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Australia and New Zealand

Citrus Producers and Markets in the Southern Hemisphere

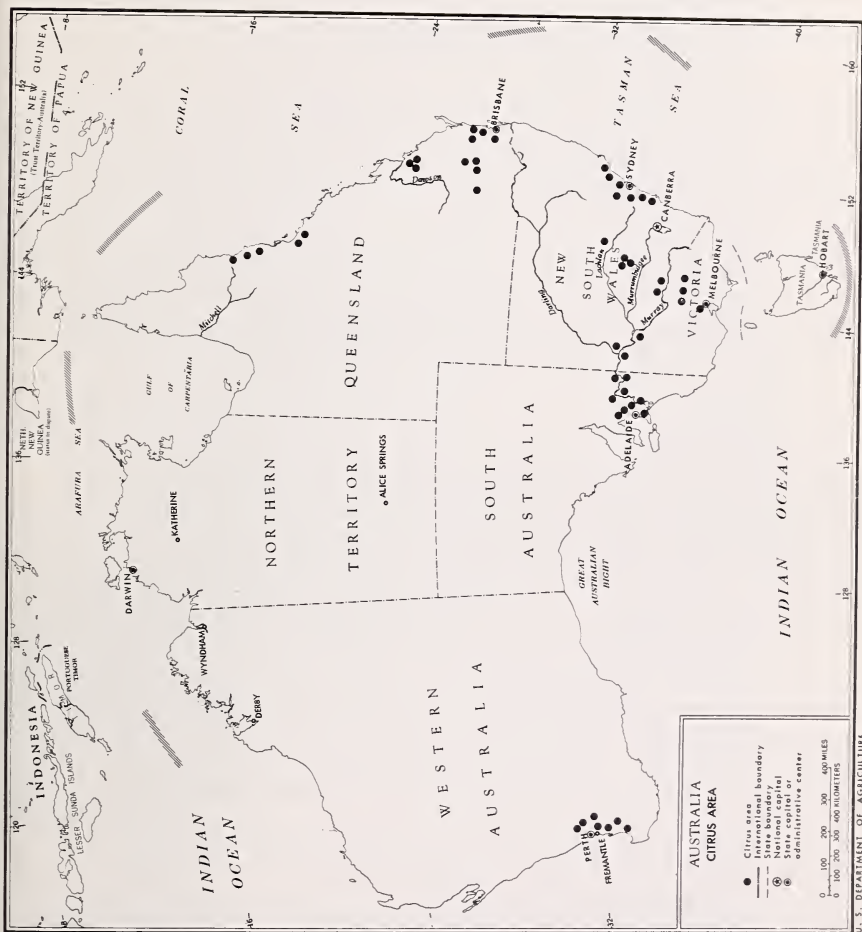
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AUSTRALIA AND NEW ZEALAND: CITRUS PRODUCERS AND MARKETS IN THE SOUTHERN HEMISPHERE

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AUSTRALIA

Australia has produced commercial citrus for over 50 years, and after remaining relatively static for a long time the industry is finding new stimulus in the postwar era. Expanding citrus production and an increasing interest in foreign markets is giving this industry a new dimension. The result of the changing attitude has been a protective policy to restrict U.S. juice imports with high duties and also to develop export markets for fresh citrus in Asia and Western Europe.

Australia is still a market for U.S. citrus products but it now has the new look of a competitor.

History

Citrus fruit has been grown in Australia since the earliest days of settlement. Seeds and young plants were purchased in Rio de Janeiro by Captain Phillip and by the Reverend Richard Johnson, Chaplain of the First Fleet, on the outward voyage to Australia, and planted about 1788 in the new settlement, now the center of Sydney. Settlers introduced many new varieties, and by 1828 the Sydney Botanic Gardens contained specimens of 16 varieties of sweet orange, 4 mandarin varieties, 4 varieties of shaddock, and specimens of common lime and lemon, seville orange, and citron. Seedlings of the early Brazilian introductions were grown, for the most part, commercially, with plantings in the Parramatta district supplying most of the colony's requirements.

The earliest export shipment recorded was made in 1828, when a sizable quantity of oranges and lemons was sent to Tasmania. In the 1830's and 1840's, citrus was introduced into other settlements on the mainland. However, expansion of acreage was slow, and most areas continued to rely on supplies from New South Wales. This State has since maintained its dominating position in the citrus industry.

In the late 1800's, the picture started to change with the introduction of irrigation along the Murray River and establishment of settlers there. The Mildura settlement in Victoria, established by the Chaffey brothers from California, and the Renmark district in the northeastern part of South Australia, rapidly became important citrus producing areas. These

Note: From reports of C. de Goede, Marketing Specialist, in the Office of the Agricultural Attaché, American Embassy, Canberra, Australia, and indicated sources.

irrigation settlements were followed by others, along the Murray River valley from Shepparton in Victoria to the Murray Bridge area near the river mouth in South Australia.

Under the provisions of the Barren Jack Dam and Murrumbidgee Canals Constitution Act of 1906, a scheme to establish an irrigation area between the Murrumbidgee and the Lachlan Rivers was approved by the New South Wales Parliament. Construction on the Barren Jack Dam, now known as the Burrinjuck Dam, was commenced in 1917 and completed in 1928. Nevertheless, sufficient water became available in 1912 to permit the settlement of the first horticultural farms.

Following World War I citrus production expanded rapidly in the major districts. New irrigation settlements were opened up along the Murray River and elsewhere, with citrus fruit comprising a major proportion of the new plantings. However, some of the plantings were made on unsuitable soils, and this, coupled with the impact of the depression in the early 1930's, caused acreages to decline. The beginning of World War II found the Australian industry with a relatively low level of production. At this point, the demand for citrus fruit from the civilian population and from Commonwealth and U.S. armed forces increased demand sharply.

Following World War II, new citrus plantings involving thousands of acres were made in the principal producing districts. Although War Service Land Settlement Schemes contributed to this expansion, the majority of plantings were carried out by private growers.

Fresh Citrus Fruit

Acreage.--Citrus is one of the most important types of fruit produced in Australia, accounting for approximately 27 percent of the total area under orchard fruit. In New South Wales, the proportion of citrus in total orchard fruit plantings is far larger than average, representing nearly one-half the total acreage. On an Australia-wide basis, citrus is the second largest individual fruit crop, exceeded only by apples. For the 1959-60 season the acreage under citrus fruit in Australia was estimated by the Commonwealth Bureau of Census and Statistics at 62,092 acres, of which 46,295 acres were in the bearing stage. This acreage reflects commercial areas of one acre or more, as home gardens and plantings on station properties for subsistence use are not included.

Production.--In 1961, production had increased to 5 million boxes of oranges, 400,000 boxes of lemons, and 200,000 boxes of grapefruit.¹ Australia thus ranks fourth among Southern Hemisphere citrus producers, following only Brazil, Argentina and South Africa.

New and projected plantings indicate a steadily increasing prospective citrus supply, which could create serious marketing problems, as the primary market is at present Australia's own 10.3 million consumers.

Table 1.--CITRUS FRUIT: Australia, total acreage, bearing and non-bearing, by type of fruit, 1955-56 through 1960-61

Item	1955-56	1956-57	1957-58	1958-59	1959-60	1960-61
	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>
Oranges:						
Navel.....	18,062	17,624	18,323	18,221	18,727	19,385
Valencia.....	27,393	26,738	27,309	28,002	28,421	29,038
Seville, Poorman and other....	2,609	2,244	2,296	2,230	2,180	2,203
Total oranges	48,064	46,606	47,928	48,453	49,328	50,626
Mandarins.....	4,000	3,764	3,894	4,210	4,426	4,661
Lemons and limes.	5,699	5,337	5,295	4,942	5,078	5,364
Grapefruit.....	1,491	1,436	1,463	1,386	1,382	1,419
Other citrus....	17	46	51	42	37	22
Total citrus...	59,271	57,189	58,631	59,033	60,251	62,092

Source: Commonwealth Bureau of Census and Statistics.

The following observations on the 1962-63 Australian citrus crop reflect in a general way the production conditions and problems in Australia's citrus industry.

The outlook was for substantially smaller crops in most areas. The New South Wales 1963 navel crop was expected to be lighter than last season in the major producing areas. Reports indicated that the Valencia fruit set in most districts was below average. For 1963, New South Wales mandarin and lemon crops were about normal.

In the Victorian citrus districts, prospects were variable. In some areas navels shed heavily, and over-all production of this type of fruit was expected down compared with last year. In the Mildura district, good crops of navels and Valencias were in prospect, but in the Swan Hill area blossoming was uneven.

Preliminary estimates for South Australia indicate that the 1963 crop in that State was significantly below that of last year. It is expected that navel production may be from 20 to 25 percent smaller than last year, while a drop of about 10 percent has been forecast for Valencias. Grapefruit production is also likely to be about 25 percent smaller than in 1962.

In the Queensland citrus districts prospects were variable, with fruit shedding fairly heavy in non-irrigated districts as a result of dry conditions during November. Heavy rains in December improved the position, and fruit sized well. Overall Queensland production of navels was down. Valencias set a fair crop. Mandarin crops are likely to be significantly smaller than 1962. In the Bundaberg-Maryborough area the mandarin crop is particularly light. Production forecasts for mandarins in the Gaydah district indicate that the crop

Table 2.--CITRUS FRUIT: Australia, production and exports by variety, 1951-52 to 1962-63

Year	Production			Exports ²		
	Oranges	Lemons	Grapefruit	Oranges	Lemons	Grapefruit
	1,000 <u>boxes</u>	1,000 <u>boxes</u>	1,000 <u>boxes</u>	1,000 <u>boxes</u>	1,000 <u>boxes</u>	1,000 <u>boxes</u>
1951-52.....	3,502	407	134	285	6	3
1952-53.....	4,419	401	142	289	5	3
1953-54.....	4,168	394	153	361	11	3
1954-55.....	4,847	459	162	350	6	4
1955-56.....	4,712	425	157	396	2	2
1956-57.....	4,507	372	169	408	6	4
1957-58.....	4,304	418	188	400	2	2
1958-59.....	5,447	477	188	276	3	4
1959-60.....	4,611	529	201	396	3	3
1960-61.....	5,949	463	219	281	2	3
1961-62.....	5,966	442	236	455	3	2
³ 1962-63.....	5,246	505	210	--	--	--

¹ In boxes of the following weights: Oranges, 70 pounds; grapefruit, 80 pounds; lemons, 76 pounds. ("Oranges" includes tangerines.)

² Year beginning July 1.

³ Preliminary.

Table 3.--CITRUS FRUIT: Australian production, 1960-1962

Variety	1960	1961	1962
	<u>1,000 boxes</u>	<u>1,000 boxes</u>	<u>1,000 boxes</u>
Navel oranges.....	2,069	2,263	1,989
Valencia oranges.....	3,313	3,154	2,743
Other oranges.....	219	206	206
Mandarins (tangerines).....	348	343	309
Lemons and limes.....	529	442	505
Grapefruit.....	219	236	210

Source: Commonwealth Bureau of Census and Statistics.

of Glen mandarins will be about average, but the Ellendale variety was likely to yield well below normal.

In Western Australia hot conditions were experienced during November, and as a result shedding of new fruit was heavy.

Citrus Districts¹

New South Wales.--New South Wales at present accounts for approximately one-half total Australian citrus acreage. Although in recent years its relative share of the total has

¹ Includes information from Land Utilization in Australia, by Sir Samuel Wadham, R. Kent Wilson, and Joyce Wood, Melbourne University Press, 1957.

Table 4.--CITRUS ORCHARDS: New South Wales, bearing and non-bearing acreage, and number of orchards, 1955-56 through 1961-62

Season	Number of Orchards ¹	Bearing	Non-bearing	Total area
	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>
1955-56.....	3,339	27,451	5,657	33,108
1956-57.....	3,216	25,722	5,437	31,159
1957-58.....	3,184	24,852	5,667	30,519
1958-59.....	3,082	23,595	6,663	30,258
1959-60.....	3,013	23,513	7,009	30,522
1960-61.....	2,938	23,347	7,152	30,499
1961-62.....	2,931	24,066	7,359	31,425

¹ Orchards of one acre or more in extent.

Source: New South Wales Bureau of Census and Statistics.

declined slightly, this trend may be reversed in future when new plantings in the Coleambally area are completed.

The decline in the number of orchards and in the bearing acreage in recent years reflects in large part a decline in coastal production resulting from urban development and inflated land prices near the larger cities, particularly Sydney and Gosford. Many orchard areas in these districts have been subdivided for homebuilding or for more intensive agricultural production, such as poultry raising. A further decline in New South Wales coastal citrus production is likely in future for these reasons, but also because of cultural and disease problems encountered there. High humidity in coastal districts, as compared with inland areas, is conducive to development of certain pests and diseases. White wax and white louse scale, black spot, melanose, and citrus scab are particularly troublesome, affecting the quality of coastal fruit in many seasons.

The principal single producing area in New South Wales is the Murrumbidgee Irrigation Area, where approximately 6,000 acres are planted to citrus. Along the New South Wales side of the Murray River, Coomealla and Curlwaa are the principal citrus districts, accounting for approximately 900 and 1,000 acres respectively. These two irrigation districts are under the control of the Water Conservation and Irrigation Commission of New South Wales, but, in addition, a further 2,000 acres under citrus cultivation are irrigated in the Murray River valley on the New South Wales side, under water pumping licenses granted to individual farmers or to small irrigation trusts. The remaining 20,000 acres under citrus cultivation in the State are located in the coastal districts running



Closely settled irrigation farms along main channel of Murrumbidgee Irrigation area, known for citrus, near Griffith in New South Wales.

Credit: Australian News and Information Bureau

from just south of Sydney to an area just north of Newcastle (with the exception of a relatively small area at Narromine west of Dubbo).

The old citrus area in the Parramatta district near Sydney produces mainly the "common orange" variety and mandarins. Quality is not good, and when the export trade to New Zealand, of special importance to this district, was stopped in 1934-35, a serious slump set in for local growers.

The Gosford district, on the coastal area of New South Wales, produces some good quality navel oranges. Orchards of both these districts are subject to damage by the Queensland fruit fly. The Murrumbidgee irrigation area is now growing a large acreage of navel types, which are improving steadily in quality and flavor; but many groves are threatened by the high water table which has developed. Other irrigation areas near the Murray, such as Curlwaa, are somewhat similar.

South Australia.--The area of South Australia planted to citrus fruit in 1960-61 was 11,771 acres, making this State the second largest producer after New South Wales. In recent years, expansion in citrus plantings in South Australia has been tremendous, particularly in the Upper Murray districts in the Waikerie-Loxton-Renmark triangle. Over the past five years, total South Australian acreage has increased despite



Orange groves near Gosford, New South Wales.

Credit: Australian News and Information Bureau

declines in some districts such as the Torrens Valley and Salisbury areas.

Plantings in the Upper Murray region account for the major part of the South Australian citrus acreage. This area has great potential for further expansion, particularly with the

Table 5.--CITRUS ORCHARDS: South Australia, bearing and non-bearing acreage, 1955-56 through 1960-61

Season	Bearing	Non-bearing	Total Area
	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>
1955-56...	6,125	2,081	8,206
1956-57...	6,483	2,180	8,663
1957-58...	7,850	2,636	10,486
1958-59...	8,171	2,739	10,910
1959-60...	8,399	2,795	11,194
1960-61...	8,485	3,286	11,771

Source: Commonwealth Bureau of Census and Statistics.

development of private irrigation settlements such as the recently established Golden Heights scheme near Waikerie, and others in that area begun at a later date. Present plantings in the Upper Murray districts total about 9,500 acres, and substantial additional plantings may be expected in the near future. The remaining acreages are in the Lower Murray district of Myponga near Murray Bridge, where about 500 acres are planted to citrus, at Salisbury 12 miles north of Adelaide with about 250 acres, and in the Torrens and Inman Valleys on the peninsula south of Adelaide, with plantings of approximately 750 acres. A small amount of citrus is also grown in the Gawler area.

Until 1930, 80 percent of production was navel oranges, but since 1945 new plantings have been mostly improved Valencia oranges. In 1961, the 840,000 orange trees planted, were about half navel and half Valencia.

Along the Murray River in South Australia there are also some excellent groves such as those at Renmark, which produce Washington Navel oranges of outstanding quality. The fruit has a well-deserved reputation in Adelaide, Sydney and Melbourne, and in addition, some successful exports have been made to New Zealand and Britain. This high standard is not, however, universal throughout the state.

Victoria.--Victoria is the third largest citrus producing State, with the total acreage in 1960-61 amounting to about 8,631 acres. Some expansion has been evident in recent years, with new plantings consisting largely of Valencias.



Valencia oranges ready for picking on a prosperous 20-acre irrigation holding at Barmera, South Australia, in the lower Murray River area.

Credit: Australian News and Information Bureau.

The major Victoria citrus-growing districts are along the Murray River, with the heaviest concentration in the Mildura and Swan Hill areas. The acreage in these Murray River districts approximates 5,000 acres, and more than half the Victorian citrus orchards are found there. The Goulburn Valley is the next most important area, with about 700 acres planted to citrus in the Shepparton and Kyabram districts. Approximately 800 acres of citrus fruit are recorded in the Melbourne metropolitan area, but this acreage consists mainly of small lemon plantings. Other types of citrus are generally not suitable for Melbourne climatic conditions. The remaining important areas in Victoria are Wangaratta (with about 500 acres), and Rochester, just south of Echuca (with about 600 acres).

In recent years, most expansion in citrus acreage has taken place in the Mildura area, while the acreage in the Melbourne area is declining. Some expansion has also been evident in the Wangaratta district.

Lemons grow well in southern districts, provided the soils are adequately manured. In the central irrigation areas, such as those of the Goulburn Valley, some good Valencia-type oranges are grown, while navels, Valencias, and grapefruits do well further north in the Mildura-Red Cliffs irrigation district, where temperatures are somewhat higher.

Table 6.--CITRUS ORCHARDS: Victoria, bearing and non-bearing acreage, and number of orchards, 1955-56 through 1960-61

Season	Number of Orchards ¹	Bearing	Non-bearing	Total Area
		<u>Acres</u>	<u>Acres</u>	<u>Acres</u>
1955-56....	1,846	6,025	1,240	7,265
1956-57....	1,852	5,599	1,453	7,052
1957-58....	1,877	5,973	1,391	7,364
1958-59....	1,945	5,943	1,287	7,230
1959-60....	1,971	5,972	1,600	7,572
1960-61....	2,004	6,363	2,268	8,631

¹ Orchards of one acre or more in extent.

Source: Victorian Bureau of Census and Statistics.

Queensland.-- The Queensland acreage planted to citrus in 1960-61 amounted to 5,843 acres. The acreage in that State has been relatively stable in recent years, although minor changes in location are evident.

The principal citrus-producing area in Queensland is the Gayndah and Howard-Burrum-Turbanlea area near Maryborough, where over 1,900 acres are planted to citrus. A

somewhat lower acreage of about 1,800 acres is found just north of Brisbane in the Landsborough and Maroochy districts. In the Cairns-Cooktown area about 500 acres are in citrus orchards, while Charters Towers and Rockhampton are next in importance with about 250 and 350 acres, respectively. The remainder is made up of about 300 acres in the Roma district, and in small plantings spread over widely-separated areas throughout the eastern part of the State.

Western Australia.--Western Australia is the least important Australian citrus-producing State. The total area in orchards in 1960-61, at 5,302 acres, was somewhat below that of Queensland, although the bearing acreage at that time was somewhat higher. Western Australian expansion in recent years has closed the gap between the two States, however, and it appears only a matter of time before production in Western Australia overtakes that of Queensland.

Table 7.--CITRUS ORCHARDS: Queensland, bearing and non-bearing acreage, and number of orchards, 1955-56 through 1960-61

Season	Bearing	Non-bearing	Total Area
	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>
1955-56....	4,640	1,076	5,716
1956-57....	4,404	939	5,343
1957-58....	4,178	1,067	5,245
1958-59....	4,213	1,318	5,531
1959-60....	4,089	1,574	5,663
1960-61....	4,162	1,681	5,843

Source: Commonwealth Bureau of Census and Statistics.

Table 8.--CITRUS ORCHARDS: Western Australia, bearing and non-bearing acreage, and number of orchards, 1955-56 through 1959-60

Season	Bearing	Non-bearing	Total area
	<u>Acres</u>	<u>Acres</u>	<u>Acres</u>
1955-56.....	4,176	767	4,943
1956-57.....	4,179	765	4,944
1957-58.....	4,154	834	4,988
1958-59.....	4,161	903	5,064
1959-60.....	4,292	968	5,260
1960-61.....	4,287	1,015	5,302

Source: Commonwealth Bureau of Census and Statistics.

Citrus is grown in Western Australia in a fairly wide area both north and south of Perth. The principal region is in the triangle Perth-Gingin-Toodyay, where more than half of the present total acreage is located. South of Perth, citrus is grown practically all along the coastline as far south as Capel, 150 miles south of Perth. Relatively well-defined areas are the Gingin-Chittering districts and Hills-Toodyay area north and northeast of Perth, and Armadale-Kelmscott and Serpentine districts just south of Perth, Harvey-Roelands north of Bunbury, and Capel-Donnybrook area south of Bunbury.

Cultural Practices²

The Australian citrus industry includes many mechanically-tilled, well-cared-for, modern groves. While some of these are irrigated, some other areas depend solely on rainfall. Irrigation is carried on both by surface application of water and by overhead sprinklers.

Non-irrigated citrus is grown on the coastal plain of New South Wales, in the foothills near Adelaide in South Australia, and in the hills near Perth in Western Australia.³

In South Australia, nearly all citrus planted since 1948 is sprinkler-irrigated by permanent overhead systems.⁴ These irrigation systems are reported to cost \$448 to \$560 per acre, but the increase in production makes the investment worthwhile.

"Permanent installations, when they were first installed, aimed at applying not less than one-third inches per hour; however, to economize on initial installation costs, areas established in recent years are being irrigated with equipment designed to apply as little as 0.2 inches per hour. This trend may create two problems - excessive accumulation of salt in the leaves due to differential foliar absorption, and in the soil through insufficient leaching. Both aspects are being closely watched.

"The soils used for the production of citrus have a high natural salt content and .02 percent chloride in the topsoil is common. Due to the repeated application of salt in irrigation water - usually 300 to 600 parts per million total soluble salts - it is now recognized that when irrigating these soils the aim should be to apply some 10 to 15 percent more irrigation water than the trees require. This is designed to ensure that soluble salts are removed downward out of the root zone."⁴

In this same article Mr. Spurling indicates that the average irrigation requirement in South Australia is 30 inches of water

² *The Citrus News*, January 31, 1962.

³ *A Manual of Australian Agriculture*, by Imre Molnar, 1961.

⁴ "The Citrus Industry of South Australia", by Milton B. Spurling; *World Crops*, January 1963.

per year, and the heaviest requirement is in the period from October to April with a peak need in mid-summer (December and January).

Rootstocks².--Rootstocks used include sweet orange, Trifoliata, Carrizo Citrange and a selection of experimental roots such as Cleopatra and Emperor mandarin, Sampson and Orlando Tangelo, and Troyer Citrange. Trees grown on Seville or sour orange root have been observed to die out due to Tristeza.

Rootstocks are chosen for resistance to Tristeza, Phytophthora and tolerance to lime and salt in soils.

Rough lemon rootstock is used in 95 percent of present plants in the Murray Irrigation District, according to Mr. Spurling. This rootstock has been demonstrated to produce the earliest and the most consistently high yields of fruit. Because of the susceptibility of rough lemon to lemon shell bark virus, sweet orange root is used for tangerines. Recently, interest in the use of sweet orange root has been revived, as it produces fruit of better processing quality.

Fertilization: In his article on "The Citrus Industry of South Australia," Mr. Spurling reports that nitrogen is the major need of the deep loose sand (Mallee soils) of the Murray Irrigation District. With the development of overhead sprinkler irrigation, many growers apply nitrogen by injecting urea solution into the irrigation water.

Experimentation has shown that the form of nitrogen used could have considerable significance in determining phytophthora root rot. Further research is being done in this subject.

A biennial zinc spray for mottle leaf control is a usual practice in the Murray district, according to Mr. Spurling. These minor element materials are usually applied by boom sprayers.

Varieties⁵.--Australian orange varieties include the Leng and Washington navel, Valencia, and common oranges such as the "Joppa", Paramatta, St. Michael and Mediterranean Sweet. Lemon plantings are 90 percent Lisbon and some Eureka, and grapefruit plantings consist mostly of marsh seedless, and a few Wheeny and Poorman, tangerine varieties, in order of maturity, are reported as early imperial, Fewtrell's, Thorny, Emperor, Dancy, Ellendale, and Beauty of Glen Retreat.

In South Australia, which is the source of most export citrus, the predominate orange varieties are navels and Valencias. Most of the Valencias grown are called "Berri Improved Late Valencia." This is a strain selected at the Berri research station for its fine tree storage characteristics. Australian citrus suffers from the following commercial pests and diseases:⁶

Pests:

Red Scale (*Aonidiella Aurantii*)

⁵ A Manual of Australian Agriculture, 1961, by Imre Molnar, and "The Citrus Industry of South Australia", by Milton B. Spurling; World Crops, January 1963.

⁶ Fruit World Annual, August 1961, page 17.

Olive Scale (*Saissetia Oleae* and *Coccus Hesperidium*)
 "Webbing Spider"
 Citrus Aphids (*Toxoptera Aurantii*, *Aphis Citricidus*)
 Cottony Cushion Scale (*Icerya Purchasi*)
 Holy Bug (*Mictus Profana*)
 Slugs and Snails (*Helix Aspersa*)
 Mealy Bug
 Citrus White Fly (*Aleuroplatus Citri*)
 Apple Moth (*Tortix Postnittana*)
 California Mite (*Tenuipalpis Californicus*)
 Sooty Mould (*Capnodium Salicinum* and *Chaetothyrium Citri*)
 Queensland Fruit Fly *Dacus* (*Strumeta Troni*), in Eastern States
 Mediterranean Fruit Fly (*Ceratitis Capitata*), in Western Australia only.

The citrus pests listed above⁶ are not present in all citrus areas. Red scale, mealy bug and aphids are the major problem in the Murray irrigation districts, but this important citrus area has never had Mediterranean fruit fly and is not bothered by rust mite, white wax scale, purple mussel scale or Fuller's rose weevil, according to Mr. Milton B. Spurling.

Red scale in the Murray District is controlled by fumigation and white oil spray. A quarantine program controls the entry of plant material into the area.

Disease:⁷

Brown Rot of Citrus (*Phytophthora citrophthora*)
 Seporia Spot
 Brown Spot of Mandarin (unidentified)
 Anthracnose
 Scab (*Sphaceloma Fawcetti*)
 Collar Rot (*Phytophthora SPP.*)
 Pink Disease (*Corticium Salmonicolor*)
 Armillaria Root-Rot
 Citrus Pit (*Phytophthora Syringae*)
 "Bud Union Decline"
 Scaly Bark (*Psorosis*)
 Scaly Butt (*Exocortis*)
 Stem Pitting of Grapefruit (*Tristeza*)
 Xyloporosis

In addition to the citrus diseases listed above, reported by Fruit World Annual, the eastern coastal, more humid, areas in Australia are said to have "black spot", (*Guignardia Phoma Citricarpa*), citrus scab, gummosis (*Diplodia* and *Phomopsis*), and Melanose.

Research Program

A modern citrus research program is being carried on at experiment stations. The projects reported include the following:

1. Studies of the cause of small-sized fruit in Valencias;

⁶ Fruit World Annual, August 1961, page 17.

⁷ Citrus Growing in Australia, by F. T. Bowman.

2. Stem pit of grapefruit;
3. Tristeza--a study of the protective value of mild strains from Lisbon and Meyer lemons and grapefruit;
4. "Scaly butt";
5. Lemon nucellar selections;
6. Psorosis free budwood;
7. Varietal behavior in reworking citrus;
8. "Benching" of Ellendale tangerines grown on Trifoliata rootstock;
9. Mechanization of fruit picking;
10. Weedicides;
11. Soil and leaf analysis;
12. Fruit-sizing sprays;
13. Minor element sprays;
14. Irrigation practices;
15. Fertilizer trials;
16. Planting distances, drainage and reclamation.

Citrus Season

Oranges bloom in September and October, and Australian citrus is harvested in the Northern Hemisphere summer and fall.

<u>Variety</u>	<u>Major marketing season</u>
Tangerines (mandarins):	
Emperor	May-August
Ellendale	August-October
Oranges:	
Navels	April-October
Valencias	September-December ⁸
Grapefruit:	
Marsh	May-November
Lemons:	
Eureka, Main Crop	May-August
Eureka, Intermediate Crop	February-March

Climate³

Climatic hazards include drought in the unirrigated citrus plantings, and in most areas, water damage in years of exceptionally heavy rainfall. At times brush fires may also damage groves; however, drought is the most important re-occurring climatic problem.

⁸ The Valencia harvest continues until May.

In the Murray River district in south Australia, rainfall in the coastal districts such as Adelaide averages 30 inches per year while the Murray districts 100 miles inland, such as Renmark, have an average rainfall of only 10 inches.

Australian areas are subject to a frost hazard and some fruit is frozen in the colder winters. Frost protection measures involve wrapping of young trees, and the use of trifoliate rootstock. Heating is seldom used.

Marketing ⁹

About 75 percent of all Australian citrus is utilized as fresh fruit for the domestic market. Exports of fresh fruit take less than 10 percent of the orange crop and about 1 percent of lemon and grapefruit production.

Australia is like California in that oranges are picked and sold every month of the year. The picking of navel oranges begins in mid-April, in most seasons, and some fruit is sold until October. The first Valencia oranges are marketed in mid-September and the peak season is November through January. The Valencia orange season continues in smaller volume to May.

Thus the last of the navel crop competes with the first-picked Valencia oranges in late September and early October, and the old Valencia crop competes with the first-picked navels from mid-April to May.

As in California, Valencia orange trees are carrying an unharvested crop at the time of blossom in September and October. As an example, in Australia, Valencia oranges which bloomed in September and October 1962 had mature fruit for picking a year later in September and October 1963, and some of the mature fruit will be tree-stored for 6 months to May 1964.

Fruit Handling

"The increasing use of road instead of rail transport introduced new (fruit handling) problems. In 1956 only 27 percent of the citrus from the Murray Irrigation Areas was dispatched by road. By 1961 this had risen to 53 percent."

"As a result of investigations in 1954 and 1955 into causes of post-harvest breakdown and sources of skin injuries during handling, the industry changed from big box handling to bulk handling from tree to the packing shed. Now about 90 percent of the crop is handled in bulk bins of fork-lift or trailer types. In the same way, demonstration of the advantages of SOPP

⁹ Prices are quoted in U.S. dollars per box of the following weights: Oranges, 70 pounds; grapefruit, 80 pounds; lemons, 76 pounds. Actual domestic trade is in bushel boxes weighing 42 to 48 pounds, and the counts shown in this Australian domestic bushel box.

dipping to reduce mould wastage and of waxing to reduce wilting and improve appearance has resulted in almost 100 percent adaption of these treatments for the whole case output in the last two seasons."⁴

Fruit Size

The sample pack out of navel and Valencia oranges indicate pack count in the Australian bushel box which contains 42 to 48 pounds of fruit. In this container most navels are packed in sizes 100 to 150 and Valencias in sizes 125 to 180 fruits per box.

The example from "Area 2" also indicates the seasonal change in size as fruit matures.

Table 9.--ORANGES: Sample size pack outs of Australian navel and Valencia oranges on indicated dates

Size count	Navel oranges			Valencia oranges		
	Area 1	Area 2		Area 1	Area 2	
	June-Nov. 1959	May 1961	July 1961	Sept. 1960-Apr. 1961	Nov. 1960	Jan. 1961
	Standard bushel box ¹			Standard bushel box ¹		
64.....	--	--	--	--	--	--
72.....	113	--	--	2	--	--
80.....	235	1	14	117	5	19
88.....	515	17	49	228	16	33
100.....	1,081	30	68	573	89	106
113.....	1,060	106	191	926	152	125
125.....	801	110	198	1,667	231	185
138.....	1,525	81	215	321	284	216
150.....	1,221	43	163	3,052	298	185
163.....	579	19	163	1,854	286	218
180.....	842	3	118	2,853	419	263
198.....	303	1	67	998	209	96
216.....	145	--	38	345	136	71
234.....	160	--	24	309	94	60
252.....	49	--	3	63	--	36
270.....	10	--	6	28	--	23
288.....	17	--	3	23	--	3
306.....	--	--	--	6	--	--

¹ The inside measurement of this box is 18" x 10 1/2" x 11 1/2"; the box holds a net of 42 to 48 pounds of fruit.

Trade sources.

Packing Costs

In 1963 trade sources indicated that packinghouse wages were about \$35 for men and \$27 for women per 40 hour week of 5 days.

The total cost of packing a 42- to 48-pound bushel export box, double wired, labeled and fully wrapped with diphenyl treated paper was reported to be \$1.08. Unwrapped packs for the domestic market in unwired, branded packs cost about \$0.85 per bushel box in 1962.

In Australia, because of the limited quantity of timber suitable for the manufacture of paper, wooden boxes are used in preference to paper cartons.

Domestic Marketing

The following data for 1961-62 illustrate the domestic marketing situation.

The very heavy 1961 Valencia crop resulted in a large carry-over of fruit into early 1962. At mid-January, large quantities of fruit were still coming to the case market from the major producing areas, despite stepped-up deliveries to processors for concentrate manufacture. As a result, prices of Valencias in January 1962 were well below the level at this time a year earlier. The market situation was in a constant state of flux, with sellers making "deals" with buyers to the best of their ability.

Action by the industry to reduce pressure on the market by selling only the best fruit, and an extensive publicity campaign, eased the situation somewhat during February and March. Nevertheless, supplies were still plentiful, and little improvement in prices was evident. On the Sydney market some lots from the Murray River areas brought prices barely covering the cost of packing and freight.

Table 10.--VALENCIAS: Selected, unwrapped, Melbourne, market minimum quotations, January 1961 and 1962

Count	January 1961	January 1962
	U.S. dols.	U.S. dols.
	Per 70-lb. box	Per 70-lb. box
84.....	\$6.53	\$3.59
96.....	7.51	3.92
126.....	8.81	4.25
140.....	9.47	4.25
168.....	10.13	4.25
225.....	9.80	4.25

The first of the new season's gassed navels came on to the market in mid-April, and met only a dull demand while substantial quantities of Valencias were still on the market. At

the end of April specially selected unwrapped navels sold on the Melbourne market at 34 shillings (\$5.55 per 70-pound box) for 96 counts and 38 shillings (\$6.21 per 70-pound box) for 112's. By mid-May, arrivals of navels commenced to be heavy, and prices fell to a low level normally not reached until late June. Arrivals of Valencias continued well into May, but these were sold at very low prices even when quality was reasonable. Prices remained at low levels during subsequent months, with the market oversupplied most of the time. Throughout June, July, and August specially selected unwrapped packs of Washington navels sold in the 18- to 20-shilling price range for 96-112 counts \$2.94 to \$3.27 per box.

The first new season Valencias made their appearance on the market in mid-September. By that time the supply of good-quality navels was tapering off, and prices had firmed somewhat. The Sydney and Melbourne markets remained well-supplied with navels during the marketing of Valencia oranges from early districts, which resulted in early Valencias being discounted as much as \$0.50 per bushel box.

The rate of Valencia arrivals increased sharply because of heavy crops, and prices weakened toward the end of October and during November through December when most Valencias sold for \$3.25 to \$4.25 per 70-pound box. Some improvement in prices was evident during January and February, particularly for the more popular sizes. This was largely because of the well-above-average proportion of large-sized fruit coming forward, and at times definite scarcity of supplies in the medium size counts, as well.

Early supplies of grapefruit came on to the market in April. A few old-season grapefruit were still on the market but, quality and condition was poor, and they generally sold at nominally low prices. New fruit did not meet a strong demand, but prices were high at about 38 shillings per bushel case for 45 count and 40 shillings for 60 count (\$8.10 to \$8.50 per 80-pound box). Supplies increased rapidly in May, resulting in some oversupply and consequent lower prices. At the end of May, quotations on the Melbourne market ranged from 20 shillings to 24 shillings per bushel for most popular counts (\$.25 to \$5.10 per 80-pound box). The market showed little change in June, but prices eased further in July by about 2 shillings per bushel, and remained at that level until the end of August. A falling off in supplies in mid-September resulted in a strengthening of prices by from 2 shillings to 4 shillings per bushel. However, demand was weak because of exceptionally cold weather, and when arrivals increased again in October it became necessary to withhold supplies in order to maintain prices. Demand improved in November, but was nevertheless not as strong as in other years.

Lemon supplies were light at the beginning of 1962, particularly on the Melbourne market, and exceptionally high prices were being realized at that time for good counts.

However, gradually increasing supplies in February brought prices down rapidly. At the end of that month most limes were selling at about 20 shillings per bushel. (\$3.55 per 76-pound box). The position remained unchanged in March, but by the end of April supplies were in excess of demand resulting in a sharp price drop. Heavy supplies continued to come forward during subsequent months. From June to December, quotations on the Melbourne market ranged between 10 shillings and 14 shillings per bushel (\$1.77 and \$2.48 per 76-pound box).

Large supplies of oranges available during 1962 led to further expansion of deliveries to processors. Prices were generally in the range of \$45 to \$50 per long ton. It is becoming obvious that the industry will have to rely on this outlet increasingly, in future years, to dispose of the growing volume of fruit.

Development of export outlets is now being seriously tackled, and New South Wales grower organizations, in particular, have been successful in opening up new markets. Special attention is to be given to the Southeast Asian area, and it appears that United States fruit may meet increasingly stiff competition in those areas. However, other markets are also being investigated. In the past two seasons significant shipments have been made to Western Europe, while this past season the first shipment ever was made to Canada. Canadian interest may have been partly caused by the freezes in the United States, but this first shipment was so successful and profitable for the buyer, that the Australian industry may well have established a permanent foothold in that market.

Foreign Trade

Australian exports of citrus fruits during fiscal year 1961-62 were at a relatively high level, and substantially above those of the previous year. The bumper crops harvested in 1961, and continued high production in 1962, permitted maximum shipments from areas free of fruitflies to New Zealand, while shipments from other areas could be made in some volume to destinations not requiring cold storage or other treatment for fruit fly infestation.

Exports of oranges to New Zealand, Australia's major market, were 69,000 boxes larger than in 1960-61, and regained the 275,000 level of 70-lb. boxes of earlier years. Shipments to Singapore and Malaya showed the largest increase, totaling 111,000 boxes, or double the quantity shipped to those destinations the previous year. A significant development in the foreign trade pattern was the opening up of the Hong Kong market, which took 36,000 boxes (70-lb.) of oranges in 1961-62. Shipments to Mauritius were over 10,000 boxes or three times as large as in 1961-61.

Exports of lemons during 1961-62 were also substantially larger than in the previous year, and reached 3,000 boxes

(76 lb.). Singapore and Papua and New Guinea remained the major customers for this type of fruit. For the first time, however, an attempt was made to ship lemons to Europe, and a parcel of about 600 boxes of 76 lb. was exported to Hamburg. Reports indicate that the shipment proved successful, and turnout was satisfactory.

Grapefruit shipments during 1961-62 showed a further decline when compared with the previous year. The principal export market, Singapore, took a slightly larger quantity than in 1960-61, but sales to other destinations declined by about 500 boxes of 80 lb. each. Exports of mandarins were nearly twice as large as those of 1960-61, mainly as a result of increased shipments to Pacific Island destinations.

Table 11.--FRESH CITRUS: Australia exports by country of destination, fiscal years 1956-57 and 1961-62.¹

Destination	Oranges		Lemons		Grapefruit	
	1956-57	1961-62	1956-57	1961-62	1956-57	1961-62
	1,000	1,000	1,000	1,000	1,000	1,000
	<u>boxes</u>	<u>boxes</u>	<u>boxes</u>	<u>boxes</u>	<u>boxes</u>	<u>boxes</u>
Europe:						
Germany, West	28	--	--	--	--	--
United Kingdom	5	3	--	--	--	--
Other.....	2	--	--	--	--	--
Total.....	35	3	--	--	--	--
Others:						
Malaya and Singapore..	74	112	2	2	4	1
New Zealand...	289	272	--	1	--	--
Other.....	10	68	4	--	--	1
Total.....	373	452	6	3	--	2
Grand total.....	408	455	6	3	4	2

¹ In boxes of the following weights: oranges, 70 pounds; lemons, 76 pounds; grapefruit, 80 pounds.

Official sources.

Heavy supplies of oranges and lemons permitted a further increase in exports from the 1962 crop. Final data are not yet available, but shipments for the 6 months ended December 1962 were already in excess of those for the whole of 1961-62. Exports of oranges approximated 710,000 bushels (487,000 70-lb. boxes) during the 6-month period, while shipments of lemons totaled about 12,275 bushels (7,750 76-pound boxes of 76 lb. each).

Exports to traditional markets were similar to those of the previous year, and most of the increase in shipments went to newly developed outlets. About 24,000 bushels of oranges were shipped to the United Kingdom, 18,500 to the Philippines, 67,500 to Hong Kong, and 1,500 bushels to Canada and Ceylon

each. In addition, exports to small markets in the Middle East and in the Pacific were also significantly expanded. Most of the increase in lemon exports went to Western Germany, which took nearly 5,000 bushels, but a shipment of 1,773 bushels was made to the United Kingdom, a trial shipment of 38 bushels went to Canada, and 655 bushels were shipped to Hong Kong.

Processed Citrus Products (Juice, Essential Oil, Soft Drinks)

Processing.--The Australian citrus processing industry has been developed primarily to supply local needs for juice and essential oil, and only citrus peel products have been exported in volume.

The quantity of juice produced from year to year has varied considerably, depending upon the supply of fruit. In the 1956-57 season, about one-half million gallons of juice was produced, compared with over one million gallons in the following season. In the 1958-59 season, citrus juice production remained at about one million gallons, but this level increased to over 1.5 million gallons in 1959-60.

As a result of the large supplies of citrus fruit available during the 1961-62 season, increasingly large quantities were diverted to juice production. It was fortunate for those several manufacturers that had just installed juicing plants in the previous season that such plentiful supplies of factory fruit were available. That season, approximately 8,000 tons of Valencias were taken up by manufacturers for concentrate manufacture, compared with 1,000 tons in 1960. The previous highest intake was in 1959, when manufacturers absorbed

Table 12.--AUSTRALIA: Total production of specified citrus items, 1956-57 to 1960-61

Year	Aerated or carbonated waters	Cordials and syrups	Natural fruit juices
	1,000 U.S. gal.	1,000 U.S. gal.	1,000 U.S. gal.
1956-57.....	73,550	5,552	3,961
1957-58.....	83,066	5,515	4,408
1958-59.....	83,211	5,472	6,093
1959-60.....	91,077	5,958	6,054
1960-61.....	97,259	6,290	5,696

Source: Commonwealth of Australia, Bureau of Census, Manufacturing Industries 1960-61 No. 22, "Aerated Waters and Cordials".

4,000 tons. Although fluctuating levels of crops will continue to harrass citrus juice processors to some extent, it appears that potential orchard production is now reaching the stage where processors can rely on a reasonable continuity of supply.

Peel production has shown little change from year to year, and in 1956-57 total production was 2.8 million pounds compared to 2.7 million pounds in 1957-58. Official Australian data do not differentiate between types of peel, and comprise all types including brined, drained and dried. Considerable quantities of this peel are exported in the form of marmalade, which is widely distributed in the United Kingdom.

Some orange and lemon essential oils are produced, but domestic output is below Australian requirements. Only a few processors are involved in the production of essential oil, and no official data on production are available. Reports from the four largest Australian producers indicate that total orange oil and lemon oil production in 1957-58 was about 24 thousand pounds. As far as is known, there is practically no leaf or flower oil production in Australia.

Australian processors report that juice from some citrus varieties has a bitter flavor. The preferred fruit for citrus processing is Valencia oranges grown on Trifoliata rootstock.

In 1961, one processor reported that juice yields for this fruit was 85 gallons per ton. The price of this type of processing fruit was reported as \$78.00 per ton, which returned about \$1.50 per box to the grower. The limited supply of fruit of this quality is a problem to processors.

Soft Drink Industry.--The growing Australian soft drink industry produces most juices, with the total 1960-61 production of 5.7 million U.S. gallons consisting of about 160,000 gallons of apple juice, 1.5 million gallons of orange juice, 150,000 gallons of grape juice, 3.5 million gallons of pineapple juice, and 300,000 gallons of other juices.

Soft drink and cordial production for 1960-61, of over 100 million U.S. gallons coming from 548 soft drink factories, indicates domestic soft drink consumption of over 10 U.S. gallons per capita.

Juice Quality.--Drs. J. F. Kefford and B. V. Chandler, in The Influence of Rootstocks on the Composition of Oranges with Special Reference to Better Principles, made the following conclusions:¹⁰

"In Australia the major rootstocks in commercial citrus orchards are rough lemon (citronelle), sweet orange, and trifoliolate orange (Nankivell 1958). Rough lemon, the most widely used stock, has been popular because it promotes tree vigour and precocity and high yields of fruit. In many recent plantings, however, particularly in New South Wales, trifoliolate orange stock has been used because it is

¹⁰ Analytical data are appended.

resistant to the root-rotting organism Phytophthora citrophthora, to moisture stress, to nematodes, and to frost injury, while the scaly-butt virus disease (exocortis), to which it is susceptible, may be avoided by careful selection of budwood (Benton et al. 1950).

"The present study has confirmed, for Australian fruit, the fact that rough lemon and trifoliolate orange stocks represent contrasting extremes in their effects on the quality and composition of the juices of Washington Navel and Valencia oranges. Trifoliolate orange stock tends to give high yields of juice, high in soluble solids and acid, while rough lemon stock tends to give low yields of juice, low in soluble solids and acid, although the actual differences in values may not be great. An interesting reversal of these trends occurred in the ascorbic acid content of Navel juices, where rough lemon stock gave the highest values and trifoliolate orange stock the lowest. Sweet orange stock occupies an intermediate position in its influence on the composition of the juice of scion varieties. With regard to the opposite effects of trifoliolate orange and rough lemon rootstocks on the acidity of oranges, it is interesting to note that Huffaker and Wallace (1959) have shown that enzyme fixation of carbon dioxide into organic acids proceeds more actively in the fruit and other parts of the trifoliolate orange than in the rough lemon.

"Further, a specific influence of rootstock on the amounts of bitter principles in the peel, seeds, and juice of oranges at different stages of maturity has been demonstrated, and the findings confirm those of Marsh (1953) for Californian oranges. Rough lemon stock encourages the persistence of bitter principles in both Navel and Valencia oranges to later stages in the season than most other stocks. Trifoliolate orange stock promotes the rapid disappearance of bitter principles, and both Valencia and Navel oranges on this stock gave canned juices substantially free from bitterness at normal maturity.

"At the present state of knowledge, the physiological mechanisms underlying the effects of rootstocks on the bitterness and other characteristics of citrus fruits remain obscure. It is unlikely that the limonoid bitter principles play an important role in the physiology of citrus fruits; they are more probably by-products of metabolic processes. The highest concentrations of bitter principles were found in the seeds, and in Valencias on trifoliolate orange stock the seeds were the only parts of the fruit found to contain limonoids. The absence of seeds in Navel oranges may upset the normal distribution of limonoids, and this may be a cause, in addition to the effect of earlier maturation, of the greater bitterness in the juice and peel of this variety. There is presumably also a process of degradation of limonoids in oranges, since they tend to decrease in amount in all parts of the fruit with advancing maturity.

"The observed effects of the rootstock on the bitter principle content of oranges suggest that it may control both limonoid synthesis and degradation. The influence of the rootstock on the amounts of carotenoid pigments in red and pink grapefruits may be an analogous phenomenon (Ting and Deszyck 1958).

"Rogers and Beakbane (1957) consider that the influence of rootstocks on scion characteristics may be accounted for by differences in nutrient absorption, metabolism, and transport, or in auxin metabolism. In this connection it is interesting to note that significant differences have been observed between trifoliolate orange and rough lemon rootstocks in their effects on the accumulation of inorganic ions, notably potassium and calcium, in the fruit and foliage of scion varieties (Wallace et al. 1952; Shannon and Zaphrir 1958)."

Foreign Trade.--Australia exports a small quantity of citrus juice--23 thousand gallons of orange juice in 1960-61 and about 34,000 gallons of other citrus juices in the same period the year before. Nearly all the large peel exports are sold to the United Kingdom and to other Commonwealth countries.

Most of Australia's foreign trade in citrus products is in the form of imports, which in the 1961-62 fiscal year included 225,000 gallons of orange juice, 77,000 gallons of lime juice, 90,000 gallons of other citrus juice, 13,000 pounds of peel, 34,000 pounds of lemon oil, 20,000 pounds of lime oil and 61,000 pounds of essential oil of orange.

Table 13.--CITRUS PRODUCTS: Australia, exports by country of destination, fiscal years 1956-1957 and 1961-1962.

Destination	Orange juice		Other citrus juice		Peel ¹	
	1956-57	1961-62	1956-57	1961-62	1956-57	1961-62
	1,000 U.S.gals.	1,000 U.S.gals.	1,000 U.S.gals.	1,000 U.S.gals.	1,000 lbs.	1,000 lbs.
Malaya, Fed. of Australian Territories.....	--	--	14	--	--	--
Singapore.....	9	--	--	--	--	--
United Kingdom.....	--	--	14	14	--	--
Other Commonwealth..	--	--	--	--	--	1,142
Other countries.....	10	8	4	13	302	132
	2	8	2	--	13	172
Total.....	22	16	34	27	315	1,446

¹ Candied, drained, dried or preserved in liquid.

Official sources.

U.S. processors have developed a small market for industrial citrus juice in Australia and in 1960 over 1,000 gallons were sold; this total rose to about 16,000 gallons in 1961. Before the establishment of new higher duties on industrial juice, over 75,000 gallons of citrus juices were sold to Australia in the period July 1961-March 1962.

The Australian industry is striving continuously for protection from imports of concentrated juice for cordial manufacture. The Australian Citrus Growers' Federation has approached the Federal Government on numerous occasions, suggesting at one stage that citrus juice concentrates should be placed on a prohibited imports list, with the exception of lime juice, which is not produced in Australia. The Government referred these demands for additional protection to the Tariff Board.

Following strong representations by the citrus industry and the juice canning interests, the Australian Government provided increased protection for the citrus industry from citrus juice imports, largely to prevent competition from a well-known U.S. product which had secured a significant share of the Australian market.

The increased duty rate was achieved through tariff reclassification of concentrated citrus juices with sugar added. Previously, such imports were classified under tariff item 16-B-1, "Fruit Juices, Syrups, and Substitutes," dutiable at 2 shillings 5-1/4 pence (27 cents) per gallon when in containers of less than one gallon. Under the new classification, these juice preparations will be considered concentrated basic citrus juice or -ades, dutiable at 2 shillings 6 pence (28 cents) per gallon single strength, with the four-to-one concentrate attracting a duty of 10 shillings (\$1.12) per Imperial gallon.

The revised tariff item classifies these concentrates as "a substitute for 4 times the same quantity of citrus juice classifiable under Tariff Item 16 (A) (2)." The tariff reclassification became effective May 10, 1962.

The new high duty rate on citrus juice concentrates is expected to prevent imports from the United States, or at least severely curtail them. During the 9 months, July-March 1961-62, imports from the United States totaled 55,484 imperial gallons.

Outlook

Mr. M. Dall, of the Australian Bureau of Agricultural Economics, in an article entitled, "The Australian Citrus Industry--Recent Trends and Future Prospects,"¹¹ indicates some of the factors to be evaluated as a part of the outlook for the future of the Australian citrus industry.

Mr. Dall said:

"The Australian citrus industry relies on the domestic fresh fruit market for the disposal of 75 percent of its output.

¹¹ The Citrus News, November 30, 1961.

Table 14.--CITRUS PRODUCTS: Australia, imports by country of origin, fiscal year 1961-62

Origin	Citrus juice			Essential oil			
	Orange	Lime	Other	Peel ¹	Lemon	Lime	Orange
	<u>1,000 U.S. gals.</u>			<u>1,000 pounds</u>			
Jamaica.....	--	--	--	--	--	4	--
South Africa, Union of.....	182	--	--	--	--	--	--
United Kingdom.....	--	--	(²)	--	1	1	--
Windward Islands.....	--	63	--	--	--	13	--
Other Commonwealth.....	1	8	--	--	--	1	28
Italy.....	--	--	--	--	19	--	7
United States.....	36	--	87	--	11	--	--
Other countries.....	6	6	3	13	3	1	26
Total.....	225	77	90	13	34	20	61

¹ Candied, drained, dried and preserved.

² Less than 500.

Table 15.--CITRUS JUICE: U.S. exports to Australia, 1960-1962¹

Item	1960	1961
Grapefruit Juice:	<u>Gallons</u>	<u>Gallons</u>
Single strength.....	300	--
Concentrate, hot pack.....	--	240
Orange Juice:		
Single strength.....	114	--
Concentrate, frozen.....	1,044	7,900
Concentrate, hot pack.....	--	7,798

¹ No juice exports were reported for 1957, 1958, or 1959.

Source: U.S. Bureau of the Census.

Exports, almost entirely of fresh fruit, absorb about 6 percent to 7 percent of the crop. Official statistics are not available, but industry estimates suggest that at present nearly 20 percent of the crop is processed.

"Domestic supplies are supplemented by relatively small imports of citrus products--mainly juice and jams. In 1959-60, of 89,000 gallons of imported juice, 43,000 gallons were lime juice, which is not produced in significant quantities in Australia. . .

"It is generally accepted that increasing real income per head raises the level of expenditure on foodstuffs, although in a lesser proportion. In the high-income countries--of which Australia is one--greater expenditure on food does not necessarily involve a greater volume of intake, but rather changes of preference for more processed, more expensive or more expensively packed foods. If it is accepted, that the deflator used in this study provides a reasonable indication of changes in money values, there is no evidence of any income effect in Australia on the consumption of citrus, which is generally regarded as a high priced fruit. In fact, over the decade reviewed, there was a slight downward trend in expenditure per head, as represented by gross values of production per head. . .

"The recent establishment of processing plants for the production of frozen juice concentrate has apparently raised hopes in some quarters that the overall consumption of citrus will increase as a result. . .

Table 16.--CITRUS: Australia, production 1958-59 and projected requirements, 1970 and 1975¹

Variety	1958-59	1970	1975
	Million <u>boxes</u>	Million <u>boxes</u>	Million <u>boxes</u>
Oranges:			
Valencias.....	2.13	2.83	3.12
Navels.....	1.75	2.22	2.44
Other.....	.18	.14	.16
Tangerines.....	.25	.36	.40
Grapefruit.....	.19	.22	.25
Lemons.....	.36	.58	.65
Total.....	4.86	6.35	7.62

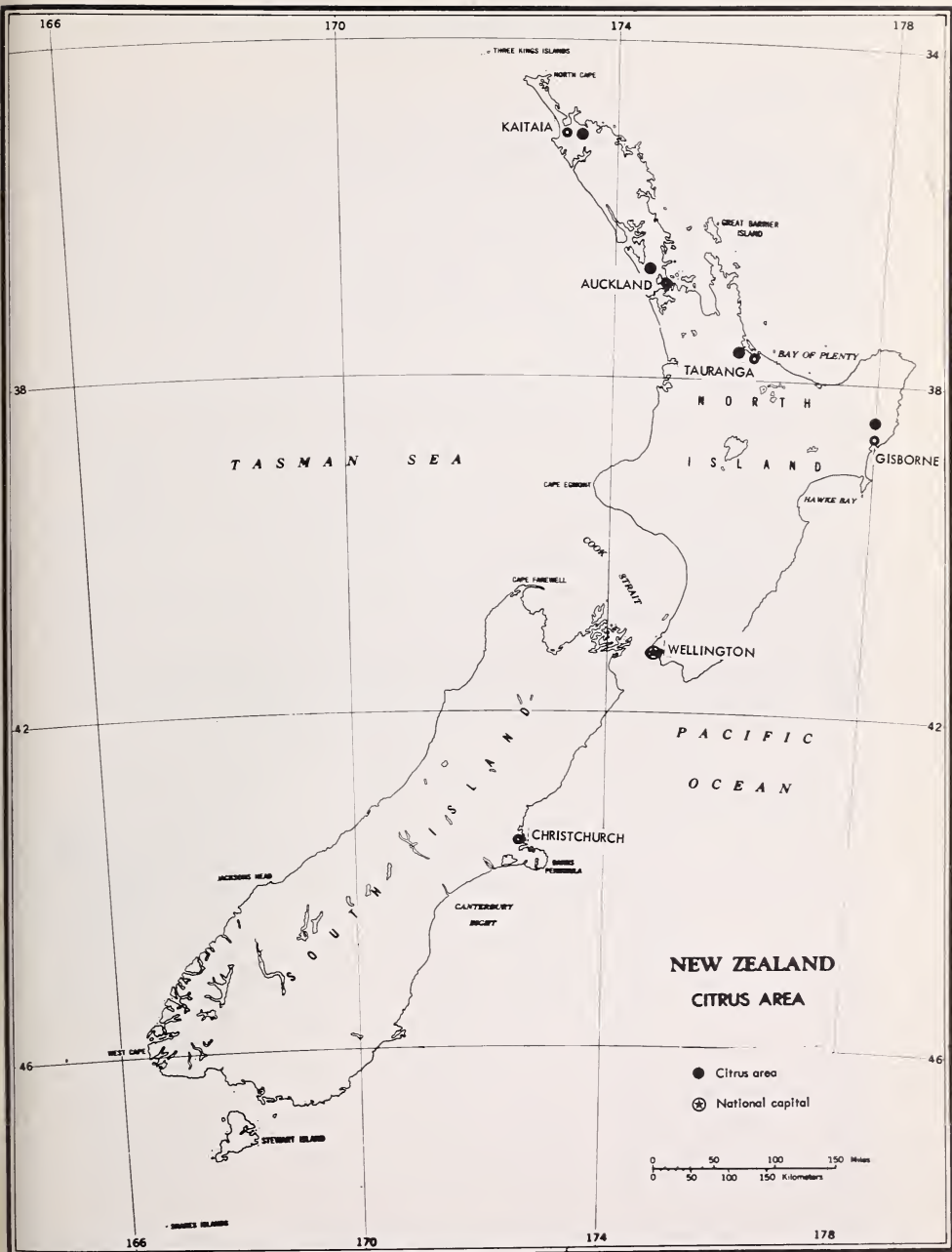
¹ Converted to boxes of the following weights: oranges and tangerines, 70 pounds; grapefruit, 80 pounds; and lemons, 76 pounds. Because of revisions, these data may not compare exactly with other production data.

Source: M. Dall, Australian Bureau of Agricultural Economics.

"However, it would be imprudent to assume that the expansion of processing facilities in Australia will automatically result in increased consumption per head of citrus, but overseas experience does indicate that increased use of processed citrus products, especially frozen or chilled orange juice concentrate, is likely. The price at which such products can be retailed, and the effectiveness of promotion, will largely determine the rate of increase. However, there are several factors which may militate against rapid expansion of frozen concentrate output during the next few years.

"Reference was made earlier to the possible limitations imposed by the quantity of fruit available on trifoliata rootstock. While processors may partly overcome this problem by importing bulk supplies of juice for blending with the local product, the duty-paid landed cost of imports may prove detrimental in increased consumption. . .

"One other aspect of processing warrants mention. Food canning by the usual hot-pack process enables seasonal surpluses to be processed on a large scale without creating acute storage problems. This helps to even out fluctuations in prices from year to year, and may permit sales of produce which otherwise would have to be dumped. Frozen orange concentrate, in contrast, must be cold-stored within optimal temperature ranges and the availability and cost of storage may limit the effectiveness of this type of processing as a device for avoiding gluts on the fresh market. . ."



NEW ZEALAND INCLUDING THE COOK ISLANDS

New Zealand

New Zealand is a marginal citrus producer, supplementing domestic production with imports. Sweet oranges and mandarins have been grown in New Zealand for many years, but they need hot summers and mild winters to attain highest quality, and the New Zealand climate is marginal for their successful production. The Department of Agriculture considers that certain selection propagated on the hardy root-stock *Poncirus trifoliata* are adapted to the climate and produce good crops of fruit.

It is believed that the best types of locally grown oranges and mandarins, if carefully processed and graded, are of sufficiently good quality to meet consumer approval, but until larger supplies of fruit from the recent plantings reach the market over the next few years, this cannot be confirmed.

While orange production, including tangerines and sevilles, may increase in the future, present production is less than 5 percent of domestic consumption.

In contrast, about 80 percent of the lemons used in New Zealand are produced by the domestic industry. Of the 48,000 boxes produced in the 1961-62 season about 20 percent were Meyer lemons. No new plantings of Meyers are being made and interplanting of many trees of this variety with other

Table 17.--FRESH CITRUS FRUIT: New Zealand, production and imports,
1951-1962¹

Cal. Year	Production			Imports		
	Oranges	Lemons	Grapefruit	Oranges	Lemons	Grapefruit
	1,000 boxes ²	1,000 boxes ²	1,000 boxes ²	1,000 boxes ²	1,000 boxes ²	1,000 boxes ²
1951.....	17	49	78	292	5	16
1952.....	12	53	81	489	0	13
1953.....	13	39	83	423	4	19
1954.....	13	38	72	387	7	10
1955.....	12	42	62	462	3	15
1956.....	10	44	46	436	5	15
1957.....	11	37	75	366	4	11
1958.....	11	53	76	387	2	(3)
1959.....	14	47	80	425	8	7
1960.....	14	51	90	398	3	10
1961.....	17	50	81	370	--	--
1962.....	24	62	77	410	--	--

¹ Exports negligible.

² Boxes of the following weights: oranges, 70 lbs.; lemons, 76 lbs.; grapefruit, 80 lbs.

³ Less than 500 boxes.

Note: From reports of Daniel E. Brady, Agricultural Attaché, and K. P. Ryan, American Embassy, Wellington, New Zealand.

citrus will limit their life. Numbers of Meyer trees have decreased by 6 percent since 1958, and this trend seems likely to continue. Although new plantings of lemons are still being made in the Bay of Plenty and at Gisborne, they are not sufficient to replace trees removed because of old age.

New Zealand is nearly self-sufficient in grapefruit, importing less than 10 percent of fruit consumed, in recent years. Domestic production of 81,000 boxes in 1961-62 consisted mostly of "New Zealand" grapefruit but it included over 3,000 boxes of "Wheeney" grapefruit. "New Zealand" grapefruit, a grapefruit species, is also known as the "Poorman's Orange" and is described on page 584 of the University of California publication The Citrus Industry by Webber and Batchelor.

Grapefruit plantings were extended in the early 1950's, but by 1958 some groves were reported to have been abandoned because of low prices. Little future expansion of grapefruit planting is expected.

While the northern half of New Zealand is reasonably well adapted to the production of citrus fruits, there is little real interest in placing production on a commercial basis. Production is, however, sufficient to satisfy local demands during certain seasons of the year. Citrus trees are commonly found in the yards of both town and country homes, but the actual number of commercial citrus orchards is very small. Since 1955 production of sweet oranges, lemons (both "Standard" and Meyer) and grapefruit has declined considerably, although there has been some increase in the number of orange, mandarin and tangelo trees.

Planted area.--In 1958, the New Zealand Department of Agriculture surveyed the citrus area and reported commercial plantings in thousands of trees as: oranges, 71; grapefruit, 48; lemons, 41; mandarins, 13; and tangelos, 1.

Citrus Season.--Blooming takes place in the spring months of October and November, with production confined largely to the period from July-September in the following calendar year. The harvesting runs from May well through December. Wheeney grapefruit may be harvested as late as December, and a few are picked in the following January.

Utilization of the Crop.--About 5 percent of the Meyer lemons are used for processing into juice, and 95 percent being consumed as fresh fruit. The oranges are all sold as fresh fruit to New Zealand's 2.3 million consumers.

About 10 percent of the grapefruit are processed into marmalade, and the balance consumed as fresh fruit.

In 1959, 62.21 percent of standard lemons was consumed as fresh fruit, 19.08 percent was manufactured into peel, and 16.44 percent was processed.

Domestic citrus consumption is estimated at 19 to 20 pounds of fruit per capita.

Marketing Controls.--The Citrus Marketing Authority Regulations, 1953, provided the Citrus Marketing Authority with the task principally of selling fresh lemons, either directly or through agents throughout New Zealand at prices



Work in citrus orchards, New Zealand. Above, spraying lemon trees, Tauranga in Bay of Plenty. Below, harvesting sweet Valencia oranges, Kerikeri, North Auckland. Chief potential for citrus expansion appears to lie in orange and mandarin output; present production meets only 3 percent of demand.

Credit: National Publicity Studios, Wellington, New Zealand.



Above, Three-year-old orange trees in commercial orchard, New Zealand.
Below, grading lemons in citrus packing house, Tauranga, Bay of Plenty.
Credit: New Zealand Department of Agriculture.



related to cost of production, and secondarily of processing unmarketable but otherwise sound fruit into by-products, such as fruit juice and lemon peel. The Authority has a membership of five, four of whom are nominees of the New Zealand Citrus Council and represent the producers, and one of whom, appointed by the Minister of Agriculture, represents the consumers.

The Citrus Marketing Authority is now empowered to control the assembly and distribution of New Zealand lemons, including the variety known as the Meyer lemon (hitherto exempt from regulation), and also New Zealand-grown sweet oranges. The entire output of packed lemons, which now comes under the jurisdiction of the Authority, is sold at agreed prices to Fruit Distributors, Ltd. The Authority has taken over the processing and packing facilities at Kerikeri, Auckland and Tauranga, and most of the staff previously associated with this work.

Since the beginning of 1951 the importation and marketing of imported citrus fruits, bananas, pineapples and grapes have been taken over by Fruit Distributors, Ltd., representing trade interests.

Foreign Trade.--In addition to New Zealand and Cook Island fruit, the major supplies of oranges are obtained from Australia, supplemented by seasonal supplies from Cyprus, Jamaica and the United States. A part of the Jamaican fruit sold in New Zealand consists of the "kid glove" orange, the Ortanique. Oranges are imported every month of the year.

Imports of oranges by month for 1960 are shown in the following table:

<u>Month</u>	<u>1,000 boxes</u>	<u>Month</u>	<u>1,000 boxes</u>
January	70	July	58
February	16	August	28
March	13	September	58
April	34	October	45
May	28	November	19
June	34	December	23

Small quantities of lemons are imported from California. For the first time in many years New Zealand imported grapefruit from the United States in 1960. On February 17 the "Monterey" brought 7,500 cases, and the "Mariposa" a similar amount in Auckland. In April, a further shipment of 7,500 cases arrived on the "Argentinean Reefer." These grapefruit are from California and have been well received on the New Zealand market.

Citrus Juices.--Nearly all citrus juice is imported for direct and industrial consumption. In 1960, imports included 58,000 gallons of unsweetened citrus juice and 62,000 gallons of "bulk" unsweetened citrus juice.

Table 18.--CITRUS FRESH: New Zealand, imports by country of origin, annual 1956 and 1961.¹

Country of origin	Oranges		Lemons		Grapefruit	
	1956	1961	1956	1961	1956	1961
	- - - - 1,000 - - - - Boxes ²					
Australia.....	324	211	--	--	--	--
Cyprus.....	--	81	--	1	--	--
Jamaica.....	78	53	--	--	15	2
South Africa, Union of	35	18	--	--	--	--
United States.....	25	35	3	2	--	8
Total.....	462	398	3	3	15	10

¹ Exports negligible.

² Boxes of the following weights: oranges, 70 pounds; lemons, 76 pounds; grapefruit, 80 pounds.

Table 19.--CITRUS JUICES, UNSWEETENED: New Zealand, imports by country of origin, 1956, 1959, and 1960.

Country of origin	Bulk			Other containers		
	1956	1959	1960	1956	1959	1960
	U.S. <u>gals.</u>	U.S. <u>gals.</u>	U.S. <u>gals.</u>	U.S. <u>gals.</u>	U.S. <u>gals.</u>	U.S. <u>gals.</u>
Europe:						
Cyprus.....	--	--	250	--	--	--
Italy.....	11,054	4,062	2,825	1,221	--	--
Spain.....	2,964	1,017	6,927	--	--	--
United Kingdom.....	7,320	13,032	12,327	703	29	733
Total, Europe.....	21,338	18,111	22,329	1,924	29	733
Australia.....	3,120	3,291	6,800	2,042	5,497	4,564
British Guiana.....	711	303	--	--	--	--
China.....	--	--	--	--	--	967
Fiji Islands.....	3,918	--	--	--	--	--
Israel.....	--	--	5,183	901	58	346
Jamaica.....	12,422	1,080	2,139	29,679	--	21,989
Japan.....	--	--	131	--	62	2,374
Leeward and Windward Islands.....	7,636	10,053	13,581	--	--	--
Rhodesia, Fed. of.....	--	289	--	118	--	--
South Africa, Union of.....	1,870	5,790	10,087	939	3,720	6,721
Tonga.....	3,077	10,140	4,424	--	--	--
Trinidad and Tobago.....	4,411	1,237	3,177	50,020	14,407	31,992
United States.....	--	--	6,726	--	26	--
Total imports.....	58,503	50,294	74,577	85,623	23,799	69,686

The United Kingdom was the major supplier of "bulk" juices which probably included bases for "squash" drinks. The West Indies and Tonga were important sources of supply, and some juice was obtained from both Australia and South Africa.

With the exception of small purchases in Spain and Italy, juice imports are confined to British Commonwealth sources.

The Cook Islands

The Cook Islands are New Zealand territory, and citrus grown there supplements New Zealand supplies. This trade is not included in either New Zealand production or import data.

These islands, sometimes called New Zealand's tropical province, stretch from 9° to 23° South latitude, east of Samoa and west of Tahiti, in approximately the same location in the South Pacific as that occupied by the Hawaiian Islands in the North Pacific. The fifteen Cook Islands (excluding Niue Island) are divided into two groups; seven in the northern group and eight in the southern.

The Cook Islands Department of Agriculture is active in the fields of citriculture, experimentation, education, the maintenance of citrus, coconut and banana nurseries, fisheries, afforestation, quarantine and the grading and inspection of produce for export.

Ownership of land is based on custom. Tenure provisions are contained in the 1915 Cook Island Act, as amended. Sale of land is prohibited by law. Practically all of the land is native-owned by way of custom or is native freehold, as defined in the Act. Very few pieces are owned by single individuals. In the great majority of cases the "family" (as in the case of the clan) own the property. Thus, many individuals customarily share ownership in very modest-size land areas.

Section 50 of the Cook Islands Amendment Act of 1946 grants jurisdiction to the Native Land Court to validate an agreement reached by owners of a piece of land whereby an individual is given an "occupational right" to part of that land for operational purposes. Thus it is possible to bring together for operational purposes, land of many and varied interests and so provide a tenure security that makes it possible to farm property over a considerable number of years. It is also possible in this way to construct buildings and make other permanent improvements. It is this provision that has made the citrus scheme possible and it could perhaps be used to advantage in the growing of peanuts, coffee, spices and other crops.

Citrus Scheme. -- Commercial orange production under the Citrus Replanting Scheme was begun in 1945. Oranges were even then not new to Cook Islands. Even before the turn of the century there was a sizable trade between the southern group and New Zealand. Orange seedings, however, tended to go wild, with resultant lowering in production and quality. To

overcome this difficulty the Government in 1937 introduced the Citrus Replanting Scheme. Nurseries were established for late Valencia oranges, and for a local hybrid, Rarotonga Seedless. To date, approximately 450 acres have been planted, half on Rarotonga, the balance on Aitutaki, Mauke and Atiu.

This scheme is under the direction of the Cook Island Department of Agriculture. The Department has in the past assumed the responsibility of preparing the land, planting, fertilizer treatments, spraying, pruning and cultivation, as well as planting of shelter belts and cover crops. This has permitted certain economies of scale, as well as ensuring that a reasonable standard of grove management was maintained. The "costs" have, however, been charged back to the grower, to be paid as soon as the revenue from the new groves make this possible. The longer range objective is to turn over the maintenance of the groves to the owners, with the Department furnishing advisory and certain other technical assistance. A reasonable degree of success has been attained along these lines. In general, the groves are small and average around one acre each. There are, however, a great many half-acre (45-tree) groves. There are also some of three to four acres, and a few up to seven or ten acres.

Finance for the scheme is provided by the New Zealand Government. Interest-bearing loans, and to a lesser extent grants, have been used in bringing in of the extra production, erection of grading and storage sheds, and providing of certain equipment. As of September 30, 1960, advances outstanding to growers under the Citrus Replanting Scheme totaled about \$500,000.

For 1961, total orange production totaled 81,800 cases, 24,000 cases above the previous year. Most of this output is attributable to the citrus scheme. In this season, 14,000 cases of tangerines, 6,000 cases of mandarins, 2,200 cases of grapefruit and 1,300 cases of lemons were exported.

At Rarotonga there have been installed very modern grading, gassing and packing facilities. Oranges are washed, waxed, and polished. Now, also, consideration is being given to the question of whether or not to color the fruit.

Citrus fruit is purchased from the growers for export to the New Zealand market, with the first shipments usually arriving in April. The fruit is sold at fixed f.o.b. prices which are negotiated annually with Fruit Distributors, Ltd., the sole importer of citrus into New Zealand. The Government thus, in effect, guarantees the purchase and shipping of satisfactory quality, where there is a market for it in New Zealand. A Fruit Advisory Committee consisting of the Resident Commissioner, Director of Agriculture, three elected members from Rarotonga, and one elected European member, represent the growers' interest. The responsibility and authority for implementing the recommendations rests with the Resident Commissioner. Relationships with Fruit Distributors are amicable, with the Commissioner promoting the

interests of the producer and Fruit Distributors, having regard for normal commercial practices and the interest of the distributive trade in New Zealand.

While availability and prices of oranges from other sources, and changes in consumer preferences, have an inevitable unstabilizing effect, nevertheless the realization of the islands' need to export citrus is appreciated by all concerned. Currently Fruit Distributors have pointed out the lessening demand in New Zealand for tangerines and mandarins. While Meyer lemons are produced in the Cook Islands, they are also available in New Zealand, and for that reason the islands' fruit is not exported in any quantity.

This past year private interest from New Zealand have installed a canning plant in Rarotonga. To date, production has been limited to orange juice and pineapple, although other possibilities are also being investigated. It is expected that out of the recent season's production, 20,000 cases (1-1/2 bushel) will be juiced and canned for the New Zealand market. The first shipment (13 oz. cans), selling retail at 25 cents, became available in New Zealand during July 1961. While New Zealand is primarily a fresh fruit market, indications are that the canned juice has been well received by consumers. The canning plant makes it possible to dispose of citrus otherwise not as suitable for the fresh market. The plant should also provide a more stable market for the production from other islands in the southern group, where shipping to New Zealand is not regularized or where costs of transshipping via Rarotonga place such a heavy charge on the oranges as to raise a serious question with regard to the overall economics involved.

From the standpoint of the commercial processor, it would appear that an increasing volume and diversification will be necessary to place the new plant's operations on an economic basis. In the meantime, the firm is receiving substantial governmental assistance and encouragement, and is reported reasonably satisfied with what progress has been made to date.

In addition to citrus fruits, principal exports of the Cook Islands are copra and tomatoes, together with smaller and more irregular exports of pineapple, bananas and manufactured goods. Paua (or mother-of-pearl shell) has been, however, in times past the most profitable export from the islands.

Total exports of citrus fruits are reported as 61,000 boxes in 1956; 80,000 boxes in 1957, 78,000 boxes in 1958, 106,000 boxes in 1959, and 94,000 boxes in 1960.

APPENDIX

Table 20.--Yield and composition of juices from Valencia Oranges on three rootstocks¹

Season	Rootstock									Overall Annual Mean		
	Trifoliolate orange			Rough lemon			Sweet orange					
	Mean	S.E.	No. of obs.	Mean	S.E.	No. of obs.	Mean	S.E.	No. of obs.	Mean	S.E.	No. of obs.
	<u>Juice Yield percent by weight of fresh fruit</u>											
1951.....	49.0	1.1	13	45.2	1.1	13	46.6	1.4	7	46.9	0.66	33
1952.....	45.2	1.2	11	41.4	1.1	12	42.8	1.4	7	43.2	.70	30
1953.....	50.3	1.0	14	46.4	0.98	15	47.9	1.2	10	48.2	.61	39
Mean ²	48.2	0.62	38	44.3	0.60	40	45.8	0.78	24	d.f. = 93		
	<u>Soluble Solids Content °Brix by refractometer</u>											
1951.....	12.50	0.34	13	11.57	0.34	13	12.38	0.46	7	12.15	0.21	33
1952.....	11.78	0.37	11	10.86	0.35	12	11.67	0.46	7	11.44	.22	30
1953.....	12.53	0.33	14	11.61	0.32	15	12.42	0.39	10	12.19	.20	39
Mean ²	12.27	0.20	38	11.35	0.19	40	12.16	0.25	24	d.f. = 93		
	<u>Acidity (as citric acid) g/100 ml</u>											
1951.....	1.22	0.078	13	0.98	0.078	13	1.15	0.11	7	1.11	0.049	33
1952.....	1.29	.085	11	1.05	.082	12	1.22	.11	7	1.19	.052	30
1953.....	1.46	.076	14	1.23	.073	15	1.39	.089	10	1.36	.045	39
Mean ²	1.32	0.046	38	1.09	0.045	40	1.25	0.058	24	d.f. = 93		
	<u>Ascorbic Acid Content mg/100 ml</u>											
1951.....	58.4	2.3	13	57.4	2.3	13	61.9	3.1	7	52.9	1.4	33
1952.....	52.8	2.5	11	51.8	2.4	12	56.3	3.1	7	53.6	1.5	30
1953.....	63.7	2.2	14	62.6	2.1	15	67.2	2.6	10	64.6	1.3	39
Mean ²	58.3	1.3	38	57.3	1.3	40	61.8	1.7	24	d.f. = 93		

¹ Fruit from orchards at Richmond, Cornwallis, Wilberforce, Dooralong, Kulnura, and Leeton, N.S.W.; Irymple, Vice; and Berri and Fullarton, S.A.

² Mean over 3 years for each rootstock.

Source: The Influence of Rootstocks on the Composition of Oranges with Special Reference to Better Principles, by J. F. Kefford and B. V. Chandler, June 27, 1960.

Table 21.--Crude bitter principle content of Valencia orange peels and seeds

Origin and picking date	Rootstock					
	Trifoliolate orange		Rough lemon		Sweet orange	
	Peels	Seeds	Peels	Seeds	Peels	Seeds
	Mg 100g dry weight	Mg 100g dry weight	Mg 100g dry weight	Mg 100g dry weight	Mg 100g dry weight	Mg 100g dry weight
<u>Cornwallis, N.S.W.</u>						
1952 Oct.....	0.0	71	6.5	91	--	--
Nov.....	0.0	32	6.0	38	--	--
Dec.....	0.0	17	4.5	35	--	--
1953						
Jan.....	0.0	23	0.0	37	--	--
Oct.....	--	--	--	41	--	--
Nov.....	--	41	--	69	--	--
Dec.....	--	27	--	61	--	--
<u>Dooralong, N.S.W.</u>						
1952 Oct.....	0.0	30	12.5	53	5.0	41
Dec.....	0.0	6	4.5	17	2.5	15
<u>Richmond, N.S.W.</u>						
1953 Sept.....	--	21	--	23	--	14
Oct.....	--	21	--	77	--	51
Nov.....	--	--	--	41	--	3
<u>Irymple, Vic.</u>						
1952 Dec.....	0.0	22	1.5	53	0.0	56
1953 Nov.....	--	7	--	--	--	22
<u>Berri, S.A.</u>						
1952 Nov.....	--	--	3.0	70	0.0	77
1953 Oct.....	--	--	--	22	--	50
<u>Fullarton, S.A.</u>						
1952 Nov.....	0.0	26	0.0	57	0.0	64
1953 Oct.....	--	7	--	90	--	15

Overall correlations with bitterness scores:

For peels: $r = 0.587$, d.f. = 20, $P < 0.01$;

excluding zero values for bitter principle content: $r = 0.489$, d.f. = 7, $P > 0.1$.

For seeds: $r = 0.405$, d.f. = 40, $P < 0.01$.

Source: The Influence of Rootstocks on the Composition of Oranges with Special Reference to Bitter Principles, by J. F. Kefford and B. V. Chandler, June 27, 1960.

Table 22.--Yield and composition of juices from navel oranges on three rootstocks¹

Season	Rootstock									Overall annual mean		
	Trifoliolate orange			Rough lemon			Sweet orange					
	Mean	S.E.	No. of obs.	Mean	S.E.	No. of obs.	Mean	S.E.	No. of obs.	Mean	S.E.	No. of obs.
	<u>Juice Yield percent by weight of fresh fruit</u>											
1951.....	40.3	0.93	10	38.2	1.0	8	40.2	1.7	3	39.6	0.64	21
1952.....	41.0	1.1	7	38.9	1.1	7	40.9	1.2	6	40.2	0.66	20
1953.....	41.0	0.98	9	38.9	0.93	10	40.9	0.93	10	40.2	0.55	29
1954.....	40.4	1.1	7	38.3	1.1	7	40.3	1.2	6	39.7	0.66	20
1955.....	41.7	2.1	2	39.5	1.7	3	41.5	2.1	2	40.9	1.1	7
Mean ²	40.9	0.50	35	38.8	0.50	35	40.7	0.56	27	d.f. = 82		
	<u>Soluble Solids Content ^oBrix by refractometer</u>											
1951.....	12.18	0.37	10	11.53	0.41	8	11.88	0.68	3	11.86	0.26	21
1952.....	11.87	.44	7	11.22	0.44	7	11.57	.48	6	11.55	.26	20
1953.....	11.95	.39	9	11.30	0.37	10	11.65	.37	10	11.63	.22	29
1954.....	11.74	.44	7	11.09	0.44	7	11.44	.48	6	11.43	.26	20
1955.....	10.22	.83	2	9.57	0.68	3	9.92	.83	2	9.90	.44	7
Mean ²	11.59	0.20	35	10.94	0.20	35	11.29	0.23	27	d.f. = 82		
	<u>Acidity (as citric acid) g/100 ml</u>											
1951.....	1.00	0.097	10	0.90	0.11	8	0.91	0.18	3	0.93	0.067	21
1952.....	1.20	0.12	7	1.10	0.12	7	1.11	.12	6	1.13	0.069	20
1953.....	1.25	0.10	9	1.14	0.097	10	1.16	.097	10	1.18	0.057	29
1954.....	1.33	0.12	7	1.23	0.12	7	1.24	.12	6	1.27	0.069	20
1955.....	0.99	0.22	2	0.89	0.18	3	0.90	.22	2	.93	0.12	7
Mean ²	1.15	0.052	35	1.05	0.052	35	1.06	0.059	27	d.f. = 82		
	<u>Ascorbic Acid Content mg/100 ml</u>											
1951.....	50.4	2.1	10	54.0	2.4	8	53.1	3.8	3	52.5	1.4	21
1952.....	51.1	2.5	7	54.7	2.5	7	53.8	2.7	6	53.2	1.5	20
1953.....	55.7	2.2	9	59.3	2.1	10	58.4	2.1	10	57.8	1.2	29
1954.....	57.4	2.5	7	61.0	2.5	7	60.1	2.7	6	59.5	1.5	20
1955.....	46.7	4.7	2	50.3	3.8	3	49.4	4.7	2	48.8	2.5	7
Mean ²	52.3	1.1	35	55.9	1.1	35	55.0	1.3	27	d.f. = 82		

¹ Fruit from orchards at Cornwallis, Yarramundi, Freeman's Reach, Griffith, and Yanco, N.S.W.; Irymple, Vic.; and Fullarton and Waikerie, S.A.

² Mean over 5 years for each rootstock.

Source: The Influence of Rootstocks on the Composition of Oranges with Special Reference to Better Principles, by J. F. Kefford and B. V. Chandler, June 27, 1960.

Table 23.--Crude bitter principle content of navel orange peels (mg/100 g dry weight)¹

Origin and picking date	Rootstock					
	Trifoliate orange	Rough lemon	Sweet orange	Kusaie lime	Cleopatra mandarin	Tangelo
	<u>Mg/100 dry weight</u>					
<u>Cornwallis, N.S.W.</u>						
1952 May.....	0.0	6.5	5.0	15.0	--	1.0
June.....	0.0	6.0	5.0	7.0	0.0	1.5
July.....	0.0	5.0	3.0	6.0	0.0	0.0
Aug.....	0.0	6.5	2.0	6.0	0.0	0.0
Sept.....	0.0	2.0	0.0	0.0	--	0.0
1953 May.....	0.0	10.0	3.0	9.0	1.5	0.0
June.....	0.0	8.0	2.8	2.3	1.9	0.0
July.....	0.0	7.5	1.5	1.5	2.0	0.0
Aug.....	0.0	6.4	1.0	2.2	2.5	0.0
Sept.....	0.0	4.2	0.0	2.1	--	0.0
<u>Irymple Vic.</u>						
1953 June.....	1.0	3.0	1.0	--	1.5	--
Aug.....	--	--	3.4	--	0.4	--
					Sweet Lime	E. Indian Lime
<u>Yarramundi, N.S.W.</u>						
1952 June.....	3.5	5.0	3.5	11.5	16.0	11.0
Aug.....	0.0	--	0.9	--	7.0	--
1953 May.....	0.0	10.0	1.5	15.5	6.5	3.0
June.....	0.0	6.5	0.0	13.6	13.0	7.5
July.....	0.0	4.0	--	11.0	9.0	7.0

¹ Overall correlation with bitterness scores: $r = 0.733, d.f. = 87, P < 0.001$; excluding zero values for bitter principle content: $r = 0.651, d.f. = 58, P < 0.001$.

Source: The Influence of Rootstocks on the Composition of Oranges with Special Reference to Bitter Principles, by J. F. Kefford and B. V. Chandler, June 27, 1960.

