^{-1} - harvests 1979-81) of the major wine grapes grown in the irrigated areas of MIA, Sunraysia, Swan Hill and Riverland, derived from the Viticultural Statistics (1979-81).

A. New Varieties			B. Major Varieties	
Red:				
Tarrango	8 canes	21	Shiraz	14
	4 bud spurs	35	Grenache	18
	Minimal pruned	38	Cabernet sauvignon	10
White:				
Goyura	8 canes	30	Muscat Gordo Blanco	17
	6 bud spurs	39	Doradillo	21
	Minimal pruned	37	Palomino	18
Tulillah	2 bud spurs	25	Semillon	19
	6 bud spurs	46	Rhine riesling	12
	Hedged	36	Trebbiano	17
	Minimal pruned	29	Sultana	16

Mechanisation:

The first mechanical grape harvesters were introduced to Australia in 1969.

Today about 160 machines harvest about 75% of the total winegrape crop. A similar trend is now occurring with mechanised pruning and about 20% of our winegrapes, mainly the spur-pruned varieties, are now hedged by machines. By combining mechanical harvesting and mechanical pruning with quality wine varieties in irrigation areas, good average quality wine can now be produced at very competitive prices.

For drying grapes the system of trellis or vine drying developed by CSIRO at Merbein is now used on a regular basis by a percentage of growers as their normal system of production (21). This technique involves severing the fruit-bearing canes when the fruit is ripe. The fruit, while still attached to the trellis, is then sprayed with drying emulsion and, when dry, is removed by mechanical harvesters. This procedure reduces the requirement for seasonal labour and lowers production costs. In wet seasons up to 20% of the farms in the Sunraysia area have been harvest-pruned as a means of reducing fruit losses from berry abscission and mould damage.

The potential of trellis drying to lower production costs was assessed in a survey of growers, committed to and prepared for the system, in 1980 (22). For most growers, producing 5-7.5 t/ha^{1} dried, total harvest costs (including vine preparation, cutting out, spraying, removal of crowns, harvest, finishing off, handling, equipment cost and depreciation) were about $100 per tonne, compared with a contract price for conventional handling of $195 per tonne. When all trellis drying operations were carried out by contractors the cost per tonne was about $120, based on a 5.7 t/ha^{-1} crop. As most costs associated with trellis drying are fixed per unit area, efficiency is greatly improved where yields are high. In the survey, the lowest harvest cost was $60 per tonne, for a 8.8 t/ha^{-1} crop.

Pruning and Training:

The cane pruning of Sultanas is labour-intensive, as spent fruiting canes must be severed and removed before attachment of new fruiting canes during winter. The hand labour input is particularly high in the case of vigorous vines where many canes are required to maximise production (Table 9).

Results with modified cane pruning systems (arched canes, the split system of training, hanging canes, swing-arm trellis; summarised by Clingeleffer,1981 (22)), indicate that labour input can be significantly reduced. All are suited to trellis drying, and suitable in varying degrees to mechanisation of harvest and pruning operations, but maintain or increase productivity. Furthermore, Sultana vines can be pruned to long spurs of about 6 nodes without loss of productivity (23). Systems based on long spurs have potential for mechanisation of harvest and pruning and a number has been tested since 1974 (i.e., hedging, cane-spur and split-cordon systems; (22)).

Further studies with Sultana have shown that pruning limits the potential of the crop. Vines left unpruned since 1967 have yielded (fresh wt) over the past 7 years (1976-82), on average, 38.6 kg/vine compared to the 22.9 kg for standard vines. In a more detailed experiment begun in 1976, 50-year-old vines were trained on a high 1.4m single wire trellis and skirted about 0.5m below the wire with a hand-held reciprocating cutter bar to position fruit at a height suitable for mechanical harvesting. This is the minimal pruning system (22). Excluding the year of conversion, yields for 5 years 1978-82 have averaged 27.7 t/ha^{-1} compared to 16.8 t/ha^{-1} for normal vines (i.e., a 65% yield increase). Apart from a slight delay in maturity and smaller berry size, quality differences are negligible. Minimal pruning is considered to be ideal for Sultanas used for wine. When mechanically harvested, the fruit was easily removed, vine damage was less and leaf retention was greater than for standard vines. For raisins, the fruit may be hand-picked, though drying of fresh, mechanically-harvested fruit (24) should be possible. Smaller berries should give faster drying and raisins more acceptable to the manufacturing market.

Minimal pruning has been adopted by some growers to increase productivity and reduce inputs. These vines have been machine-harvested for wine or hand-picked and dried conventionally for raisins. In 1982, minimally-pruned vines yielded 30-40 t/ha^{-l} (fresh wt) or 7.5-10.0 t/ha^{-1} of raisins, compared to the expected district average in 1982 of 20 t/ha^{-1} (5 t/ha^{-1} of raisins). One grower, with the high-yielding Sultana clones trained on a wide T-trellis (1.4m), has minimally pruned for four years, obtaining yields between 37.5 and 55 t/ha^{-1}. Another, with vines grafted to Ramsey, trained on 1.0m T-trellis and minimally pruned, averaged in 1982 70 t/ha^{-1} (i.e., 18 t/ha^{-1} of raisins).

Wide trellises which can increase production of vigorous winegrape varieties can also be hedged or cane-spur pruned. One grower has consistently obtained yields of 25-30 t/ha^{-l} from Cabernet sauvignon and,38 t/ha^{-1} for Shiraz vines trained on 1.4m wide T-trellis, hedged and mechanically harvested, compared to the Australian average for these varieties (1979-81) of 6.6 and 8.3 t/ha^{-1} respectively. In addition, commercial claret wine produced in 1976 from a 60:40 blend of the Cabernet sauvignon (30 t/ha^{-1}) and Shiraz (38 t/ha^{-l}) won a number of medals at capital city Royal Shows, indicating that high-yielding, irrigated vines can produce acceptable wine.

In more recent studies (25), high yields for winegrapes have also been achieved by planting rows closer together. Thus vines trained on simple trellises, planted close together, offer a further alternative to increase production, particularly if minimally pruned (22). Even closer plantings of Cabernet sauvignon, simulating a French vineyard (2.2 x 1.0m), have given excellent yields when hedged, illustrating that irrigated plantings can also be developed without trellises for support.

Conclusions

Because of difficulties with export markets, a number of Australian horticultural industries will have to contract until their volume approximates the size of the Australian market, which for a number of crops is about 5% of that of the USA. To achieve this contraction, tree-pull schemes, similar to those used for the apple and pear industry, should aim to assist the less productive and inefficient producers to leave particular horticultural industries. Although management is an area of extreme importance in horticulture, it should be recognised that factors such as the quality of soils, irrigation water and of the environment set prescribed limits to production of most horticultural crops. This is best illustrated by the large variations (of the order of a factor of 2) in the unit farm prices within some of Australia's irrigation districts. It is critical that government policies, including product subsidies, do not retain substandard farms and inefficient producers. On the other hand, to survive, efficient producers are required to use improved cultivars and adopt labour-saving techniques for harvesting and pruning, and to aim for high yields per unit area.

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