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SUPPLY AND DEMAND  
PROJECTIONS FOR NEW ZEALAND  
CITRUS 1973-77

By  
R.W. Cartwright



COMMODITY REPORT No: 3 - JUNE 1973

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SUPPLY AND DEMAND PROJECTIONS FOR

NEW ZEALAND CITRUS 1973-77

by

R.W. Cartwright

Market Research Centre,  
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Palmerston North.

Commodity Report No.3  
June 1973

## Preface

One of the objectives of the Market Research Centre is to publish up-to-date marketing analyses and information concerning commodities of importance to the New Zealand economy. In keeping with this aim, the present publication - the third in the Centre's Commodity Report series - describes projections of supply and demand in the domestic citrus market over the period 1973-77.

As noted in the text, the study was severely constrained by a paucity of high-quality market data. Despite this, the projections show clearly that the citrus industry will face a severe depression in product prices and income unless immediate action is taken to stimulate consumer demand for citrus products.

This report provides warning of a potentially undesirable market situation, but it does not purport to provide solutions to the marketing problems that it exposes. Urgent attention should now be given to the development of new marketing systems that will encourage and sustain a massive increase in citrus consumption in New Zealand. The Market Research Centre has in progress an investigation of consumer needs and attitudes, and the results of this work will be available shortly. However, the scope of this research falls far short of the requirements suggested by this report, and a comprehensive programme of market research should be planned immediately.

R.W. Cartwright  
DIRECTOR

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SUMMARY

The New Zealand citrus industry is currently expanding more rapidly than at any other time in its history. In this situation, projections of future market trends are essential to responsible market planners. This report describes a modest attempt to provide information concerning trends in supply and demand of New Zealand grapefruit, tangelos, mandarins, oranges, and standard lemons over the period 1973-77. The scope of the study was limited by inadequacies in basic data, a deficiency which should concern the citrus industry.

Note that the projections developed should not be regarded as forecasts or predictions. Projections are logical developments of existing historical data and specific assumptions concerning social and market behaviour. They are developed to provide information to market planners and, because market plans change as a result of the review of projections by planners, one should not generally expect projections to be actually attained. The assumptions made and the procedures used in this study are described in the main text.

Projection of Fruit Supply

Increases in supply are projected for all fruits, with particularly rapid growth rates occurring in New Zealand grapefruit and tangelos. Compared with 1972 production, grapefruit supply is projected to increase by more than 250% by 1977, with a four-fold increase in tangelos. On the same basis, expected increases of 150%, 180% and 224% are projected for mandarins, oranges, and standard lemons respectively.

Projections of Demand for Fruit

The projections express demand for all citrus products in terms of demand for each type of fruit. Increases in demand due to growth in population and national income, at constant 1972 prices, are projected to be comparatively modest. Using 1972 supply as a base, the expected projected increases in 1977 are:

New Zealand grapefruit :	38,900 bu.
Tangelos :	10,100 bu.
Oranges :	132,500 bu.
Mandarins :	7,900 bu.
Standard lemons :	18,200 bu.

Comparison of Projected Supply and Demand

Substantial excesses of supply over demand are projected in all years for all fruits except oranges, for which a relatively small excess demand is projected.

Expressed as percentages of total supplies in 1972, the excesses of supply over demand in 1977 are projected as:

(iii)

New Zealand grapefruit :	139%
Tangelos :	288%
Mandarins :	42%
Standard lemons:	108%

Unless excess supplies can be equated by additional demand stimulated and induced by the citrus industry, prices at retail and prices received by growers are projected to fall drastically. For example, in the absence of any action to stimulate demand, average retail prices in 1975 are conservatively projected to fall by the following percentages of 1972 prices:

New Zealand grapefruit :	30%
Tangelos :	40%
Mandarins :	11%
Standard lemons :	41%

Further substantial declines in prices are projected for grapefruit and tangelos in 1976 and 1977.

#### Implications of the Projections for the Citrus Industry

The projections imply early and drastic depressions in prices unless urgent steps are taken to stimulate consumer demand. In the absence of such action, growers of tangelos, grapefruit, and standard lemons are projected to be placed under a severe cost-price squeeze, and this would be attended by pressure on processors and distributors to reduce their margins. On the basis of the projections, success in processing and distribution will depend crucially on diversification into new products, penetration of existing and new products into present retail outlets that have not previously handled citrus, and the development of new forms of outlet. These developments will not take place easily or at low cost. Innovation in processing technology is especially costly. Considerable scope will exist for individual firms to secure competitive advantages through innovative developments in processing and marketing. Nevertheless, it is clear that the industry as a whole would benefit from a centrally planned and directed programme of promotion for citrus fruits and their products. The low overall level of citrus consumption in New Zealand, relative to consumption in several other developed economies, leads the writer to suspect that such a programme could well produce spectacular results.

The Market Research Centre is currently engaged on an examination of consumer attitudes to fresh citrus and citrus products, and it is envisaged that this study will provide further information to market planners in the industry.



Supply and Demand Projections for

New Zealand Citrus 1973-77

1. Introduction

The New Zealand citrus industry is currently expanding more rapidly than at any other time in its history. The expansion is now at a point where relatively large new plantings established over the past five years are beginning to reach bearing age. Consequently, substantial increases in supply of fruit can be expected over the next five years and beyond. Casual observers may well suppose that these increases in supply will depress fruit prices unless new marketing strategies designed to stimulate demand are introduced. In view of the hardship that this eventuality would impose on growers and processors - especially those who have established their operations in the expectation that prices for fruit and citrus products would be maintained - it is remarkable that comprehensive examinations of market trends have not been undertaken. Although projections of the supply of some fruit types have been developed, principally by Fletcher [3,4]<sup>1/</sup> who has focussed most attention on New Zealand grapefruit and tangelo production, there has apparently been no recent attempt to project demand for citrus. Consequently, it has not been possible to compare supply and demand trends with a view to identifying undesirable market situations that may occur in the future. In short, a lack of sufficient information has precluded any informed attempt to develop marketing strategies for the industry as a whole and for the growers, processors, and distributors in it.

This report describes a modest attempt to provide more information about the future trends in the supply and demand of New Zealand grapefruit, tangelos, mandarins, oranges, and standard lemons. The projections prepared in the study relate to the period 1973-77. The report has three main parts. The first, contained in Section 2 describes projections of annual supplies of each type of fruit. Section 3 then turns to the demand side of the market, and projects annual consumer demand for citrus. These two series of projections are reconciled in Section 4, which also makes tentative suggestions concerning appropriate marketing strategies for the future.

The scope of the study was severely limited by inadequacies in data relating to fundamental issues such as the productivity of citrus trees, and the consumption levels and prices of the various citrus products. This scarcity of high-quality data should be a source of considerable concern to the industry.

Before proceeding, it is necessary to emphasise that this report does not contain forecasts or predictions. The report does, however, present projections, and it is important to distinguish these from forecasts. Market projections are logical developments of known market data and specific assumptions concerning the future behaviour of society and of the firms and individuals who participate in the market.

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1. Numbers in parentheses refer to references listed at the end of the main text.

Projections state what would happen in the future if observable trends continue and if the behavioural assumptions made are vindicated. In general, however, one should not expect future realisation of market projections. This is because the projections themselves constitute new information that can be used by market managers. If projections suggest that an undesirable market situation will develop unless remedial action is taken, this information may well induce market managers to act. The result of this will be a change in market behaviour. In general, then, market projections become obsolete and should be revised as soon as market managers have taken an opportunity to act on them. This characteristic illustrates the essential difference between projections and forecasts. Projections are planning tools developed for use by marketing managers. Subsequent managerial action often implies a need to revise the projections. Forecasts, on the other hand, are forthright and unconditional assertions of what will happen in the future. Forecasts are based on the assumption that any managerial action taken after examining the forecasts will not affect the nature of the events being forecasted.

The actual assumptions used in developing the present projections are explicitly identified in the report.

## 2. Projections of Fruit Supply

The projection of marketable supplies of citrus fruits over the period 1973-77 is a conceptually simple operation. The bulk of the trees that will bear during the period were already planted by 1972, the last year for which planting data are available. In the absence of catastrophic falls in fruit prices that would induce growers to not harvest fruit, market supplies will therefore be directly related to tree numbers and yields. Thus fruit supply in any single year can be assumed to depend only on biological and physical factors, and can be considered to be independent of fruit price levels and input costs.<sup>2/</sup>

The procedure used in this study for projecting the supply of each fruit consists of making preliminary independent projections of bearing tree numbers and yield per tree. Multiplication of these pairs of projections then leads directly to projections of total supplies. This procedure contrasts with the one used earlier by Fletcher [4], who projected acreages planted, then applied standard yields per acre to obtain total supply. The method used here has the advantage of permitting adjustment of yields per tree according to the age of trees and changes in planting density, if appropriate data are available.

It was found in the present study, that the quality of data varied substantially between fruit types. Another complication arose from the relatively recent development of production

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2. Studies completed overseas, such as the one by French and Bressler [6] that considered lemon supply in California, have allowed for tree removal in response to low prices. Moreover, increases in the prices of fertiliser, insecticides and fungicides relative to fruit prices might induce growers to use less of these inputs, thereby depressing yields and marketable supplies.

A general lack of data concerning the presence or otherwise of these effects has resulted in their omission from the present analysis. However, more sophisticated research and analysis could well be rewarding to the citrus industry.

of some varieties, such as tangelos. In these cases, historical records of yields must be treated with considerable caution. For these various reasons, it was necessary to modify the general projection procedure described above to meet the specific requirements of projecting the supply of each fruit type. The following sections describe these projections.

### 2.1 Projected supplies of New Zealand grapefruit

The method chosen for projecting market supplies of New Zealand grapefruit consisted of:

- (i) Developing age-specific 'typical' estimates of yields per acre,
- (ii) Transforming these yield estimates to production levels per tree, taking account of changes in planting densities,
- (iii) Developing projections of tree numbers in the age categories specified by the yield estimates, and
- (iv) Computing the supply projections.

Estimates of 'typical' yields per acre were developed in consultation with citricultural advisers. These estimates are given in Table 1, together with estimates of yields per tree that were computed on the assumption that trees planted before 1971 have an average density of 145 per acre while those planted in 1971 and subsequently have average densities of 230 per acre. Note that these yield estimates do not account for any increases in production per acre that may result from high-density planting. Since the original estimates of per acre yields were based largely on expert observation of low-density plantings, the writer considers that the estimates of per-tree yields of high-density trees are conservative.

The projections of numbers of bearing trees given in Table 2 were developed from data supplied by the Ministry of Agriculture and Fisheries. Data obtained from the Ministry's 1968 Orchard Survey provided a census of tree numbers, classified into five-year age groupings. Estimates of tree-numbers in one-year classes were made by dividing each five-year total by five. Implicit in this procedure is the assumption that trees within each five-year group were uniformly distributed according to age in 1968. While this assumption is questionable, the ultimate projections are relatively insensitive to the age distribution of trees within five-year groups.

The two other categories of data used were Ministry estimates of plantings and removals in each year over the period 1969-72. In view of the assumption that initial bearing occurs four years after planting, estimates of plantings were required for 1973 and 1974. Plantings over the years 1970, 1971, and 1972 were 16,830, 29,850, and 37,290 trees respectively, indicating that annual plantings had increased, but at a decreasing rate. The 1973 and 1974 projections were computed on the basis that each annual increase is a constant proportion of the increase in the previous year. From the planting data for 1970-72, this proportion can be calculated as 0.57. Thus we have:

$$\begin{aligned} \text{Projected New Plantings (1973)} &= 37,290 + (0.57)(37,290 - 29,850) \\ &= 37,290 + 4,251 \\ &= 41,541 \end{aligned}$$

and, using this projection,

Table 1 : New Zealand Grapefruit: Estimated Yields

Age of trees (years from planting)	Yield per acre (bu.)	Yield per tree; low density plantings* (bu.)	Yield per tree; high density plantings** (bu.)
0 - 3	0	0.00	0.00
4	50	0.34	0.22
5 - 6	250	1.72	1.09
7 - 8	500	3.45	2.17
9 - 10	700	4.83	3.04
11 - 12	900	6.21	3.91
13 - 14	1,100	7.59	4.78
15 and older	1,150	7.93	5.00

\* 145 trees per acre

\*\* 230 trees per acre

Table 2 : New Zealand Grapefruit: Projections of Numbers of Bearing Trees

Year	Age of Trees (years from planting)						
	4	5 - 6	7 - 8	9 - 10	11 - 12	13 - 14	15 and older
Numbers of Bearing Trees							
1973	16,830	28,440	7,122	7,122	3,926	730	16,053
1974	29,850	36,270	12,561	7,122	7,122	730	15,566
1975	37,290	46,680	28,440	7,122	7,122	3,926	15,079
1976	41,541	67,140	36,270	12,561	7,122	7,122	14,592
1977	43,970	78,831	46,680	28,440	7,122	7,122	17,301

$$\begin{aligned}
 \text{Projected New Plantings (1974)} &= 41,541 + (0.57)(4,251) \\
 &= 41,541 + 2,429 \\
 &= 43,970.
 \end{aligned}$$

Projections of removals in each year 1973-77 were also required. On the assumption that all removals would be made from the tree group 15 years and older, the near-constancy of this population over the period 1968-77 justified use of the simple average removals 1968-72 as the projection.

Thus based on Ministry removals data:

$$\begin{aligned}
 \text{Projected Annual Removals (1973-77)} &= (510 + 2,360 + 550 + 1,100 + 250)/5 \\
 &= 852.
 \end{aligned}$$

Multiplication of the tree numbers given in Table 2 by the yield estimates shown in Table 1 provide projections of supplies from trees in each age class. These projections were aggregated within each year to give the supply projections presented in Table 3.<sup>3/</sup> It should be recalled that the yield estimates used result in the projections being conservative. Rapid growth rates in supply are projected. An increase of more than 70% over the 1972 supply level is projected for 1975, while 1977 supply is projected to be in excess of two and one half times the 1972 supply level.

## 2.2 Projected supplies of tangelos, mandarins, standard lemons, and oranges

Plausible age-specific yield estimates for tangelos, mandarins, standard lemons, and oranges cannot be obtained from the data available. Consequently, the method used for projecting grapefruit supplies cannot be applied to these fruits. The procedure actually adopted in this study projects bearing tree numbers, but does not classify these trees according to age. Average yields per bearing tree are then estimated on the basis of historical data and judgement.

Bearing trees are defined as those planted for five years and longer in the case of tangelos, mandarins and oranges, but for three years and longer in the case of standard lemons. Data obtained from the Ministry of Agriculture and Fisheries were used to develop the projections of bearing tree numbers that appear in Table 4. As in the case of grapefruit, removals were projected at the average rate of removals over the period 1968-72. Thus annual projected removals were 192, 418, 500 and 957 trees respectively for tangelos, mandarins, oranges and lemons.

It was also necessary to project new plantings; for 1973, 1974 and 1975 in the case of standard lemons, and for 1973 alone for the other three fruits.

After consultation with citricultural advisers, the projection for new lemon plantings was fixed at 2,500 trees in each year.

Again after consultation, tangelo plantings in 1973 were estimated at 22,500 trees, some 150 trees more than were planted in 1972.

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3. The projection procedure used was checked by applying the yield estimates to actual tree numbers in 1971 and 1972. This gave 'projections' of 199,200 and 228,600 bushels, respectively, compared with Ministry estimates of actual supplies in those years of 199,000 and 230,100 bushels. In the writer's view the 'projections' were sufficiently precise to validate the procedure.

Table 3 : New Zealand Grapefruit; Projections of Supply

Year	Projection of Supply* (bu.)	Projected Supply Expressed as Percentage of 1972 Supply	Excess of Projection Over 1972 Supply* (bu.)
1973	271,000	117.8	40,900
1974	319,900	139.0	89,800
1975	395,600	171.9	165,500
1976	481,700	209.3	251,600
1977	590,900	256.8	360,800

\* Projections are rounded to nearest 100 bushels.

Due to historical variability in the size of annual plantings, the projected plantings of mandarins and oranges in 1973 were computed as weighted averages of new plantings in the previous four years. Weights of 0.4, 0.3, 0.2, and 0.1 were applied to actual plantings in 1972, 1971, 1970, and 1969 respectively, thus attaching a reducing level of importance to more distant planting occasions. Thus we have:

Projected New Mandarin Plantings (1973)

$$\begin{aligned} &= (0.4)(8,940) + (0.3)(15,140) + (0.2)(12,060) + (0.1)(13,910) \\ &= 11,921 \end{aligned}$$

and

Projected New Orange Plantings (1973)

$$\begin{aligned} &= (0.4)(16,590) + (0.3)(19,980) + (0.2)(17,610) + (0.1)(15,570) \\ &= 17,709. \end{aligned}$$

As in the case of grapefruit, Ministry data was used to compute average annual yield per bearing tree over the period 1968-72 for each of the four fruit types considered in this section. Table 5 displays these yields. It is clear from the table that all fruits except lemons have in recent years produced relatively low yields per tree. For instance, while Fletcher's projections for tangelos [4] assumed an average yield per bearing tree of 2.74 bushels,<sup>4/</sup> average production per bearing tree in 1972 was still at less than 50% of that level. This situation may well be due to the presence of a very high proportion of young bearing trees at this stage in the development of tangelo production. Again, while Ministry data for some individual orchards indicate common orange yields of 2 bushels per tree, the table shows that the national average is substantially lower than this. Evidently, a high proportion of mature trees currently bear at very low levels. It is clear that the supply projections should be based on the average yields rather than on production levels attained from high-yielding orchards.

The projected yields per tree are shown in Table 6. Two series of projections are provided for each fruit type. The expected projections are, in a sense, average or 'most likely' yields. They are based on analysis of the historical data given in Table 5. In the case of tangelos, mandarins, and oranges, the projections are linear extrapolations of a linear trend fitted by a regression of yield on time. The standard lemon yield projection is a simple five-year average. Technical aspects of these derivations are detailed in the Appendix. Consultation with citriculturalists reveal strongly-held opinions that for each fruit there exists a minimum yield that future production levels would be 'most unlikely' to fall beyond. These minimum levels are reflected in the 'low' yield projections given in Table 6. The variances of the yield projections are given in the Appendix and could be used by interested readers to develop upper confidence limits on the supply projections. However, the discussion that follows is based on the more conservative projections provided by the expected and low yield series given in Table 6.

Multiplication of appropriate pairs of the tree and yield projections discussed above gives the final supply projections presented in Tables 7, 8, 9, and 10.

As shown in Table 7, the expected projection of tangelo supply implies rapid rates of

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4. This yield was actually expressed by Fletcher as 600 bushels per acre, given a planting density of 219 trees per acre.

Table 4: Tangelos, Mandarins, Oranges, and Standard Lemons;  
Projections of Bearing Trees

Year	Tangelos	Mandarins	Oranges	Standard Lemons
1973	70,904	90,907	174,061	44,175
1974	82,812	102,549	191,171	50,358
1975	97,770	117,271	210,651	52,121
1976	119,928	125,793	227,241	53,664
1977	142,236	137,296	244,450	55,207

Table 5: Tangelos, Mandarins, Oranges, and Standard Lemons;  
Average Annual Yields per Bearing Tree, 1968-72.

Year	Tangelos (bu.)	Mandarins (bu.)	Oranges (bu.)	Standard Lemons (bu.)
1968	0.63	0.71	0.63	6.03
1969	0.63	0.50	0.57	3.94
1970	0.90	0.68	0.75	5.43
1971	1.00	0.56	0.67	4.97
1972	1.22	0.65	0.74	3.78

Table 6: Tangelos, Mandarins, Oranges, and Standard Lemons;  
Projections of Annual Yields per Bearing Tree

Year	Tangelos		Mandarins		Oranges		Standard Lemons	
	Expected (bu.)	Low (bu.)	Expected (bu.)	Low (bu.)	Expected (bu.)	Low (bu.)	Expected (bu.)	Low (bu.)
1973	1.34	1.00	0.60	0.50	0.77	0.57	4.78	3.60
1974	1.50	1.00	0.60	0.50	0.80	0.57	4.78	3.60
1975	1.65	1.00	0.59	0.50	0.83	0.57	4.78	3.60
1976	1.81	1.00	0.58	0.50	0.86	0.57	4.78	3.60
1977	1.96	1.00	0.58	0.50	0.90	0.57	4.78	3.60



Table 7: Tangelos : Projections of Supply

Year	Projections of Supply*		Projected supply Expressed as Percentage of 1972 Supply		Excess of Projection Over 1972 Supply*	
	Expected (bu.)	Low (bu.)	Expected	Low	Expected (bu.)	Low (bu.)
1973	95,000	70,900	137.3	102.5	25,800	1,100
1974	124,200	82,800	179.5	119.7	55,000	13,600
1975	161,300	97,800	233.1	141.3	92,100	28,600
1976	217,100	119,900	313.7	173.3	147,900	50,700
1977	278,800	142,200	402.9	205.5	209,600	73,000

\* Projections are rounded to the nearest 100 bushels

Table 8: Mandarins : Projections of Supply

Year	Projections of Supply*		Projected Supply Expressed as Percentage of 1972 Supply		Excess of Projection Over 1972 Supply*	
	Expected (bu.)	Low (bu.)	Expected	Low	Expected (bu.)	Low (bu.)
1973	54,500	45,500	108.1	90.3	4,100	-4,900**
1974	61,500	51,300	122.0	101.8	11,100	900
1975	69,200	58,600	137.3	116.3	18,800	8,200
1976	73,000	62,900	144.8	124.8	22,600	12,500
1977	79,600	68,600	157.9	136.1	29,200	18,200

\* Projections are rounded to the nearest 100 bushels

\*\* The low projection of supply for 1973 is 4,900 bushels below 1972 production.

growth in production of this fruit. Compared with 1972 levels, supply is projected to more than double by 1975 and to undergo a four-fold increase by 1977. The low projections embody the very conservative yield assumption of 1 bushel per tree (that is, 230 bushels per acre) - the actual yield achieved in 1971. Even so, this assumption results in a doubling of supply by 1977.

The mandarin projections displayed in Table 8 are less spectacular. Nevertheless, the 1977 expected projection results in a supply level nearly 58% higher than 1972 supply. The low projection, based on a yield of 0.50 bushels per tree, indicates a 36.1% increase.

The expected projections for oranges shown in Table 9 also indicate substantial expansion of supply. The increase by 1975 is projected to be almost one-half of total production in 1972, and supply is projected to increase by nearly 85% from 1972 to 1977. The low projections - based on a yield assumption of 0.57 bushels per tree, the actual yield obtained in 1969 - indicate more modest increases. Indeed, on the basis of this very conservative yield assumption, supply in 1973 and 1974 is projected to be below the 1972 level, and to increase by only 18.4% over that level by 1977.

Finally, the projections for standard lemons are given in Table 10. With yield projected at the five year average 1968-72, the expected supply projections indicate massive expansion in production, with a doubling of the 1972 level occurring as early as 1974. The low projections, which are based on a yield level lower than any attained over the period 1968-72, also imply substantial and early increases in supply of lemons, as shown in the table.

### 3. Projections of Demand for Fruit

Retail demand for citrus fruit can be classified into several segments. Within each fruit type there may be, for example, a demand for fresh fruit, separate demands for fresh and frozen juice, and a demand for canned pieces, as well as demands for fruit derived from the demand for products such as marmalade, cordials, and aerated drinks, that contain citrus components. Ideally, projections of total demand should maintain a distinction between these segments, while taking due account of the substitutability and complementarity between them. Unfortunately, the quality of available data concerning the consumption and prices of citrus products in New Zealand is insufficient to support this approach. Consequently, this study utilised a more aggregated procedure that directly projects total demand for each fruit, without differentiating between the various forms in which the fruit is sold to consumers.

In developing demand projections, it is helpful to distinguish between:

- (i) Increases in demand that stem from population increases and rising levels of disposable income in the economy, at constant prices, and with unchanging consumer preferences, and
- (ii) Shifts in demand that are caused by changes in consumers' attitudes to the product.

In rough terms, the forces that determine the first type of increase in demand are outside the control of marketing managers. On the other hand, demand shifts due to changing consumer attitudes can be directly stimulated by marketing managers through product promotion and advertising. Of course, some changes in attitudes, such as consumers' views

Table 9: Oranges ; Projections of Supply

Year	Projections of Supply*		Projected Supply Expressed as Percentage of 1972 Supply		Excess of Projection Over 1972 Supply*	
	Expected (bu.)	Low (bu.)	Expected	Low	Expected (bu.)	Low (bu.)
1973	134,000	99,200	113.9	84.3	16,300	-18,500**
1974	152,900	109,000	129.9	92.6	35,200	-8,700**
1975	174,800	120,100	148.5	102.0	57,100	2,400
1976	195,400	129,500	166.0	110.0	77,700	11,800
1977	217,600	139,300	184.9	118.4	99,900	21,600

\* Projections are rounded to nearest 100 bushels

\*\* The low projections of supply for 1973 and 1974 are 18,500 bu. and 8,700 bu. respectively below 1972 production.

Table 10: Standard Lemons ; Projections of Supply

Year	Projections of Supply*		Projected Supply Expressed as Percentage of 1972 Supply		Excess of Projection Over 1972 Supply*	
	Expected (bu.)	Low (bu.)	Expected	Low	Expected (bu.)	Low (bu.)
1973	211,200	159,000	179.3	135.0	93,400	41,200
1974	240,700	181,300	204.3	153.9	122,900	63,500
1975	249,100	187,600	211.5	159.3	131,300	69,800
1976	256,500	193,200	217.7	164.0	138,700	75,400
1977	263,900	198,700	224.0	168.7	146,100	80,900

\* Projections are rounded to the nearest 100 bushels

regarding healthful diets, can be stimulated by other forms of activity within society. When this occurs, marketing managers may choose to reinforce or rebut the externally-introduced stimulus for change.

In this study, initial attention has been focussed on projecting demand changes that can be attributed to changes in population and income. The subsequent discussion then compares these demand projections with the supply projections and determines the shifts in demand or supply that the citrus industry would need to induce in order to maintain prices at 1972 levels. In this way, the projections are immediately applied to a critical policy issue facing the industry.

Population projections developed by the Department of Statistics [1] were used in the study. The specific projections adopted, which are based on an annual net immigration of 5,000 persons, are displayed in Table 11.

The projection of increases in disposable income per capita was based on the data shown in Table 12. To develop the table, Net Private Income was computed as Private Income less the sum of House Rentals and Direct Taxation, as published [1, p.671]. Net Private Income was then converted to per capita terms and deflated by the Consumer Price Index, resulting in a measure of annual per capita disposable income with the effects of inflation removed. As shown in the final column of the table, this measure of purchasing power varied considerably over the period 1960/61 - 1970/71. The average annual change over the period was +1.4%, and this figure was used to project Net Private Income per Capita in each year through to 1977.

### 3.1 Projections of demand for New Zealand grapefruit

Table 13 contains the demand projections for New Zealand grapefruit. Separate projections were developed for fresh and processed fruit and, within each of these classes, separate projections were made to account for changes in population and per capita disposable income. A description of the derivation of the 1973 projections will suffice to illustrate the computational procedure used for all years.

#### 3.11 Computation of projections for fresh fruit

In reviewing official statistics [9] and other data sources, Frampton [5] has estimated consumption of marketed fresh grapefruit at 1.00 lb. per capita in 1970. In keeping with the projected trends discussed below, per capita consumption is subjectively estimated to have reached 1.03 lbs. by 1972. Thus, to account for the projected population increase in 1973, we have:

$$\begin{aligned} &\text{Projected consumption increase in 1973 due to population increase} \\ &= (1.03)(3,009,000 - 2,956,000)/40 \\ &= 1,365 \text{ bu.} \end{aligned}$$

The number 2,956,000 is the estimated population at 31/12/72 [1].

Calculation of the income effect is a little more complicated. Recall that disposable income per capita was projected to increase by 1.4% per year. To make the projection, we need an estimate of the 'income elasticity of demand' - the percentage increase in per capita consumption that would result from a 1% increase in disposable income. Estimates of these coefficients for citrus demand in New Zealand are available from another study published by

Table 11 : Population Projections

Year	Populations (31 Dec.)	Percentage Change Over Previous Year
1973	3,009,000	1.7
1974	3,063,000	1.8
1975	3,119,000	1.8
1976	3,175,000	1.8
1977	3,234,000	1.9

Source: New Zealand Official Year Book, 1972

Table 12 : Past Levels of Disposable Income

Financial Year	Net Private Income (\$m)	Net Private Income per Capita (\$)	Consumer Price Index (1965=1,000)	Deflated Net Private Income per Capita (\$)	Percentage Change on Previous Year
1960/61	1,885	789	877	900	+3.3
1961/62	1,912	783	893	877	-2.6
1962/63	2,108	844	916	921	+5.0
1963/64	2,309	905	935	968	+5.1
1964/65	2,469	949	967	981	+1.3
1965/66	2,660	1,005	1,000	1,005	+2.4
1966/67	2,703	1,003	1,028	976	-2.9
1967/68	2,788	1,019	1,090	935	-4.2
1968/69	2,975	1,078	1,137	948	+1.4
1969/70	3,240	1,162	1,193	974	+2.7
1970/71	3,702	1,308	1,271	1,029	+5.6

Table 13 : New Zealand Grapefruit : Projected Increase in Demand,  
Over 1972 Levels, Due to Effects of Population Growth,  
and Rising Disposable Income, at Constant 1972 Prices.

Year	Increase in Demand for Fresh Fruit (bu.)			Increase in Demand for Processed Fruit (bu.)			Total Increase* (bu.)
	Due to Population	Due to Income	Total	Due to Population	Due to Income	Total	
1973	1,325	903	2,228	2,756	2,332	5,088	7,300
1974	2,675	1,838	4,513	5,564	4,748	10,312	14,800
1975	4,075	2,729	6,804	8,476	7,252	15,728	22,500
1976	5,475	3,810	9,285	11,388	9,922	21,310	30,600
1977	6,950	4,851	11,801	14,456	12,613	27,069	38,900

\* Projected total increases have been rounded to the nearest 100 bushels

F.A.O. [2]. Although grapefruit were not classified separately, a coefficient of 0.80 was estimated for 'fresh citrus other than oranges, tangelos, and lemons', based on time series data terminating in 1966. It is reasonable to apply this coefficient to grapefruit. Thus the increase in annual per capita consumption due to income increases is projected as  $(0.80)(1.40\%) = 1.12\%$ . Hence projected per capita consumption in 1973 is  $(1.030)(1 + 1.12/100) = 1.042$  lbs, an increase of 0.012 lbs over 1972. Applying this figure to the projected 1973 population we obtain:

$$\begin{aligned} &\text{Projected consumption increase in 1973 due to increase in disposable income} \\ &= (0.012)(3,009,000)/40 \\ &= 903 \text{ bu.} \end{aligned}$$

### 3.12 Computation of projections for processed fruit

Frampton [5] reported that 149,000 bu. of grapefruit was processed in 1970. Thus consumption of the fruit in processed form averaged 2.08 lbs. per capita which, on the basis of further data presented by Frampton, can be disaggregated into 1.68 lbs. consumed as juice and 0.40 lbs. consumed in the form of marmalade and other manufactured products. Again in keeping with the projected trends discussed below, per capita consumption of grapefruit as juice and marmalade is subjectively estimated to have reached 1.74 lbs. and 0.402 lbs. respectively by 1972. Application of income elasticities of 1.21 for juice and 0.25 for marmalade [5] leads to project increases in annual per capita consumption of  $(1.21)(1.40\%) = 1.69\%$  and  $(0.25)(1.40\%) = 0.35\%$  respectively. Hence the projected increase in per capita consumption of grapefruit as juice in 1973 is  $(1.74)(1.69\%) = 0.03$  lb. The corresponding quantity for marmalade is 0.001 lb. Applying these results, we obtain:

$$\begin{aligned} &\text{Projected increase in consumption of processed grapefruit in 1973 due to projected} \\ &\text{increase in disposable income} \\ &= (0.03 + 0.001)(3,009,000)/40 \\ &= 2,332 \text{ bu.} \end{aligned}$$

### 3.13 Projected total increases in demand due to combined effects of population and income

The last column in Table 13 displays the sum of projected increase in demand for fresh and processed grapefruit. Demand increases are projected to accelerate over the period of interest, reaching a level in 1977 that is nearly 39,000 bushels greater than total demand in 1972.

### 3.2 Projections of demand for tangelos

In developing projections of the demand for tangelos, no distinction has been made between consumption of fresh and processed fruit. The advent of tangelos on the New Zealand

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5. No estimates of the income elasticities of grapefruit juice and marmalade in New Zealand have been made in previous studies and attempts to do so in the present study failed due to data inadequacies. The elasticities actually used here were estimated in a published study of food consumption in the United Kingdom [10]. Although per capita consumption of both products is rather higher in the United Kingdom than in New Zealand, similarities in per capita income and ethnic origins support the adoption of the coefficients for this study.

market is so recent that historical data provides little guidance to the relative importance of future demand for fresh tangelos and processed products such as juice and canned segments.

The method used to develop the projections shown in Table 14 was similar to that described in Section 3.14 above. In the case of tangelos, however, base-level demand in 1972 was computed as 0.94 lbs. per capita.<sup>6/</sup> The projection of income effects is based on the income elasticity of 0.60 estimated in an F.A.O. study [2].

The table indicates that projected demand increases due to population and income advances are modest. An increment of approximately 2,000 bushels is projected each year, reaching an increase of 10,100 bushels over 1972 demand by 1977.

### 3.3 Projections of demand for mandarins

On the assumption that the entire 1972 supply was consumed, consumption in that year averaged 0.68 lbs. per capita. The income elasticity of 0.80 estimated by F.A.O. [2] for New Zealand 'citrus other than oranges, tangelos, and lemons' can be assumed to apply to mandarins. On the basis of these data, the projected increases in demand due to increases in population and income are shown in Table 15. A demand increase of 4,500 bushels is projected for 1975, with the increase reaching 7,900 bushels per year by 1977.

### 3.4 Projections of demand for oranges

Annual per capita consumption of oranges fluctuated over the five years 1968-72 without demonstrating any noteworthy trend. This variation has been due in part to the fact that approximately 90% of the total supply is imported, so that any variation in the supply of imports has a marked effect on the rate of consumption. Consequently, the present projections were based on an average level of consumption, rather than the actual 1972 level. Specifically, total consumption in each year 1968-72 was averaged and then divided by 1972 population, yielding the base consumption datum of 12.8 lbs per capita. Income effects were projected on the basis of the F.A.O. estimates [2] of income elasticity for oranges and tangelos, 0.60. The results of the projection computation are given in Table 16. Since the consumption level of oranges is already far higher than for other citrus fruits, the projected increases in demand are more spectacular. An increase of over 132,000 bushels is projected for 1977.

### 3.5 Projection of demand for standard lemons

Projections of increase in demand for the last category of fruit considered in this report, standard lemons, are given in Table 17. As with oranges, a 1968-72 five-year average of consumption of fresh and processed lemons was used, together with 1972 population data to arrive at a base level of per capita consumption - in this case 1.76 lbs. The

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6. Total production of 69,200 bu. in 1972 provided an average supply of 0.94 lbs. per capita, given the population estimate of 2,956,000. It has been assumed that the entire supply was consumed.



Table 14 : Tangelos: Projected Increase in Demand, Over 1972 Levels, Due to Effects of Population Growth and Rising Disposable Income, at Constant 1972 Prices.

Year	Increase Due to Population (bu.)	Increase Due to Income (bu.)	Total Increase* (bu.)
1973	1,511	594	2,100
1974	2,780	1,217	4,000
1975	4,097	1,864	6,000
1976	5,413	2,540	8,000
1977	6,799	3,252	10,100

\* Projected total increases have been rounded to the nearest 100 bushels

Table 15 : Mandarins: Projected Increase in Demand, Over 1972 Levels, Due to Effects of Population Growth and Rising Disposable Income, at Constant 1972 Prices

Year	Increase Due to Population (bu.)	Increase Due to Income (bu.)	Total Increase* (bu.)
1973	857	572	1,400
1974	1,779	1,172	3,000
1975	2,719	1,801	4,500
1976	3,675	2,461	6,100
1977	4,702	3,153	7,900

\* Projected total increases have been rounded to the nearest 100 bushels.

Table 16 : Oranges; Projected Increase in Demand, Over 1972 Levels, Due to Effects of Population Growth and Rising Disposable Income, at Constant 1972 Prices.

Year	Increase Due to Population * (bu.)	Increase Due to Income * (bu.)	Total Increase * (bu.)
1973	16,100	8,100	24,200
1974	33,400	16,500	49,900
1975	51,000	25,400	76,400
1976	69,000	34,600	103,600
1977	88,300	44,200	132,500

\* Projected increases have been rounded to the nearest 100 bushels.

Table 17 : Standard Lemons; Projected Increase in Demand, Over 1972 Levels Due to Effects of Population Growth and Rising Disposable Income, at Constant 1972 Prices.

Year	Increase Due to Population (bu.)	Increase Due to Income (bu.)	Total Increase * (bu.)
1973	2,214	1,113	3,300
1974	4,599	2,274	6,900
1975	7,026	3,485	10,500
1976	9,498	4,755	14,300
1977	12,153	6,080	18,200

projections of income effects used the F.A.O. estimates [2] of the income elasticity of demand for lemons in New Zealand, 0.80. The table indicates projected increases in demand of 10,500 bushels by 1975 and more than 18,000 bushels in 1977.

#### 4. Projections of Excess Supply or Demand

Subtraction of the demand projections given in Section 3 from the corresponding supply projections described by Section 2 yields projections of excess supply or demand. Citrus supply over the period of interest is jointly determined by the number of trees planted and weather conditions. Thus aggregated fruit supply is not subject to control by market managers. Although managers have some discretion in processing and storage of citrus products, it follows that the aggregate volume of citrus products reaching the market is also ultimately determined by factors not controlled by market managers. Thus with supply essentially fixed by previous decisions to plant trees, the presence of an excess supply means that a shift (increase) in demand must be induced if depressions in price are to be avoided. On the other hand, presence of an excess demand means that prices will rise, thereby reducing demand to equate supply, unless an opportunity is taken to augment domestic supplies with imports.

The projections of demand and expected supplies are compared in Table 18. An excess supply is projected to exist in each year for all fruits except oranges, for which an excess demand is projected to exist in all years.

A similar comparison between the projections of demand and low supply appears in Table 19 for all fruit except grapefruit, for which no low supply projections were prepared. A similar pattern exists, although the excess demand for oranges is projected to be higher and the excess supplies of the other fruit are lower than those derived from the expected supply projections. Except for noting that these projections provide lower limits on excess supplies and upper limits on excess demand for oranges, they will not be discussed further.

Returning to the results given in Table 18, it is clear that increases in demand for each fruit due to population and income growth are projected to account for only a relatively small fraction of supply increases. It is salutary to compare the projected excess supplies in each year with total supplies in 1972. As shown in Table 20, the excess supply of grapefruit projected for 1977 is 139% of the total consumption recorded in 1972 and excess supplies of tangelos in 1976 are projected to be double total 1972 supplies. Substantial, but less spectacular, excess supplies of mandarins and standard lemons are also projected. Table 21 provides another means of appreciating the magnitude of the excess supplies, by expressing these in terms of the per capita consumption that they represent. Recall that estimated total per capita consumption figures in 1972 were 3.71 lbs. for grapefruit, 0.94 lb. for mandarins, and 1.76 lb. for standard lemons.

#### 5. Conclusion: Implications of the Projections for Market Flanning

It would be dangerous to regard the projections presented here as anything more than

Table 18 : Expected Projections of Excess Supplies of New Zealand Grapefruit, Tangelos, Mandarins and Standard Lemons ; and Excess Demand for Oranges

Year	Expected Excess Supply (bu.)				Expected Excess Demand for Oranges (bu.)
	New Zealand Grapefruit	Tangelos	Mandarins	Standard Lemons	
1973	33,600	24,700	2,700	90,100	7,900
1974	75,000	51,000	8,100	116,000	14,700
1975	143,000	86,100	14,300	120,800	19,300
1976	221,000	139,900	16,500	124,400	25,900
1977	321,900	199,500	21,300	127,900	32,600

Table 19 : Low Projections of Excess Supplies of Tangelos, Mandarins and Standard Lemons ; and Excess Demand for Oranges

Year	Low Excess Supply (bu.)			Low Excess Demand for Oranges (bu.)
	Tangelos	Mandarins	Standard Lemons	
1973	-1,000*	-6,900*	37,900	42,700
1974	9,600	-2,100*	56,600	58,600
1975	22,600	3,700	59,300	74,000
1976	42,700	6,400	61,100	91,800
1977	62,900	10,300	62,700	110,900

\* Negative values indicate that an excess demand is actually projected in the years indicated. For example, the excess demand for mandarins in 1974 is projected as 2,100 bu., given 'low' projections of supply.

Table 20 : Projected Excess Supplies of Citrus Fruits Expressed as Percentage of Total Supplies in 1972.

Year	New Zealand Grapefruit	Tangelos	Mandarins	Standard Lemons
1973	14.6	35.7	5.4	76.5
1974	32.6	73.7	16.1	98.5
1975	62.1	124.4	28.4	102.6
1976	96.0	202.2	32.7	105.6
1977	139.9	288.3	42.3	108.6

Table 21 : Projected Excess Supplies of Citrus Fruits Expressed as Increase in Consumption per Capita Over 1972 Levels (lbs.)

Year	New Zealand Grapefruit	Tangelos	Mandarins	Standard Lemons
1973	0.45	0.32	0.04	1.20
1974	0.98	0.66	0.11	1.51
1975	1.83	1.10	0.18	1.55
1976	2.78	1.76	0.21	1.57
1977	3.98	2.47	0.26	1.58

indicators of general market tendencies, given the validity of the underlying assumptions. Nevertheless, the magnitude of the projected deviations between supply and non-induced demand are sufficiently large for the writer to be confident that drastic changes in market prices of fresh citrus products will occur unless urgent action is taken. On the basis of the expected projections, the following market tendencies warrant specific discussion.

- (i) Retail prices of New Zealand grapefruit, tangelos, mandarins and standard lemons (and their products) will tend to fall over the period at an increasing rate unless immediate action is taken to stimulate demand. The demand stimulations projected to be required in each year, in order to maintain 1972 price levels, are equal to the excess supplies given in Table 18.
- (ii) Retail prices of fresh oranges will tend to rise unless the quantity imported is increased in each year. The quantities shown in the final column of Table 18 are the projections of imports required to maintain 1972 price levels.<sup>7/</sup> It is possible that the projected excess supply of tangelos and mandarins could offset excess demand for oranges, thus ameliorating price falls on the one hand and price increases on the other. The extent of this effect would depend on the degree of substitutability of tangelos and mandarins for oranges at the retail level. Since data are not currently available to indicate the strength of these relationships, no more precise statement can be made.

It is conceptually possible to estimate the price changes referred to above. Unfortunately, data inadequacies prevented estimation of price responsiveness to changes in the quantity of fruit supplied to New Zealand consumers, so that recourse had to be made to estimates made in the United Kingdom.<sup>8/</sup> Although similarities exist between New Zealand and United Kingdom markets, the resulting estimates of price changes must be regarded as rough approximations. Nevertheless, the estimates given in Table 22 are regarded as conservative because relatively low responses in price to changes in the quantity marketed have been assumed. In the absence of demand stimulation, grapefruit prices are projected to decline 21% by 1975 and 40% in 1977, compared with 1972 prices. Even more severe

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7. It should be noted that due to the relatively short selling season for oranges grown in New Zealand (approximately three months), a proportion of these extra imports would be required irrespective of the size of the New Zealand crop. It is also possible for oranges to be in excess supply (thus depressing prices) in some periods of the year, and in excess demand at other times. While the writer suspects that seasonal variation exists in demand for oranges, data relating to this could not be obtained. Thus the implications for seasonal orange prices of various levels of domestic and imported supplies could not be examined further in this study.
  8. The price responsiveness coefficient is known as the 'price elasticity of demand', which is the percentage change in quantity consumed that is induced by a 1% increase in price. In the United Kingdom study referred to, this coefficient was estimated as -1.27 for oranges, and -2.15 for other citrus [10]. That is, demand for citrus is 'price-elastic' in the United Kingdom, and is assumed to be so in New Zealand. By contrast demand for citrus is price-inelastic in the United States, George and King [7] having estimated a coefficient of -0.66 for oranges. The assumption of price-elastic demand in New Zealand has the effect of providing conservative estimates of the effect on prices of excess supplies or demands.

Table 22 : Price Changes Implied by Projected Excess Supplies and Demand;  
Expressed as Percentage Difference from 1972 Price Levels

Year	New Zealand Grapefruit	Tangelos	Mandarins	Oranges	Standard Lemons
1973	-6	-16	-2	+1	-35
1974	-12	-31	-7	+1	-42
1975	-21	-49	-11	+1	-41
1976	-30	-73	-12	+2	-38
1977	-40	-93	-14	+2	-35

Note: Negative numbers indicate percentage decreases and positive numbers indicate percentage increases.

depression is projected for tangelo prices, which decline 49% from 1972 levels by 1975 and decrease even more rapidly thereafter.<sup>9/</sup> Prices of standard lemons are projected to decline immediately to levels some 30% to 40% below 1972 prices, remaining at that level over the period. As shown in the table, the excess supply of mandarins is projected to have a less spectacular affect on price, although steady declines are indicated. The excess demand for oranges would have only a minor affect on the price of this fruit.

In general, the projections indicate massive increases in supply of citrus over the projection period. The projections imply early and drastic depressions in prices unless urgent steps are taken to stimulate consumer demand. In the absence of such action, growers of tangelos, grapefruit, and standard lemons are projected to be placed under a severe cost-price squeeze, and this would be attended by pressure on processors and distributors to reduce their margins. On the basis of the projections, success in processing and distribution will depend crucially on diversification into new products, penetration of existing and new products into present retail outlets that have not previously handled citrus, and the development of new forms of outlet. These developments will not take place easily or at low cost. Innovation in processing technology is especially costly. Considerable scope will exist for individual firms to secure competitive advantages through innovative developments in processing and marketing. Nevertheless it is clear that the industry as a whole would benefit from a centrally planned and directed programme of promotion for citrus fruits and their products. The low overall level of citrus consumption in New Zealand, relative to consumption in several other developed economies, leads the writer to suspect that such a programme could well produce spectacularly successful results.

The Market Research Centre is currently engaged on an examination of consumer attitudes to fresh citrus and citrus products, and it is envisaged that this study will provide further information to market planners in the industry.

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9. While Table 22 indicates 1976 and 1977 prices equal to 27% and 7% of 1972 prices respectively, it is possible that such low prices would make it uneconomic to harvest tangelos, thereby curtailing supply and raising prices to those growers remaining in the market.



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### Appendix

This Appendix contains a technical discussion of the development of yield projections for tangelos, mandarins, oranges, and standard lemons. These projections are presented and used in Section 2.2 of the main text.

#### The Statistical Model

The following statistical model was postulated to analyse historical variation in yield:

$$y_t = a + bt + u_t \quad (1)$$

where  $y_t$  is the yield per tree in the year  $t$ ,

$u_t$  is a disturbance term with an expected value of zero, and

$a$  and  $b$  are constants.

#### Estimation of the Model

The coefficients of (1) were estimated for each fruit by ordinary least squares [8, p.108]. Five observations of annual yield were used in the regression, and these are listed in Table 5 of the main text. The independent variable, time, was coded so that 1968, 1969, ..., 1972 took the values 1, 2, ..., 5 respectively. The results shown in Table A.1 demonstrate that for some fruits, particularly mandarins, the linear model explains very little of the observed variation in yield. Nevertheless, given the maintained hypothesis of the linear model (1), the coefficients are unbiased and it is appropriate to use them in developing projections.

#### The Projections

The linear trends specified in Table A.1 were extrapolated to provide expected yield projections. These are presented in Table A.2, together with their variances. To illustrate the extrapolation procedure, consider the expected yield projection for tangelos in 1977. The year 1977 has a coded value of 10. Hence applying the coefficients shown in Table A.1, we have

$$\begin{aligned} \hat{y}_{10} &= \hat{a} + 10\hat{b} \\ &= 0.411 + (10)(0.155) \\ &= 0.411 + 1.550 \\ &= 1.961 \text{ bu./tree.} \end{aligned}$$

Derivation of projection variances is described by Johnson [8, pp.36-37].

#### Subjective Appraisal of the Projections

The yield projections were subjected to appraisal by expert citriculturalists, who

Table A.1 : Estimated Regressions of Yield per Tree on Time

Fruit Type	$\hat{a}$	$\hat{b}$	$R^2$
Tangelos	0.411 (0.074)	0.155 (0.022)	0.94
Mandarins	0.638 (0.105)	-0.006 (0.032)	0.01
Oranges	0.576 (0.068)	0.032 (0.020)	0.45
Standard Lemons	5.871 (0.959)	-0.347 (0.289)	0.32

Note: Standard errors of the estimated coefficients are given in parentheses.

Table A.2 : Expected Yield Projections and Variances (bu./tree)

Year	Tangelos	Mandarins	Oranges	Standard Lemons
1973	1.341 (0.056)	0.602 (0.007)	0.768 (0.005)	3.789 (0.816)
1974	1.496 (0.092)	0.596 (0.011)	0.800 (0.008)	3.442 (1.336)
1975	1.651 (0.138)	0.590 (0.017)	0.832 (0.012)	3.095 (2.003)
1976	1.806 (0.194)	0.584 (0.023)	0.864 (0.017)	2.748 (2.820)
1977	1.961 (0.261)	0.578 (0.031)	0.896 (0.024)	2.401 (3.784)

Note: Variances of the projections are given in parentheses

approved of the projections for tangelos, mandarins, and oranges, but agreed that the projections of lemon yields were unreasonably low. The opinion with respect to lemon yields was that the yield of 3.78 bushels per tree achieved in 1972 reflected a very poor growing season. It was thought that the downward trend indicated by the regression was spurious, being unduly influenced by excellent and very poor growing seasons for lemons in 1968 and 1972 respectively. Opinion tended in favour of future yields being near the 1968-1972 average, while it was thought 'most unlikely' that annual yield would fall below 3.60 bushels per tree. Consequently, the projections for standard lemons based on regression analysis, and shown in the right-most column of Table A.2, were abandoned and replaced by the five-year average of 4.78 bushels per tree.

Development of confidence intervals from the yield variances must be approached with caution. It is standard practice in econometric prediction to assume that predictions are distributed normally [8, p.132], but in the present case this assumption is not valid. The assertion that yields can be negative is clearly nonsense; hence the lower tail of the projection distribution must be truncated. In practice, these distributions should be truncated at the lower feasible limit of yields. The 'low' projections specified in Section 2.2 identify these truncations. Since yields certainly cannot be infinite, truncation from above is also appropriate. However, since yield possibilities greater than the mean are not important to the main theme of this report, upper truncations will not be considered further.

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