AN ECONOMIC ADJUSTMENT STUDY OF

THE NELSON PIP FRUIT INDUSTRY

A thesis presented in partial fulfilment
of the requirements for the degree of
Master of Horticultural Science
in Horticultural Economics and Marketing at
Massey University.

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PREFACE

The terms of reference for this research project were:

> "To examine the nature of the economic problems confronting the Nelson Pip Fruit Industry and suggest policy measures by which the industry can adjust in order to facilitate an improvement in the welfare of pip fruit growers."

This thesis sets out the findings of the research and the conclusions that have been reached with respect to the terms of reference. The thesis is organized into three sections. In the first section the nature of the problem confronting Nelson pip fruit growers is examined. The second section discusses the structure and the results obtained from an intertemporal linear programming analysis of orchard adjustment and finally, in the third section the conclusions and implications for rural policy are discussed.

Much of the data used during the course of this study is included in the appendices. However, because of the extensive amount of data required to specify the intertemporal model it was decided to exclude appendices containing data relating to the model. All such data is, however, freely available upon request from the author.

I would like to record my appreciation for the guidance and advice given to me by my supervisor Dr. A.N. Rae. Many of the ideas contained in this thesis were developed with him. During the latter part of this study Dr. Rae was overseas on sabbatical leave. I am particularly grateful for the dispatch with which he returned the draft copy of this thesis together with many invaluable comments.

The Economic Survey of the Nelson Pip Fruit Industry discussed in this study formed part of a national survey of the New Zealand Pip Fruit Industry, which was conducted by the author as part of another study. I am grateful to the New Zealand Fruit Growers Federation and the New Zealand Apple and Pear Board for permission to use the survey data.
A complete set of survey data relating to the Nelson Province has been included in Appendix A for reference purposes.

This study was undertaken while acting as a member of the staff of the Department of Agricultural Economics and Farm Management. I am grateful for the time which was made available in order to complete the study. I am in debt to Professor R.W. Cartwright for his comments as well as the financial support that he and Professor A.R. Frampton were able to arrange. Dr. A.D. Meister read several drafts of the thesis and made many valuable comments. Special acknowledgement is also due to Professor R.J. Townsley for his sound advice and encouragement.

I would also like to thank the pip fruit producer who so willingly gave up many hours of his time to provide data for the linear programming model. Particular thanks are due to Mrs Rama McGee for the care and accuracy with which she deciphered and typed my handwritten script.

Finally I wish to thank my wife, Ruthie, for her encouragement throughout and assistance in proof reading. Were it not for her enthusiasm this study would never have been commenced.

The usual caveat applies in relation to all those mentioned above.

Peter P. Oppenheim.

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ABSTRACT

For many years the Nelson Province has been the major region involved in the production of New Zealand's export pip fruit crop. However, in recent years there has been a severe decline in the income of Nelson Pip Fruit Producers.

An economic survey of New Zealand pip fruit producers revealed that 44 percent of the growers producing on the infertile Moutere Hill soils near Nelson recorded negative net farm incomes in 1974/75. The failure of these orchardists to adjust to changing economic and technological conditions is reflected in orchards consisting of a large number of old trees with a high percentage of less preferred varieties.

In order to derive feasible adjustment strategies a ten year intertemporal linear programming model was constructed. This model was based on an orchard, representative of those experiencing adjustment problems. The model allowed for the adoption of new enterprises in addition to a variety of replanting, reworking, interplanting and tree removal activities.

The results obtained from experimentation with the model included optimal patterns of tree replacement and intertemporal cash flows. These results indicated that the financial position of Moutere Hill pip fruit producers would continue to deteriorate over the next decade with considerable borrowing being required to finance maintenance and/or developmental expenditure. Positive cash flows could be expected towards the end of the 1980's after which the benefits of orchard restructuring would continue to accrue.

While it was shown that considerable potential exists for increased incomes to be generated from Moutere Hill orchards it was recognized that the extent of the delay might necessitate a withdrawal from the industry of those growers who could not, or did not, wish to persevere with fruit growing. Accordingly, two new policies were suggested as possible measures which could supplement existing rural policy in order to alleviate problems of poverty on the Moutere Hills.

SECTION A

CHAPTER 1

STUDY BACKGROUND AND OBJECTIVES

1.1 Introduction

Pip fruit production rates, in terms of export earnings and the number of growers engaged in the industry, as New Zealand's largest horticultural industry. In 1975/76 the New Zealand Pip Fruit Industry produced 176 822 tonnes of apples and pears of which 71 600 tonnes were exported earning $19.2 million (f.o.b.) in export receipts. Although this represents only a small percentage of New Zealand's total export earnings for 1975/76, it does represent a significant contribution to the welfare of the nation.

While pip fruit may be grown throughout New Zealand, 49.7 percent[1/] of the total area planted to apples and pears is centred about Hastings and Nelson. For many years the Nelson Province has been the major region involved in the production of pip fruit, particularly for the export market. The production and export value of the Nelson apple crop, which accounts for 95 percent of the region's pip fruit production, is summarised in table 1.1.

In 1975/76, 205 orchardists in the Nelson Province produced more than 56 000 tonnes of apples and 2700 tonnes of pears. This represented 32.7 percent of the total New Zealand pip fruit crop and 23 percent of the value of that province's agricultural production.[2/] The Nelson pip fruit industry may therefore be viewed as one of both national and regional importance.

1/ Report on the Official Survey, New Zealand Fruit Growing Industry 1973.

2/ M.A.F. Estimate of the Value of Production in Waimea and Golden Bay Counties, March 1975.

Table 1.1 Nelson Apple Exports ($ million f.o.b.)

Year	Production		Exports		Value	
	N.Z. total[b] ('000 tonnes)	Nelson[b] (%)	N.Z. total[a] ('000 tonnes)	Nelson[b] (%)	N.Z.[a] ($'m) f.o.b.	Nelson[c] ($'m) f.o.b.
1969	106.9	47.6	54.6	45.6	8.9	4.06
1970	133.7	40.5	52.1	57.0	8.6	4.90
1971	120.7	45.0	58.1	50.0	10.4	5.20
1972	149.4	38.4	66.8	52.5	12.9	6.77
1973	143.1	37.4	66.3	47.9	12.8	6.13
1974	152.1	39.8	79.6	43.7	18.1	7.91
1975	159.4	38.0	71.6	49.5	19.2	9.50

Source: (a) 1969/70 - 1975/76 N.Z. Department of Statistics.

(b) M.A.F. Horticultural Statistics.

(c) Computed from the average N.Z. f.o.b. earnings/tonne.

In recent years, however, there has been a decline in the level of income of Nelson pip fruit producers. The following table compares the net income of pip fruit producers in Hawkes Bay with the three regions involved in pip fruit production in the Nelson Province for the years 1972/73 to 1974/75:

Table 1.2 Pip Fruit Growers Net Income[a)] 1972/73 to 1974/75 ($)

Year	Hawkes Bay	Nelson	Mapua	Motueka	New Zealand
1972/73	8 411	4787	5295	14 841	7536
1973/74	11 598	4383	4196	11 559	8292
1974/75	13 283	3153	3919	13 974	9172

a) Net Income = gross farm and off farm receipts less cash costs and depreciation.

Source: Rae, A.N. *et al*. /‾56_7

In addition, extensive plantings of semi-intensive orchards and increased productivity in Hawkes Bay since 1965 have slowly eroded the prominent position the Nelson Province once occupied. As a result the quantity of pip fruit submitted to the Apple and Pear Board from the Nelson Province has fallen during the period 1970-76, from 48 percent to 44 percent of the Board's total receipts. Over the same period, the contribution from Hawkes Bay has increased from 30 to 41 percent.[3/]

The deteriorating position of the Nelson Pip Fruit Industry is therefore a twofold problem. First, it is a problem of national importance as 50 percent of the nation's export income from pip fruit is derived from this province. Secondly, it is a problem of regional significance as the emergence of rural poverty in a sector of the agricultural community is likely to have a significant effect on other sectors in Nelson Province.

3/ The New Zealand Apple and Pear Marketing Board, 28th Annual Report 1976.

1.2 The Problem in Perspective

In recent years many changes have occurred in the pip fruit industry. There have been substantial changes in the technology used on orchards, bulk handling, better pest control and improved management practices. There have also been significant adjustments in the product mix of apple and pear varieties in the face of changing relative profitabilities. However, a significant number of pip fruit growers in Nelson have, for a variety of reasons, not responded to or have been unable to respond to, these changes. As the prosperity of any industry is dependent upon its ability to adjust to changes in the demand for its product (e.g. the product mix) or changes in the cost structure (e.g. the scale of operation), a failure to do so may mean that the resources engaged in the industry will fail to achieve satisfactory economic returns. It will be shown in this study that some sectors of the Nelson Pip Fruit Industry currently exhibit signs of failure to adjust to changing economic conditions.

The inability to adjust can show up both in the industry's income position (table 1.1) and in its financial structure (see table 1.2) - the importance of each reflects the intensity with which individual growers have been affected. Table 1.3 shows the change in the level of indebtedness of pip fruit growers in Hawkes Bay, Nelson and New Zealand (total) between the years 1972/73 and 1974/75.

Table 1.3 Percentage Changes in Grower's Indebtedness:[a] Base 1972/73

Year	Hawkes Bay	Nelson	Mapua	Motueka	New Zealand
1972/73 to 1973/74	+11	+32	+55	+13	+22
1973/74 to 1974/75	+22	+78	+56	+22	+31

a) Indebtedness = the combination of short and long term debt.
Source: Rae, A.N. et al. /‾56_7.

Since the income earned on the farm enterprise determines the debt repayment capacity, declining incomes increase the burden of any given debt repayment. Moreover, when profitability is declining and debts are significant, any short term adverse factors, such as hail or drought, are more difficult to cope with. Where the safety margin between incomes and debt servicing is small and declining productivity significant, extreme financial difficulty may result. This is the situation at present for many producers of pip fruit on the Moutere Hills near Nelson.

In response to the deteriorating financial position, representatives of the industry presented a number of submissions to the New Zealand Government during 1974 and 1975 requesting financial assistance. As a result of these submissions the Government outlined the measures already available to growers but declined to introduce additional assistance. The measures outlined were:

- a two year interest-free seasonal finance loan of $5000
- fertiliser subsidies and cartage rebates
- a pesticide rebate of 6 cents a bushel on fancy grade fruit
- overdraft and term loan facilities for seasonal finance, re-financing, and development expenditure through the Rural Bank.

Debt and income problems of the magnitude currently being experienced by Nelson growers are a sign of a longer term economic weakness in parts of the industry's structure. Any assistance therefore, to be effective and to lessen the likelihood of similar financial problems arising to the same extent in the future, must be associated with measures designed to facilitate structural change in the industry.

This study is directed towards an examination of the nature of the problem confronting the Nelson Pip Fruit Industry at the present time. It looks at ways in which the industry can adjust to changing economic conditions in order to facilitate an improvement in the welfare of growers.

1.3 The Approach Adopted

The aim of the study is to provide a set of recommendations which will materially improve the welfare of the low income sector of the Nelson pip fruit industry. The study consists of three sections. In Section A the current status of Nelson pip fruit growers is examined in order to arrive at a definition of the nature of the problem which they face.

In Section B a model of orchard production is constructed to allow adjustment strategies to be identified. In the final section the conclusions drawn from experimentation with the model are used as a basis upon which policy recommendations are made.

A variety of factors are likely to have an influence on, and be in part responsible for, the current status of the pip fruit grower. These factors are discussed in Chapter 2. This discussion also acts as a base upon which to consider the Nelson Pip Fruit Industry in more detail. Chapter 3 presents a detailed examination of the recent financial position of Nelson pip fruit producers. A further objective here is to isolate orchard practices likely to be associated with high and low income producers. The various factors likely to contribute towards the current financial position of the pip fruit producer are then discussed. Following this discussion, a number of previous studies are reviewed in Chapter 4 in order to assist in the selection of a suitable methodology with which to analyse the problems facing low income growers.

Section B deals with a description of the methods and results of a model of orchard adjustment. This model is based upon an orchard representative of those experiencing adjustment problems. The purpose of this model is to derive optimal, feasible, adjustment strategies. The model is described in Chapter 5, and the analysis and the results obtained from experimentation are presented in Chapters 6 & 7. In the final section the various measures currently available to assist pip fruit producers are examined in order to determine whether the conclusions derived from the empirical work could be implemented within the framework of existing rural policy. As much of New Zealand's agricultural policy is directed towards providing direct financial assistance and stabilization of farm incomes several new policy measures designed specifically for alleviating rural poverty in Nelson are discussed. The implications of these policy recommendations on the economy of the Nelson Province are then outlined in the concluding section of this study.

CHAPTER 2

HORTICULTURE IN THE NELSON PROVINCE WITH PARTICULAR REFERENCE TO PIP FRUIT PRODUCTION

The Nelson Province consists of two counties, Waimea (753 000 ha) and Golden Bay (260 000 ha), located in a central position at the northern end of the South Island of New Zealand. (See figure 2.1) The province is generally hilly to mountainous with only 16 percent of land being suitable for cultivation. Pip fruit production is centred about three major areas which are defined, on the basis of soil type and topography as:

(a) Nelson - the Waimea Plains between Nelson and Appleby

(b) Mapua - the Moutere Hills between Appleby and Motueka

(c) Motueka - the flood plains and terrace soils of Motueka and Riwaka.

The natural resources of the Nelson Province and the current systems of horticultural production serve not only to indicate the degree of diversification that the horticulture of an area can physically accept, but may also indicate possible directions in which pip fruit producers might move in order to adjust to changing economic conditions.

Situations which exist today are often the result of actions taken in the past. For this reason a history of the Nelson pip fruit industry is presented so that current issues may also be viewed in an historical perspective. The services of government and semi-government organizations in providing research and extension services are recognized as a further factor affecting on farm productivity. The influence of these agencies is discussed in the final section of this chapter.

2.1 Natural Resources of the Nelson Province

The natural resources that generally act as limiting factors for horticultural production in general include climate, topography and soils.

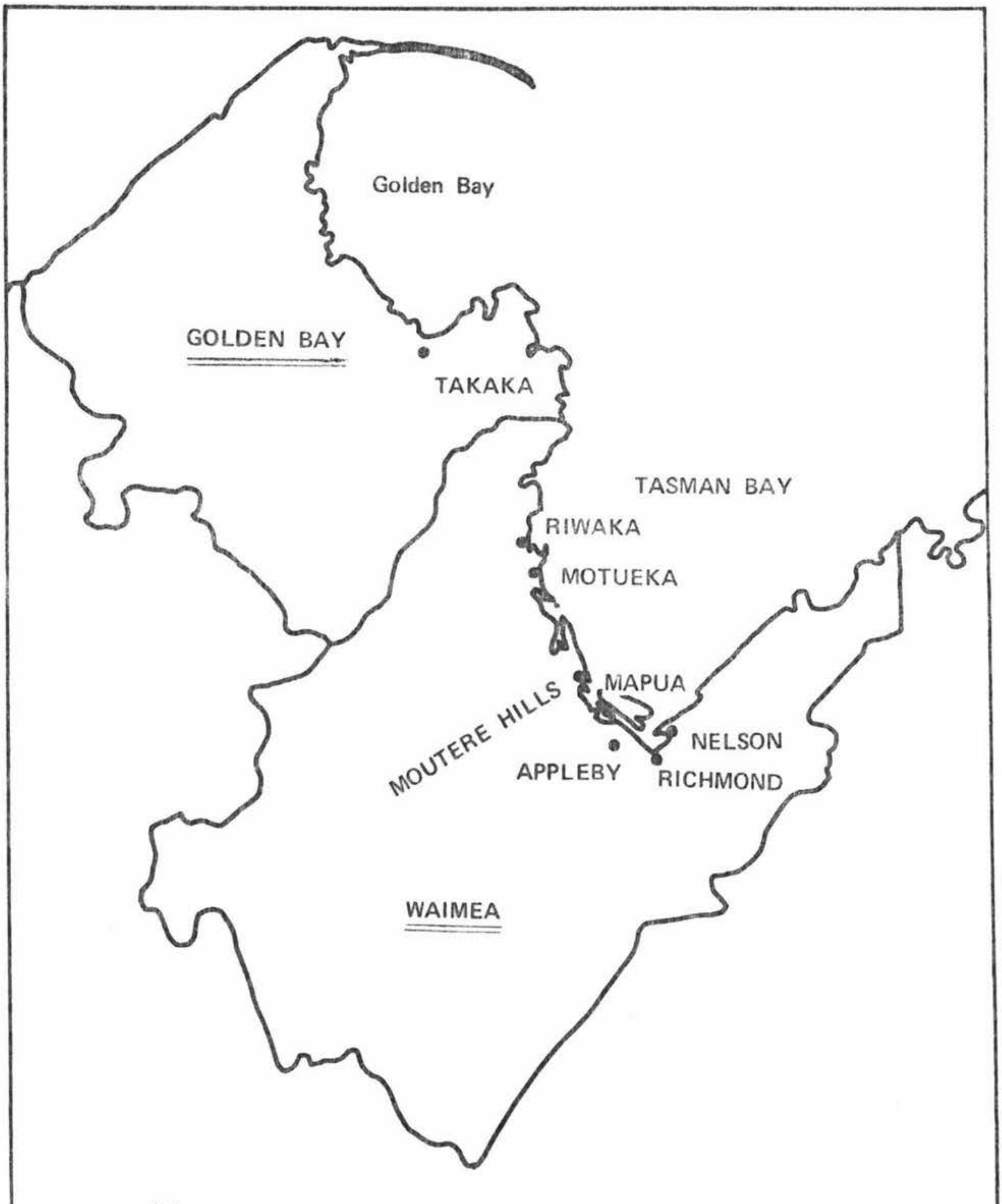

Figure 2.1 The Nelson Province

2.1.1 Climate

Sunshine and calm weather characterize the climate of the Waimea County. Nelson City records show a total of 2400 sunshine hours per year while districts to the west and south of the Waimea and Motueka plains usually record slightly fewer hours. Rainfall varies considerably. In the western ranges, annual precipitation exceeds 3800 mm/year while on the Waimea Plains an average rainfall of 1000 mm may be experienced. To the south, annual falls increase once again to about 1500 mm at Murchison. Rain falls on the average, between 100 and 150 days a year over most of the area with an even distribution between seasons. Strong winds are less frequent than in most parts of New Zealand. At Nelson airport, for example, 25 percent of all winds are from the north or north-east, while 45 percent of the time calm conditions prevail. Frosts are common over wide areas of the district. On the Waimea Plains frosts of up to $-10^{o}C$ can be expected. However, as there are no screen frosts[1/] in the summer months (December, January and February) Nelson has been classified as being suitable for fruit growing by the Town and Country Planning Branch of the New Zealand Ministry of Works. [46]

Hail storms are rare with only one or two occurring a year, although they may occur in any month. For example, in December 1976 several hail storms resulted in widespread damage to apple and pear orchards in the Nelson Province with the result that the entire Nelson fruit district was declared a disaster area.[2/]

Overall however, Nelson generally enjoys a sunny, mild, reasonably wind-free climate with an evenly distributed rainfall - a climate well suited to temperate horticulture production.

1/ Frosts may be classified as (i) a ground frost which is measured from a minimum thermometer exposed 2.5 cm above grass level, and (ii) a screen frost, measured from a thermometer exposed in a standard screen 1 metre above the ground.

2/ Fruit District Named as Disaster Area - DOMINION - 15/1/1977.

2.1.2 Soils and topography

Over 70 percent of the province is hilly or mountainous. The cultivatable land occurs on the Waimea, Motueka and Takaka Plains, and on the rolling hills and valley floors throughout the area. The nature of the country has influenced the land use pattern with agriculture and horticulture being concentrated on the flatter land and rolling hills. Pip fruit production has been limited by topographical factors to the easy rolling slopes of the Moutere Hills, and the Waimea and Motueka Plains.

The Soil Bureau of D.S.I.R. /̅14̲7̅ has classified the soils of the Waimea County into five major groups:

(1) Soils of the Flood Plains and Low Terraces
(2) Soils of the Intermediate to High Terraces
(3) Soils of the Coastal Sands
(4) Soils of the Rolling and Hilly Lands
(5) Soils of the Steeplands.

Most pip fruit produced in Mapua is located on a Mapua Sandy Loam (Class 4) while production in Motueka and Nelson is concentrated on most fertile Class 1 soil types.

Mapua Sandy Loam (often referred to as Mapua Clay Loam), is a transitional soil, between a Yellow Grey and a Yellow Brown Earth. The soils are strongly leached and have a deep heavy clay subsoil. The top soil is a sandy clay with a weak structure and is easily eroded. For example on cultivated land it is common to find the upper slopes and ridges denuded of topsoil, which then accumulates in the lower slopes and gullies. On the gentle slopes there is evidence of impeded drainage with moderately gleyed subsoils. The following profile is typical of a considerable area in the Tasman-Mapua locality:

50-80 mm	grey sandy loam, structureless
50 mm	transitional pale grey fine sandy loam
450 mm	bright yellow brown clay, very hard and cloddy vertically cracked into massive columns.
	On strongly weathered gravels in a clay matrix.

The fertility of the soil is very low and it has a low pH. Phosphorus and calcium are also low while potassium varies from low to very low. Several trace element deficiencies have been identified, e.g. Boron in apple trees, molybdenum and sulphur in pastures and copper and cobalt deficiencies have been reported in livestock.

In spite of its low fertility Mapua sandy loam is extensively used for producing a large proportion of the Nelson pip fruit crop, improved pasture and forestry plantations. There are about 1000 ha of apple and pear orchards on Mapua sandy loam, which require large inputs of artificial fertilizer together with supplementary applications of borax to individual trees every four to five years.

2.1.3 Ground water

The ground water potential in the Motueka and Waimea valleys, and the intervening Moutere Hills has been investigated in some detail. Good supplies are available under the soils of the Waimea and Motueka Plains, but in the gravel beds under the Mapua soils, water supplies are variable. For orchard supplies on the Moutere Hills a bore coupled with a storage dam would be necessary.

2.2 Horticultural Production Systems

The Nelson region is notable for the diversity of agricultural enterprise. Although Golden Bay is devoted to pasture and associated livestock production, the balance of the region produces livestock, dairy products, fruit, tobacco, hops and other horticultural crops. An estimate of the value of production for the various agricultural industries of the Nelson Province is given in table 2.1. This table shows the relative economic importance of the various agricultural and silvicultural industries.

There are approximately 20 000 hectares in the Nelson district which the Ministry of Agriculture and Fisheries estimates could be used for horticultural crops. Table 2.2 shows the areas occupied by horticultural crops in the Nelson district in 1975.

Table 2.1 Estimated Value of Production in Waimea and Golden Bay Counties March 1975 ($'000 at farm gate)

		Tobacco	7 350
Dairy	3 260	Pip fruit	7 500
Town milk	1 128	Stone fruit	150
Pigs	1 045	Hops	865
Poultry	1 402	Glasshouses	990
Stud stock	130	Vegetables	500
Sheep	100	Berries	993
All cattle	2 000	Nursery	25
Arable	771	Beekeeping	15
TOTAL	$13 836	TOTAL	$18 388

Agriculture	$13 836
Horticulture	18 388
Forestry	12 650
	$44 874

Source: Ministry of Agriculture and Fisheries, March 1975.

Table 2.2 Nelson Horticultural Production 1975[a] - (ha)

Tobacco	1850
Hops	254
Deciduous tree fruit	2073
Berry fruit	200
Glasshouses	15
Vegetables	1000
Nurseries and cut flowers	47
Citrus, grapes and sub-tropicals	28
TOTAL	5467

a) Major crops obtained by surveys and registrations, others by partial survey and estimation.

Source: Ministry of Agriculture and Fisheries.

Tobacco. All commercial tobacco growing in New Zealand is located in the Waimea County. The light textured, well drained soils, desirable for tobacco production, are found in the Motueka-Riwaka district. This district is the centre of the tobacco industry and supplies about 50 per-cent of the New Zealand demand for tobacco.

Hops. The hop industry in the Waimea County supplies the requirements of all New Zealand brewers. In recent years this industry has stabilized in size as the demand for hops within New Zealand is not increasing. Therefore any expansion of the industry at this time would have to cater for an export market. However, current world prices suggest that this is not a feasible alternative for the immediate future.

Vegetable production. A wide range of vegetables are grown in the region. Potatoes and pumpkins often form part of the cropping programme of mixed farms, or a cash crop for farmlet occupiers. Several orchardists have also intercropped their trees with a variety of vegetables including pumpkin; however, this practice has produced difficulties with tractor movement within the orchard. Most vegetable production is now located on the Waimea Plains and in the Moutere Valley.

Berry fruit production. Most kinds of berry fruit have been grown in the Waimea County and the total Nelson berryfruit production amounts to about 23 percent of the New Zealand crop. Raspberries and boysenberries together occupy 82 percent of the land used for berry fruit production in Nelson. Although raspberries tend to prefer the lighter soils, boysenberries have been successfully grown on the poorer Moutere hill soils. The renewal of interest in the marketing possibilities of this crop has led to increased plantings since 1969.

Grape and wine production. At present the area devoted to viticulture is only about 10 hectares. The grapes are marketed fresh or converted to juice. In 1976 classic wine grapes were successfully grown at Upper Moutere and high quality wines produced. With the recent interest in wines within New Zealand it is possible that expansion in this industry may occur in the future.[3/]

3/ Hobby may Herald new Industry - THE NELSON EVENING MAIL - 17/9/1976.

Pip fruit production. The Nelson pip fruit industry is located on the Moutere Hills between Appleby and Motueka; on the flood plains and terrace soils at Motueka and Riwaka; and on the Waimea Plains. In 1976 there were 204 pip fruit growers in the Nelson Province. Fifty-four growers were located on the Moutere Hills, 85 in the Nelson district and 65 in Motueka.4/ In 1974/75 the pip fruit industry contributed 23 percent of the province's Gross Farm Revenue making the industry one of major regional importance.

2.3 A Brief History of the Nelson Pip Fruit Industry to 1948

One of the first references to fruit production in Nelson was made by Heaphy in a letter dated Nelson October 22, 1847.5/

> "We have made an orchard this year and grafted some five dozen apple stocks so that in three years, which is the age at which apple trees come into bearing in New Zealand, we shall be well stocked with fruit."

With the exception of farm orchards such as Heaphy's, which were planted to supply the individual farm household, little development occurred in fruit growing for the next twenty years, at which time the first commercial orchard was planted (an acre of mixed orchard near Riwaka). Although several further plantings followed at Riwaka, the emphasis later shifted in this locality from fruit production to a centre for hops and tobacco production. Instead the Moutere Hills became the site for orchard development. By 1908 fruit growing had shown signs of expansion. Growers became conscious of the need to diversify their market outlets which were confined almost exclusively to Wellington with occasional consignments to Auckland. The first signs of a potential export trade in apples appeared in 1908 when E. Buxton and Co. of Nelson sent a successful shipment of 1236 cases of apples to England, under a government guarantee of one penny a pound net for fruit.

4/ Source: Ministry of Agriculture and Fisheries Horticultural Statistics.

5/ EARP; "New Zealand" (Handbook for New Zealand Company - 1849) London (W.S. Orr and Co.) p.247.

In 1910, T.W. Kirk[6/] (Director, Division of Orchards, Gardens and Apiaries) supported the new pip fruit industry by stating:

> "... the building up of an export trade in fresh fruit was of greatest importance to New Zealand and the establishment of a regular export trade at an early date should be encouraged in every possible way...."

In 1910 as a result of the government's support for an export trade[7/] a planting boom began on the Moutere Hills. This boom was stimulated by various syndicates which were interested in the subdivision of the Moutere Hill lands. The most notable of these syndicates was Tasman Fruit Lands Ltd; a company floated by Mr A. McKee[8/] in 1911 which acquired 810 hectares at Tasman for the purpose of subdivision.

A large amount of publicity was given to the potential for apple production in Nelson by newspapers, the government, and "experts". A booklet /‾39_7 "Apples for Export", published by Mr A. McKee in December 1910, popularised the export trade and its potential thus encouraging investment in the industry. It consisted of a series of photographs and newspaper articles about the Moutere Hills which proclaimed that the cheaper lands of the hills were better for apples than the richer soils elsewhere, e.g.

> "It is proven that apples grown on this land with its friable clay subsoil, are unequalled for colour, quality and texture; will keep longer and carry better than those grown in the richer soils of Nelson and Motueka."
>
> <u>The apple export trade and its possibilities</u>, McKEE /‾39_7, p.2.

> "Hawkes Bay Land is rich and good, but is not suitable for apple culture. They in Hawkes Bay had found by bitter experience that this rich land was altogether unsuitable...."
>
> <u>The Moutere Hills for apple growing - an important pronouncement by a high authority</u>, McKEE /‾39_7, p.6. Reprinted from THE MOTUEKA STAR, October 28, 1910.

6/ New Zealand Journal of Agriculture - July 1910.

7/ To encourage export the government renewed the guarantee of one penny per pound on all fruit sold in Europe for 1910, 1911 and 1912.

8/ See <u>The end of a 65 year era</u> - THE ORCHARDIST OF NEW ZEALAND, May 1976, for a brief history of the McKee property at Tasman.

People were encouraged to buy land with assurances that little knowledge or capital was needed to successfully grow apples, e.g.

> "... The Moutere particularly offers facilities to the man of small capital to make a start in what is admitted to be one of the healthiest and most profitable industries that the 'simple life' affords.... It is a mistake to suppose that a man needs special scientific knowledge to commence fruit growing ... and the enjoyment of vigorous health consequent on a busy out-door life, and the sight of a constantly improving asset, the months soon slip by and the orchard is in bearing before one realises that the necessary years have actually passed...."
>
> A man need not have special scientific knowledge to commence fruit growing, McKEE [39], p.32.

The land development syndicates usually agreed to supervise the clearing, planting and maintenance of orchards for absentee owners for periods of up to five years until the orchard came into bearing. As a result of their advertising propaganda the development companies often attracted people with little idea of resources required to establish orchards. Consequently many investors were forced to abandon their holdings before the trees reached their bearing age. Several court cases claiming misrepresentation subsequently arose from this issue.

In 1916 as young men enlisted in World War I, the planting boom subsided. It has been calculated that 2830 hectares in total were planted on the Moutere Hills during the years 1910-1916, compared with an area of 575 hectares planted to pip fruit in 1973.[9/]

The government's export incentive of one penny per pound net for fruit continued until 1926 at which time the incentive was amended to cover only the cost of packing and transporting fruit from the orchard to overseas markets. However, even under the reduced guarantee, exports of apples continued to increase from Nelson.

In 1926 the New Zealand Fruit Export Control Board, assumed control over the export of apples until 1939. As Nelson was predominantly an exporting district the depression years of the 1930's did not have a great

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9/ Report on the Official Survey 1973, N.Z.F.F. and M.A.F., July 1975.

effect on Nelson growers. However with the outbreak of World War II and the consequent curtailment of an export trade it was feared that the Nelson district would be severely disadvantaged as the New Zealand market would be unable to absorb the volume of production from Nelson at economic prices. In order to allow Nelson orchards to continue to operate, the government set up a marketing scheme whereby all fruit was initially purchased by the government. This scheme was later replaced by a Fruit Marketing Council which was assisted by a government subsidy. However the anticipated problem never eventuated as production declined during the war years owing to a shortage of labour and capital. Nevertheless a large number of marginal orchards were removed as prices fell during the years of the war. In 1944 a special fund of £25,000 was set aside by the government to assist unproductive orchards. This fund was to be "applied to those orchards which with reasonable expenditure could be made economic".

Because of rising costs and marketing difficulties the subsidy was considered insufficient to meet production costs. Consequently a cost of production survey was undertaken in 1947 in order to determine standard costs. These were later accepted by the government and incorporated into regulations referred to as the Apple and Pear Marketing Act 1948.

2.4 The Apple and Pear Marketing Board and the Nelson Pip Fruit Industry Since 1948

In 1948 the New Zealand Apple and Pear Marketing Board (A.P.B.) was formed at the request of New Zealand fruit growers to co-ordinate and market pip fruit on both the local and export markets. Although it is now the sole exporting body for New Zealand pip fruit it is not a complete monopoly on the local market as growers are allowed to sell up to two bushels of fruit directly to each customer per sale. For sales above this amount a licence from the A.P.B. is required. Such a licence is also required for sales to processing firms. In Nelson more than 95 percent of the regional apple crop and 82 percent of the pear crop are currently marketed through the A.P.B., Rae, *et al.* [56].

Until 1967 the guaranteed price paid to pip fruit growers was based on an estimate of the average cost of production. However as a cost of production criterion in price determination is inappropriate in an industry largely dependent upon export markets, Rae /‾55_7, an important change occurred in 1968 with the formation of an Apple and Pear Prices Authority (APPA). The APPA now determines the average guaranteed price in relation to such criteria as production and marketing costs, present and expected market returns and the state of the APB's finances. This price cannot fluctuate more than 10 percent above or 5 percent below the previous year's price. The APB then sets prices to be paid to growers with respect to variety, size and grade.

During the early 1950's a number of major technological advances were made. The most important of these was largely as a result of N. and E. Williams of Nelson who pioneered the introduction of bulk handling and the use of pallets at harvest time. Automation of spraying occurred between 1952 and 1957. During the late 1950's and early 1960's optimism was expressed in many quarters for a "flourishing" pip fruit industry. For example, Theodore Rigg /‾59_7 notes the increased pip fruit acreages, yields and replanting programme and states:

> "These are good omens for the future but more important is the evidence of healthy and vigorous growth of trees in a high proportion of the orchards".

At the same time, however, horticultural advisers in the Department of Agriculture were already advocating a systematic programme of tree replacement for trees older than 45 years. Since 1955 production has continued to rise and this trend is now expected to continue as young trees recently planted come into bearing. Since 1969 more than 300 000 apple trees have been planted, approximately half of which are tree replacements - the remainder, additions to established plantings. Plantings of pears in recent years on the other hand have been minimal, with slightly more than 2700 additional pear trees being planted on the Moutere Hills since 1969.

The current trend to closer planting and interplanting is shown in table 2.3. Between 1962 and 1974 yield per hectare of apples increased from 1402 bushel to 1731 bushel equivalents or an increase of 23.4 percent. On average the density of apple plantings have increased by 21 percent from 366 trees/hectare in 1962 to 444 trees/hectare in 1974.

Table 2.3 Nelson Pip Fruit Production 1962, 1974, 1982

Pip fruit	1962			1974			1982
	Area (ha)	Production (bushels)	No.trees	Area (ha)	Production (bushels)	No.trees	Production (bushels)
Apples	1402	1 966 700	513 741	1859	3 301 069	826 793	4.4 mil.
Pears	168	256 400	58 896	106	194 333	39 185	220 000

Source: New Zealand Ministry of Agriculture and Fisheries.

As a result of the improved technology and increased area of plantings the Ministry of Agriculture and Fisheries have projected that the total Nelson Production will reach a level of 4.4 million bushels by 1982.

2.5 Pip Fruit Research and Extension Services

While the research and extension services are seen as active participants in the infrastructure of the Nelson pip fruit industry the direction in which their efforts have been aimed may be questioned.

Research into the problems facing pip fruit growers in Nelson has centred about three major institutions:

(a) Cawthron Institute
(b) D.S.I.R. Appleby Research Station
(c) Ministry of Agriculture and Fisheries.

The Cawthron Institute was established in 1921. During the first Forty years the institute engaged itself in agricultural and biological research, contributing to the pip fruit industry in many ways. The most notable being the various soil/plant and fertilizer response studies conducted by Rigg, Chittenden and others.10/ During the early 1960's as

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10/ See for example:
(a) Fruit Investigations at Annesbrook Orchard, Nelson, N.Z. Cawthron Institute Monograph No.3, 1959.
(b) RIGG, T. CHITTENDEN, E.T.; Apple Manurial Experiments in the Nelson District, New Zealand Journal of Science and Technology, Vol.27, No.5, (sect.A), 1946.

the effect of inflation began to erode the working capital of the institute, the nature of the research work undertaken tended to shift with the result that by 1968/69 a new research policy had evolved. To preclude the duplication of the research work and hence avoid bringing the institute into competition with other organisations seeking a limited share of public finances, it was decided to change the institution's work to "an area of microbial and biochemical degradation of organic materials, both natural and man induced, particularly where these may affect water and soil quality". [13] In addition, a chemical services section for analytical and consultant services to agriculture such as water, soil and leaf analyses, and local authorities was developed to provide additional income.

The D.S.I.R. Research Station is located on the Moutere Hills at Appleby. It consists of 28 hectares of which 15 hectares is planted in orchard. Research programmes are initiated and supervised by D.S.I.R. scientists generally located at the Plant Diseases Division in Auckland. In the past the research station has made several major contributions to the technology of fruit production on the Moutere Hills. Among these contributions is the work of Tiller, Roberts and Bollard [74] who reported the cumulative results of long term fertilizer trials at Appleby. However, in recent years little has been published to describe the results of work conducted at the research station.

Officers of Ministry of Agriculture and Fisheries appear to perform the dual role of being both research and advisory officers. Currently Horticultural Advisory Officers conduct trials on various properties. These trials are associated with investigations into Bitter Pip, fertilizer requirements and the pruning of apple trees.

The extension services in the Nelson Province emanate from a variety of organizations. Table A.6 (Appendix A) lists the attitudes of sample growers towards the various sources of information, with respect to their perceived value. The assistance offered by the New Zealand Fruit Growers Federation was considered the most valuable by growers in Nelson, Mapua and Motueka. The value of the Ministry of Agriculture and Fisheries Advisory Officers ranked second in Mapua and Motueka, while in Nelson the advice of other growers ranked in second place. In 1975 a total of six advisory officers serviced Nelson pip fruit growers, i.e. a ratio of one advisory officer to 48 growers.[11/]

2.6 Summary

Although the climate of the Nelson Province is generally well suited to supporting most kinds of temperate horticultural systems, soils and topography often act as factors limiting production. The Nelson pip fruit industry is centred about three localities, Nelson, Mapua and Motueka. While the topography and soil fertility data suggest that this industry should be located on the more fertile Waimea and Riwaka Plains, for historical reasons more than 30 percent of the trees are located on the infertile soils of the Moutere Hills.

Horticultural industries which are unable to support themselves either because of low productivity or cost inefficiency can be supported by government assistance in the expectation of future benefits. The Nelson pip fruit industry has received such assistance through time from successive New Zealand governments in the expectation that the industry will generate export income. However, it would appear that the infertile soils of the Moutere Hills have acted as one of the most important constraints restricting the progress of this industry on the Moutere Hills.

11/ HARRE, A.J., An assessment of personnel servicing Central Otago and Nelson orchardists with particular reference to advisory officers, M.A.F. Communication Paper, 1975.

CHAPTER 3

AN ECONOMIC SURVEY OF THE NELSON PIP FRUIT INDUSTRY

During November and December, 1975 a nationwide economic survey of the New Zealand Pip Fruit Industry was conducted, as part of a research project for the New Zealand Apple and Pear Marketing Board and the New Zealand Fruitgrowers' Federation. In this chapter the major physical and financial results of the survey of pip fruit producers will be discussed with particular reference to growers in the Nelson Province.

The main objectives of the survey were:

(a) to examine the financial status of the pip fruit industry, and

(b) to assess the level of regional disparity among growers.

The survey covered the financial years 1972/73, 1973/74 and 1974/75 and 177 growers or 21 percent of the growers eligible to be included in the survey were used in the final sample. While a description of the survey method and results obtained are discussed elsewhere [56] a complete listing of the survey results relevant to the Nelson Province appears in Appendix A.

An examination of the welfare of the Nelson pip fruit grower will necessarily involve a study of the production of pip fruit in relation to the structure of holdings and the various managerial technologies currently practiced. In addition, an assessment of the capital, income and cost structures of pip fruit farms, and an analysis of various income and cost measures are needed to describe the economic situation of the pip fruit producers. The pattern of resource use in relation to managerial practices is discussed in order to identify practices likely to lead to inefficient on-farm resource allocation and, where appropriate, inferences are drawn regarding the effect and relation of these practices to economic performance.

3.1 Farm Organization

3.1.1 Characteristics of farm operators

The results of the survey showed that pip fruit growers on the Moutere Hills generally entered fruit growing with little or no practical experience and little formal education in horticulture. For example, 27 percent of sample growers on the Moutere Hills had received specialized training in fruit growing and 29 percent had become orchard managers with less than one year's practical experience. An hypothesis which suggested a movement of inexperienced growers into the industry in response to a reduced price for orchard land on the Moutere Hills[1/] was supported by the fact that 57 percent of Moutere Hill growers with little orcharding experience, had purchased established properties. In addition, 47 percent of sample growers were found not to have relatives that were fruit growers.

3.1.2 Orchard size and land use

Table 3.1 shows the average land use of pip fruit farms on the Moutere Hills. Although the average size of farms was found to be 23.8 hectares, 62 percent of all sample farms were less than 16 hectares in area.

Sturmer has been one of the main varieties grown in Mapua because of its regular cropping habits and relatively consistent market realizations. In recent years however, Granny Smith has become increasingly important. In the three years 1972/73 - 1974/75 the number of Granny Smith trees increased by 25 percent while a zero rate of growth was experienced for the Sturmer variety. Cox's Orange Pippin which comprises 14 percent of Moutere Hill apple trees, represents the largest planting of this variety in New Zealand. This variety is particularly useful as it helps New Zealand gain access to the British Market. Appendix tables A.15 and A.16 list the major varieties of apples and pears grown at Nelson.

1/ J. Wilton (M.A.F. Fruit Specialist) pers. comm.

Table 3.1 Average Land Use of Mapua Pip Fruit Farms - 1974/75 (ha)

Land use	Mapua
Apples - bearing	7.77
- non bearing	3.64
Pears	.60
Pip fruit	12.01
Stone fruit	0.04
Other orchard	-
Other horticultural	0.04
Pasture	7.28
Agric. crops	1.17
Waste and buildings	2.50
Other (forestry)	0.76
Total area	23.80

Most trees on the Moutere Hills are grafted on the Northern Spy stock as it exhibits resistance to Wooly Aphid. Prior to the introduction of this rootstock heavy losses were experienced. With increased interest in semi-intensive plantings growers adopted MM106 and MM104, however the susceptibility of these rootstocks to Phytophora has precluded their adoption and MM793 is now recommended.

Generally older orchards have been planted at spacings 4.8 x 4.8 metres (434 trees/hectare). On lighter soil types spacings of 5.5 x 5.5 metres (330 trees/hectare) have been adopted. Interplanted orchards are spaced at 2.7 x 4.8 or 2.7 x 5.5, while semi-intensive planting generally occurs at a rate of 4.8 x 3.6 metres (578 trees/hectare).

3.1.3 Orchard management

A relatively large proportion of orchards (52 percent) on the Moutere Hills are either totally or partially cultivated. The combined effects of cultivation, use of heavy spraying equipment and the natural characteristics of the soil has resulted in widespread soil panning and erosion. Although grassing orchards to a clover/rye sward has been recommended for many years, growers on the Moutere Hills have in general been slow to adopt this practice. Appendix Table A.25 contrasts the soil management practices of Mapua, Nelson and Motueka and clearly shows the higher rate of adoption of grassing down in Motueka.

In most older orchards drainage is lacking. This is evidenced by tree losses in the wetter areas and is accentuated by the presence of a soil pan at a depth of 20 cm in orchards which are cultivated. Nevertheless growers still plant apple trees in areas where drainage is suspect with the intention of improving these areas at a later date. However, by the time these trees show signs of water-logging substantial damage has been incurred.

In conjunction with drainage the use of irrigation has recently been recognized as a major factor affecting production[2/] disproving the locally accepted idea that the high water holding capacity of Moutere Hill soils was sufficient to produce fruit and supplementary irrigation was not required. Trickle irrigation represents a significant advance in irrigation technology. Although this technique is not widely used at present in Mapua, preliminary results indicate that it provides an efficient relatively low cost irrigation system which is particularly suitable for use on undulating land.

The relatively infertile soils of the Moutere Hills demand heavy rates of fertilizer. On average, growers in the Moutere Hills apply 1 tonne of lime-acre every 3 years and approximately 1 tonne/acre "KP orchard mix" annually with 4 lbs of Nitrophosen being applied to young trees annually.

2/ Hewett [21] has found that Golden Delicious yields over a seven year period increased by 21 percent if irrigated at 80 percent available moisture and by 12 percent if irrigation occurred at 20 percent available moisture. The increase in yield was mainly due to an overall increase in fruit size and a significant reduction in the proportion of smaller sized fruits as opposed to the number of fruit per tree which was not influenced by irrigation. Irrigation was also found to increase shoot and trunk growth giving potential for greater yields in future years.

3.1.4 Thinning and pruning

Thinning and pruning are related practices, as both are largely instrumental in controlling the number and size of fruits at picking time. In addition both practices affect the quality of the fruit (by determining the size distribution of the crop). Both are also highly labour intensive and costly. Orchards on the Moutere Hills tend to practice hand thinning of apples to a greater extent than those in Motueka. Also pruning practices on the Moutere Hills tend to be more labour intensive than those in Motueka. Varieties such as Gravenstein, Cox, Golden Delicious and Jonathan usually set heavy crops and require thinning and are therefore more costly to produce.

Pruning fruit trees consists of two basic operations; tree training and detailed pruning. In New Zealand there are three basic systems of tree training: the multileader, the four leader and the central leader system.

The multi leader system consists of establishing a circle of up to ten leaders in order to create a vase shaped tree. Multi leader trees are difficult and costly to manage, especially during picking and spraying operations, as the weight of the crop causes the older leaders to spread and break. The four leader system is a modification of the multi leader system. It has the effect of inducing vigorous growth and as a consequence trees are slow to come into bearing. The central leader system of tree training relies on a central leader with three tiers, of four branches forced almost into a horizontal plane and spaced evenly about the tree. The aim of this system is to achieve precocious bearing with the majority of the fruit on the first and second tier so that a high percentage of the crop may be picked without the use of ladders, and consequently at a lower cost.

Detailed pruning generally refers to the practice of removing various laterals and spurs or parts of laterals and spurs for the purpose of reducing crop size and increasing crop quality. The traditional practice of extremely detailed and judicious pruning is not only costly and tedious but physiologically unsound. In recent years the amount of pruning has been reduced to a minimum and mechanization has been introduced where possible with the use of hydraulic platforms and pneumatic pruners.

However, although these innovations are relatively commonplace in Motueka they have not been readily adopted by growers in Mapua because of the rolling topography which does not readily lend itself to mechanization, and the conservative nature of many growers in the district.

3.1.5 Pest and disease control

Leaf roller is one of the major pests affecting orchards on the Moutere Hills. Other pests which were mentioned included red spider mite. Most growers appeared to follow the advice of either the Ministry of Agriculture and Fisheries or the Fruitgrowers Federation and conducted a reasonably comprehensive spray programme.

Two diseases which present some difficulties to growers on the Moutere Hills are *Phytophthora* spp. and *Peniophora* spp. both of which are root pathogens. *Phytophthora* is often specifically associated with Cox's Orange Pippen and losses of 50-60 percent of the trees in some localities has been recorded.[3/] *Phytophthora cactorum* is responsible for the collar rot disorder which may affect trees at the graft union, or even on branches and limbs in the tree itself. This disease is accentuated by poor drainage and poor weed control about the base of the tree. Some measure of control may be achieved by higher working of trees particularly onto Northern Spy and MM793 which are more resistent to *Phytophthora*. The other major problem, *Peniophora sacrata*, a native of New Zealand, is found in the Nelson district. *P. sacrata* produces a canker on the roots of apple trees inducing a slow decline which currently cannot be controlled. Both Fire Blight in pears, Block Spot and Powdery Mildew were named as additional diseases which concerned growers in all three districts.

Virus diseases such as Mosaic, flat limb, rubbery wood and scaley bark may be seen to a greater or lesser extent in all orchards, reflecting in part the lack of clean propagating material in the past.

The most serious physiological disease in the district is Bitter Pit. This disorder can affect most varieties especially Cox, Golden Delicious, Granny Smith and Gravenstein. A large amount of research has been directed towards this problem in the past with the result that 6-8 calcium sprays per year are now recommended to combat this disorder.

3/ C. Cook (H.A.O., Nelson) pers. comm.

3.1.6 Harvesting and packing

Harvesting is the most labour intensive activity in fruit production. The weekly quantity of fruit available for harvest throughout the harvest season is a critical factor in planning the variety mix of the orchard. Thus a change in the scale of operation or an increase in the efficiency of the harvesting operation can directly affect the variety mix and consequently farm income.

The introduction of bulk handling of fruit at harvest time has done much to increase the efficiency of the harvest operation and the movement towards fewer varieties. Bulk handling, which is now a world wide accepted orchard practice, was originally developed by Nelson growers. In the past fruit was generally packed on each grower's property. However there has been a movement away from this capital intensive activity, and at present more than 50 percent of the growers are members of co-operative packhouses.

3.2 Production and Yields

The following discussion refers to Appendix tables A.33 - A.37. An examination of the distribution of farms by total apple production shows that 86 percent of farms in Mapua produced between 10 000 and 30 000 bushels of apples in the 1974/75 season.

The average yield per bearing apple tree was found to be lowest in Mapua with a yield of 5.7 bushels as compared to Nelson with 5.8 bushels and Motueka with 7.6 bushels. However, the greater yield of 2310 bushels per bearing hectare in Mapua compared with 1737 bushels per bearing hectare in Nelson reflected the higher density of plantings between Mapua (422 trees/hectare) and Nelson (383 trees/hectare), see Appendix tables 22 and 23.

The production trends for pears between the three districts is less significant with few properties producing more than 1000 bushels in total. However, Nelson appeared to produce the highest yields with 7.1 bushels per bearing tree as compared to Mapua with 4.5 bushels per bearing tree.

Therefore pip fruit production per farm in Motueka is on average

26 percent higher than the production per farm in Mapua, and Motueka production per tree is 25 percent higher than the yield per bearing tree in Mapua.

3.3 Costs and Receipts

In the context of the survey, farm costs included both cash operating costs and imputed non-cash costs. Development costs were excluded where possible from annual current expenditure and included in capital expenditure. Similarly private expenditures unrelated to the farm business were excluded as were payments in respect of taxation. All costs were considered on a whole farm basis, with no allocation being attempted between pip fruit and the production of other commodities.

(i) Cash costs. Total cash costs were the sum of cash payments for hired labour, materials, services and any other operating cost. Any cash payment made to family labour, shareholders or partners, rent and interest paid on borrowed money, were excluded from cash costs. "Internal" rentals paid for the hire of land or machinery, e.g. by a company to one of the shareholders, were also eliminated from costs.

(ii) Imputed costs. Costs were imputed for the following non-cash items:

(a) operator's labour, family, partners and shareholder's labour;
(b) depreciation on plant and machinery, buildings and improvements;
(c) interest on capital for land, improvements, plant and machinery, and working capital (see Table A.43).

Information about labour use on survey farms was supplied by the operator. The weeks spent on direct farm work, off-farm work and the contribution of family, partners and shareholders were recorded. The imputed cost of operator's labour was computed as $5000 multiplied by the proportion of the year spent on "farm work". In a similar way the imputed cost of partner's labour was computed as the sum of each partner's/shareholder's contribution multiplied by $5000. In the case of sole ownership, contribution by members of the family were charged at the rate of $1.60 per hour (i.e. the average casual worker's wage rate paid in 1974/75). This imputed cost was charged irrespective of any amounts actually paid since such amounts often bear little relationship to the actual work input of some family members of the farm labour force; profit sharing and capital transfers are additional means of recompensing family members for their contribution to the farm business.

An average depreciation on plant and machinery and structural improvements covering the period 1972/73 - 1974/75 was imputed using the current market value of the individual items. For items purchased or sold during the survey period, depreciation was assessed as if the transaction took place at the start of the financial year; i.e. one-third of the annual depreciation was charged for items purchased in 1974/75. The rate applied was 10 percent of current value per annum for plant and machinery; and 2 percent current value for farm buildings and improvements.

For certain economic analyses of farm performance, interest on estimated capital is required. The rates adopted were 8 percent for interest on capital involved with land improvements, plant and machinery, and 6 percent on the estimated working capital which was computed as half of the total annual cash costs.

Gross farm receipts were determined for each financial year as the sum of all cash receipts earned by the farm business from the sale of pip-fruit, other crops and livestock products. Income earned as a result of other business activities, part-time jobs etc. is listed as off farm income.

3.3.1 Movements in farm costs and receipts 1972/73 - 1974/75

In recent years there have been considerable changes in grower's costs and returns. Table 3.2 shows farm and off-farm receipts and costs 1972/73 - 1974/75 together with the percentage change between these years.

The largest increases in costs and revenues were experienced in Nelson where average gross farm receipts for the surveyed properties rose from \$15,735 in 1972/73 to \$26,559 in 1974/75, and total farm cash costs rose from \$11,052 to \$21,913. The disproportionate increases in revenue and cost items between Nelson and Mapua stem from several facts:
(a) there were a large number of gate sellers in the Nelson sample compared with Mapua; (b) Mapua growers have on average a greater percentage of low-valued varieties; and (c) Mapua growers have a greater percentage

of higher valued varieties that are non-bearing when compared with Nelson growers.

Table 3.2 Farm and Off-farm Receipts and Costs 1972/73 - 1974/75 ($)

Year	Nelson	Mapua	Motueka
Average gross farm receipts per farm			
1972/73	15 735	32 076	47 563
1973/74	23 963	30 271	46 209
1974/75	26 559	32 604	53 166
% change 1972/73-1974/75	68	1.6	12
Total farm cash costs (including rent and interest paid)			
1972/73	11 052	25 254	30 468
1973/74	17 843	25 247	32 121
1974/75	21 913	28 586	37 233
% change 1972/73-1974/75	98	13	22
Average off-farm income			
1972/73	430	1 345	1 813
1973/74	400	2 044	1 537
1974/75	645	2 773	2 107
% change 1972/73-1974/75	50	106	16

A reduction in inputs was a feature throughout New Zealand but was most apparent in those districts where the level of off farm income tended to show the greatest increase, e.g. Mapua, where many orchardists have found that their holdings are returning insufficient income and as a result have been forced to seek alternative sources of income.

During the survey period, off-farm income was of increasing importance in Nelson and more especially in Mapua where the average off-farm income rose 106 percent to $2773 per annum in 1974/75 reflecting the serious position of orchardists in this locality.

3.4 Farm Incomes

Various measures of farm income are normally used to compare and estimate economic performance of the farm business. Two measures of income were used in the pip fruit survey, net farm income and net income. Net farm income shows the income earned by the farm as a business concern. It is closely related to the economic position of the farm and for comparative purposes will be used as an indicator of whole farm economic achievement. Net income on the other hand includes non farm costs and receipts and serves to illustrate the financial situation of the farm family. In table 3.3 the level of net income over the three years of the survey together with the percentage change in net income during these years is shown.

Table 3.3 Change in Net Income[a] - 1972/73 to 1974/75 ($)

Year	Nelson	Mapua	Motueka
1972/73	4 787	5 295	14 841
1973/74	4 383	4 196	11 559
1974/75	3 153	3 919	13 974
% change 1972/73-1974/75	-34	-26	-5.8

a) Net income = total receipts (farm and off farm) less total cash costs and depreciation.

Holdings in both Nelson and Mapua are disadvantaged by the fact that a large proportion of the variety mix consists of low valued varieties such as Jonathan. Therefore as already mentioned, in order to avert their deteriorating financial position growers have in many cases taken additional employment to supplement their incomes. However, it is clear from table 3.3 that incomes are still insufficient to meet immediate requirements.

The average net income derived in table 3.4 for participating growers shows that large disparities exist between these three fruit growing districts. In 1974/75 the range which separated the net income of growers in Mapua and Motueka was $10,055. The gravity of the situation for growers in Nelson and Mapua is, however, shown more clearly when the net income is expressed on a "per operator" basis. In 1974/75 $2482 and $2480 was earned per operator in Nelson and Mapua respectively.

Table 3.4 Pip Fruit Producers' Average Incomes - 1974/75 ($)

Item		Nelson	Mapua	Motueka
A.	Gross farm receipts	26 559	32 604	53 166
B.	Farm cash costs	20 239	27 288	36 249
C.	Rent and interest paid	1 674	1 298	984
D.	Depreciation	2 138	2 872	4 066
E.	Net farm income (A-(B+C+D))	2 508	1 146	11 867
	(Median NFI)[a)]	(2 469)	(1 681)	(7 125)
F.	Off-farm income	645	2 773	2 107
G.	Net income (E+F)	3 153	3 919	13 974
	(Median NI)	(2 660)	(2 737)	(8 900)
H.	Average number of operators	1.27	1.58	1.61
I.	Net income per operator	2 482	2 480	8 679

a) The median is likely to be a better measure of central tendency in districts where the distribution of incomes differs from a normal distribution.

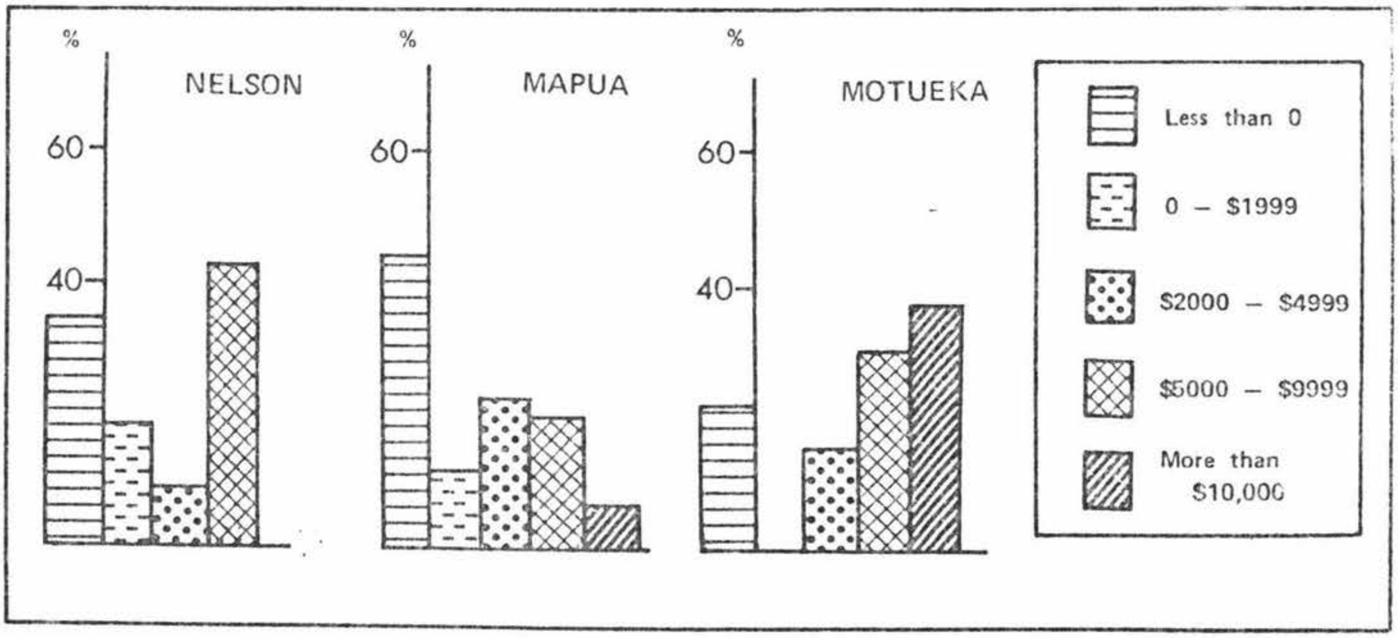

Figure 3.1 Distribution of Net Farm Income - 1974/75

Although negative net farm incomes occurred in all districts (see table A.38 and Figure 3.1) the district which showed most evidence of a low income problem was Mapua where 44 percent of sample growers recorded negative net farm incomes and only 23.3 percent earned in excess of $5000, while in Nelson 41.7 percent and in Motueka 64.3 percent of the growers earned in excess of $5000.

3.5 Capital Structure

Capital values were assessed for land, structural improvements, plant and machinery and working capital for 1974/75. Valuations of land and improvements were based on the latest government valuation, updated by the New Zealand Valuation Department's 1975 Horticultural Land Prices Index.[4/] The current market value of plant and machinery was estimated by growers and working capital was assessed as one half of the annual cash costs paid for labour, materials and services. For purposes of determining returns to capital and equity, the total capital value was computed as the sum of fixed and current assets, i.e. the value of the land, improvements, plant and machinery and current assets. (See table 3.5) The average total capital value of sample farms was found to range from $116,375 in Nelson to $160,114 in Motueka, with some farms in each district having a total capital value in excess of $200,000 indicating a considerable on farm investment.

3.5.1 Levels of indebtedness and equity ratios

So far measures of income have been used to demonstrate the financial situation of growers; however there are other factors which influence their general financial position. Two of these are the level of indebtedness and the equity ratio. The latter is defined as the capital value of the farm less the indebtedness, divided by capital value and expressed as a percentage. (See table 3.5)

4/ Rural Real Estate Market in New Zealand 1972-74, N.Z. Valuation Department, Research Paper 75-2.

Table 3.5 Capital Structure, Indebtedness and Equity - 1974/75 ($)

Item	Nelson	Mapua	Motueka
Land value	38 661	30 360	36 058
Value of improvements	50 585	63 905	73 591
Plant and machinery	11 988	16 180	28 918
Current assets	15 141	18 667	21 547
A. Total capital value	116 375	129 112	160 114
Term liabilities	15 881	20 127	16 635
Current liabilities	6 578	7 263	9 159
B. Total Indebtedness	22 459	27 390	25 794
C. Equity (A - B)	93 915	101 722	134 319
Equity ratio (%)	81	78	83

Table 3.6 Return to Capital and Management - 1974/75 ($)

Item	Nelson	Mapua	Motueka
A. Net income	3 153	3 919	13 974
B. Total imputed labour cost	6 871	7 901	7 634
C. Rent and interest paid	1 674	1 298	984
D. Depreciation	2 138	2 872	4 066
E. Return to capital and management (A-B+C+D)	94	188	11 390
F. Total capital	116 375	129 112	160 113
G. Rate of return to capital and management $\left(\frac{E}{F} \times \frac{100}{1}\right)$ %	0.08	0.15	7.11
H. Rent and interest paid	1 674	1 298	984
I. Return to equity and management (E-H)	-1 580	-1 110	10 406
J. Average equity	93 915	101 722	134 319
K. Rate of return to equity and management $\left(\frac{I}{J} \times \frac{100}{1}\right)$ %	-1.68	-1.09	7.75

The average level of indebtedness was found to vary from $22,459 for Nelson growers to $27,390 for growers in Mapua with approximately 70 percent of the debt being of a long term nature (see table A.47). In the case of Mapua where 73 percent of the indebtedness was found to be long term an amount of $7,395 would represent the average short term debt. Such an amount, when combined with the low annual income can only confound the financial situation of these growers creating additional liquidity problems.

On average, the equity ratios were found to be relatively high and not to vary much between the three districts. However, the distribution of equity within districts (table A.44) revealed that whereas there were no growers in Motueka with equity ratios less than 60 percent; 24 percent of growers in Mapua were found in this category. Unfortunately, it was not possible to determine the change in equity over time from the data which was collected. Had this been possible, the hypothesis "that growers in Mapua and Nelson were able to remain on their properties in spite of their low annual incomes was due to the fact that consumption of capital was occurring" could have been tested. Intuitively, however, it is suspected that the consumption of capital plays a major role in permitting low income growers to remain on their properties.

3.5.2 Return to capital and management

When the imputed costs of all labour provided by operators, family, partners and shareholders are deducted from net income, and depreciation and interest paid are added, the residual represents the return to capital and management. A further measure of economic success used, is the relationship that this return to capital and management bears to the estimated total capital expressed as a percentage of total capital. This measure facilitates comparisons of farm profitability between districts. Table 3.6 in addition to showing net income, gives the percentage rates of return to capital and management.

Since the estimate for total capital includes land updated to 1975 values, the estimate for the return to capital must be considered low in all instances because of the disparity in land values between conservative government valuations, and actual market realisations. Nevertheless, the rates shown are of use in comparing results between survey regions.

Thus only growers in Motueka with a rate of return of 7.11 percent appear to be earning sufficient income to provide a realistic return to their inputs of labour, capital and management.

When the cost of borrowed capital is deducted from the return to capital and management, the residual represents the return to Equity Capital and Management. The rate of return to equity capital and management which is also shown in table 3.6 is on average lower than the rate of return to capital and management. This indicates that the average rate of return achieved by borrowing is less than the average interest rate being paid on borrowed funds which implies that borrowing is irrational for a producer wishing to maximize revenue.

3.6 Summary

The financial position of the Nelson Pip Fruit Industry has been examined in this chapter. A large disparity in terms of income and the rate of return to capital and management was found to exist between growers in Motueka and the other two pip fruit growing localities of the Nelson Province, namely Mapua and Nelson. While growers in Motueka recorded incomes well in excess of the New Zealand average, growers in Nelson and Mapua were seen to be in the most critical financial position. Although a number of factors doubtless contribute towards the income differentials between these districts, it is stressed that no one factor can be implicated as the major contributor to the differences in net farm income between districts. For example:

(a) Growers on the Moutere Hills were found to have had little practical experience or formal education in horticulture and only 33 percent of growers claimed to have had agricultural or horticultural occupations before becoming fruit growers. By comparison, 67 percent of growers in Motueka stated that their previous position had been agricultural or horticultural in nature.

(b) The adoption of new technologies has been far more rapid in Motueka than in Mapua. For example, growers in Motueka have introduced semi-intensive plantings, irrigation, chemical thinning, lighter pruning techniques and grassing down of orchards to a far wider extent than have the orchardists on the Moutere Hills.

(c) The heavy clay soils of the Moutere Hills with its drainage problems has been a further factor affecting the productivity of trees grown at Mapua. The practice of orchard cultivation has led to soil panning and erosion. In addition the natural infertility of these soils has demanded heavy applications of artificial fertilizer - adding to an already high cost structure.

(d) The distribution of total apple trees by variety (table A.15) shows that Motueka has a greater proportion of higher valued varieties than Nelson or Mapua. The older varieties which predominate at Mapua are usually more costly to produce as they require a greater amount of picking, thinning, pruning. In addition, prices received for some of these less preferred varieties may be insufficient to cover their variable costs of production when fruit is submitted to the A.P.B. However, the distribution of apple trees by variety that are of non bearing age (table A.18) shows Mapua to have a greater proportion of high valued trees than Motueka. This reflects a recent trend by growers on the Moutere Hills to restructure their orchards. Hence one may conclude that incomes in Mapua are likely to rise as these trees come into bearing.

The low incomes and poor rates of return to capital and management recorded by growers in Mapua can therefore be explained in terms of lower yields from older, less preferred varieties and higher costs from less efficient technologies.

On the basis of the survey, growers in Motueka are shown to be the most financially viable in the Nelson Province. But even in this district a reward to management would barely be available if imputed interest costs were deducted from the reward to capital and management. Pip fruit production in the Nelson Province at the present time is therefore insufficiently profitable to reward labour, capital and management at their opportunity costs.

Table 3.7 Summary of Survey Results - 1974/75

Item		Nelson	Mapua	Motueka	New Zealand
Total farm	(hectares)	35.6	23.7	44.3	21.8
Area planted					
- apples, bearing	(hectares)	5.9	7.7	9.8	5.2
- apples, non bearing	(hectares)	2.5	3.6	3.6	1.9
- pears	(hectares)	1.6	0.6	0.0	0.89
- stonefruit	(hectares)	0.08	0.04	0.12	1.67
- other horticultural crops	(hectares)	3.7	0.04	1.5	1.41
Total horticultural area[a)]	(hectares)	13.9	12.0	15.0	11.1
Yield per bearing hectare					
- apples	(bu/ha)	1 737	2 310	2 945	2 399
- pears	(bu/ha)	1 957	1 4481	1 195	1 664
Land capital	($)	38 661	30 360	36 057	41 753
Total capital	($)	116 375	129 112	160 113	130 408
Total farm receipts	($)	26 559	32 604	53 166	33 775
Off farm income	($)	645	2 773	2 107	1 171
Total cash costs	($)	21 913	28 586	37 233	23 083
Net farm income	($)	2 508	1 146	11 867	8 000
Rate of return to capital and management	(%)	0.08	0.15	7.11	4.20
Total farm debt	($)	22 459	27 390	25 794	21 137
Average equity ratio	(%)	81	78	83	82.4

a) The difference between total farm area and total horticultural area is utilized by pasture, agricultural crops and unproductive land (buildings, etc.)

CHAPTER 4

THE NELSON PIP FRUIT INDUSTRY ADJUSTMENT PROBLEM

The situation facing pip fruit growers on the Moutere Hills has been outlined in preceding chapters. It has been shown that the critical financial position of many of these growers is due, at least in part, to infertile soils and a failure to adjust their orchard practices in the face of a changing economic environment.

In this chapter the economic pressures which demand an adjustment response will be discussed in relation to the Nelson Pip Fruit Industry. It will also be shown that the economic pressures which induce adjustment inevitably move in a direction to disadvantage the primary producer. As such the problems facing the low income sector of the Nelson Pip Fruit Industry are accentuated.

A number of previous studies are then reviewed in order to facilitate the selection of an appropriate methodology with which to develop policy recommendations aimed at increasing the standard of living of the Moutere Hills pip fruit producer. In the final section of this chapter, the selected methodology is discussed to illustrate the nature of the technique and show why it is appropriate in this instance.

4.1 The Adjustment Problem

The term adjustment, is used to describe the possible changes that growers and other businessmen can make in response to changing economic conditions. A number of factors have been proposed as being responsible for creating pressures for adjustment. Fisher and Rowan [21] classify these factors into two broad categories, long and short run cyclical factors, while Heidues [26] summarizes the major factors influencing change as: population growth, technological change, industrialization, development of new institutions and shifts in social values. James [32] on the other hand, prefers to identify four classes of pressures which induce adjustment responses as economic, marketing, technological and social factors.

Economic factors have been cited as the major pressure creating a need for an adjustment response (see Ross [61] for example). The main economic factor influencing agricultural adjustment arises from a change in the ratio of the prices growers pay for their inputs to the prices they receive for their farm products. When product prices fall and input prices rise a "cost/price squeeze" is said to exist. Evidence for the existence of such a squeeze was shown in the previous chapter in table 3.2 where the movement in farm costs and receipts was seen to have increased by 98 percent and 68 percent respectively between 1972/73 and 1974/75. The relevance of this cost price squeeze will now be discussed by examining the influence of pressures arising from both the demand and the supply side of production.

In section 1.1 it was noted that 49 percent of New Zealand's exports in pip fruit were derived from the Nelson Province. The significance of an industry earning export income as opposed to income derived from the local market can lead to a number of specific implications for farm adjustment. Exporters who supply a small proportion of total world trade in any commodity are not able to influence prices and are therefore price takers on overseas markets. Since the New Zealand pip fruit industry, in conjunction with the Australian apple and pear industry, account for 2 percent of the world trade in pip fruit they would therefore be classified as price takers on the export market. In addition, in recent years domestic and international inflation have resulted in increased prices for inputs to the industrial sector. These increases have been passed on in the form of increased prices of outputs from the industrial sector. As such outputs often form inputs to the agricultural sector, the cost/price squeeze affecting agriculture is perpetuated.

In response to rising costs some growers may attempt to increase productivity in order to lower average costs and offset the effects of the cost price squeeze. While such an increase in supply may allow the individual grower to increase net farm income in the short term, this strategy will not hold in aggregate in the long run because of the low price elasticity of demand for food. An increase in food production in response to increased costs rather than an increase in demand is therefore likely to result in a decline in total farm income. Hocking [28], for example, has shown the price elasticity of demand for apples in the United Kingdom to be less than -0.68. Such a price elasticity of demand implies that a given change in the price of apples has a proportionately smaller effect on the quantity purchased. In other words a given percentage increase in supply can only be sold with a larger percentage drop in price.

The demand for New Zealand apples can also be quite sensitive to changes in consumer incomes in importing countries. As the income elasticity for apples is low, for example George and King[1/] have estimated the income elasticity of fresh apples in U.S.A. to be 0.14, the rate of growth in demand for fruit is more dependent on population growth than the rate of growth in real personal income. A low income elasticity of demand for food in general also implies that the proportion of income spent on food items will decrease as incomes increase. Accordingly agriculture's share of the Real National Product can expect to decline in the future in developed countries - the countries to which New Zealand predominantly exports apples.

The combined effects of these factors have contributed towards the cost price squeeze which affects New Zealand's agriculture. The extent to which the cost price squeeze has affected pip fruit growers is shown in table 4.1. The ratio of prices received to the prices paid by growers is referred to as the grower's terms of trade. This ratio can be used as an indication of the conditions under which trading is conducted. A decline in the grower's terms of trade, as illustrated in table 4.1, reflects the presence of the cost price squeeze.

The projected increase of export quality apples in New Zealand at the rate of 8 percent per year between 1975 and 1984 (Rae, et al. [56] when set against a background of low income and price elasticities of demand for apples accentuates the long term problems facing the Mapua pip fruit producer. Elsewhere, Miller [41] has generalized this view to the entire rural industry and has suggested that average rural producers are likely to face a continuing decline in their terms of trade as economic forces move to disadvantage the rural sector. It therefore appears inevitable that agricultural adjustment will need to occur. Fundamentally any

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1/ GEORGE, P.S. and King, G.A., Consumer Demand for Food Commodities in the U.S. with Projections for 1980. Giannini Foundation Monograph 26, University of California, 1971.

Table 4.1 Prices Paid and Prices Received by Growers, 1971-1976
(base 1971 = 1000)

Year	Prices received[a)]	Prices paid[c)]			Growers[b)] terms of trade
		Farm wages	Farm freight	Total farm costs	
1971	1 000	1 000	1 000	1 000	1 000
1972	1 047	1 111	1 070	1 058	990
1973	1 104	1 232	1 110	1 140	968
1974	1 160	1 412	1 223	1 295	896
1975	1 217	1 623	1 515	1 439	846
1976	1 274	1 840	1 703	1 593	800

a) The average guaranteed price for pip fruit expressed as an index number is given by: $x_t : 1000 :: P_t : P_b$

where x_t = the index number in year t

P_t = the average guaranteed price in year t

P_b = the average guaranteed price in the base year b

b) The ratio of prices received to prices paid. As the index relating to "total farm costs" was used in this computation instead of an index of total pip fruit grower's costs, these terms of trade must be considered as an approximation.

c) Source: N.Z. Department of Statistics.

change is likely to result in conflict as people, particularly the more conservative farmers, tend to view change with some concern. Accordingly a further problem of agricultural adjustment involves the methods or ways by which adjustment may be induced without conflict and a minimum of social upheaval.[2/] This aspect of the adjustment problem of the pip fruit growers

2/ For case study examples of adjustment patterns see:

(a) CUTHBERTSON, A.G. et al., Income Levels and Adjustment Patterns in a Rural Community. B.A.E. Industry Economics Monograph No.2, Canberra, 1974.

(b) Welfare and Resource Use. Effects of Farm Adjustment. B.A.E. Industry Monograph, No.14, Canberra, 1975.

(c) SALMON, I.M. et al., The Human Crisis of Change in Agriculture. Agricultural Extension Research Unit, University of Melbourne, 1977.

of the Moutere Hills will be discussed again in Chapter 8.

Pip fruit producers on the infertile Moutere Hill soils now face the situation of declining orchard profitability, even though they have been supported by the actions of successive governments in the past. The decline in annual income was seen to be due to a number of factors including the variety and age structure of orchards. It was then shown that the present position of these growers was due to the failure of these growers to adjust to a changing economic and technological environment. The dynamic economic forces responsible for change were discussed next and the nature of these forces were seen to be beyond the control of individual growers. Mauldon and Shapper [31] summarise the thrust of this study by stating that although growers are collectively partly responsible for a movement in their terms of trade they are not powerless to respond to them.

This study will now address itself to the problem of determining how Moutere Hill pip fruit growers might proceed in order to improve their current standard of living. Accordingly, in order to find a methodology that can analyse such a problem and suggest or recommend adjustment strategies, a selected number of previous adjustment studies will be reviewed.

4.2 Methods of Analysis

Agricultural adjustment studies have been carried out at national, regional and farm levels. Several examples of each type of study will be briefly discussed before selecting the appropriate level of aggregation at which to conduct this study.

A national model of agricultural production, adjustment and supply response has been described by Schaller [63] and others.[3/] The purpose of this model was to analyse commercial agricultural production in the United States and to determine the year to year changes in agriculture that should have occurred in the United States by regions. Recursive

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3/ See also: DAY, R.H., An Approach to Production Responses. Agr.Econ. Res. 14: 134-148, 1962.

SHARPLES, J.A. and W.N. Schaller, Predicting Short Run Aggregate Adjustment to Policy Alternatives. Am.J.Agr.Econ. 50: 1523-1536, 1968.

programming, a modified version of linear programming, was used in this model. The modification entails the use of flexibility constraints which restrict the change in production from one year to the next. The flexibility constraints as described by Day[4/] appear in the matrices in the form of upper and lower bounds on individual crop enterprises.

Using the same technique, Schaller and Dean [62] carried out an analysis of cotton and eleven alternative crops in Fresco County, California. This study analysed an adjustment problem at the regional level. An earlier study employing reactive programming has analysed watermelon production in Mississipi. This method determined flows of goods among regions which have transport cost functions, demand schedules and supply schedules.[5/]

Hogg and Larson [29] developed a method based on linear programming that estimates patterns of agricultural land use. They integrate responses to determine the optimum use of land in a situation where an increase in output of a crop will affect the price.

A large number of regional adjustment studies have been carried out using linear programming techniques. These have been reviewed by Brokken [7]. In contrast to the studies based on a geographical region, agricultural economists in the United States have concentrated on adjustment studies built upon the representative farm approach. The first study analysed adjustments on farms in the Lake States Dairy Region. The supply analysis was based on the individual supply response of 80 representative farms in Illinois, Iowa, Minnesota, Wisconsin and Michigan [71]. Another representative farm study carried out in North Dakota used three case study farms to produce profit maximising plans of farm resource allocation which were derived by linear programming.[6/]

4/ DAY, R.H., Recursive Programming and Production Response. Amsterdam, North Holland Pub. Co., 1963.

5/ TRAMEL, T.E. and A.D. Searle, Reactive Programming of Supply and Demand Relations - Applications to Fresh Vegetables. J. of Farm Econ. Vol.XLI, No.5, 1959.

6/ ANDERSON, J.D. and R.G. Johnson, Analysis of Optimum Farm Organisation in the Red River Valley. North Dakota, State University Bull. 489, 1971.

In Australia linear programming has been combined with a simulation approach by Sinden /̲67̲/ to determine the economics of introducing poplar trees on to the low income dairy farms of Northern New South Wales. The Australian Bureau of Agricultural Economics /̲8̲/ has also used a linear programming analysis to examine farm adjustment in Northern New South Wales.

A number of difficulties arise in the use of national and regional models. The aggregation problem will occur when estimating total regional resource constraints as most farmers in a region will not use their resources to capacity. The regional restraints derived from the summation of available resources ordinarily do not allow for this non-use. Consequently, the total resources of a region will be greater than that which is actually available for production in the short run. Regional models also oversimplify the production possibilities in a region and between regions, see Brokken /̲7̲/.

On the other hand aggregating micro data to represent the macro level of analysis is a serious weakness in such representative farm models.[7/] The representative farm model also fails to answer the question of what farms and which areas should produce certain crops at various prices. Therefore, the representative model does not provide the type of data needed for individual farmer decisions. As the objective of this study is to derive policy recommendations which will assist the low income sector the Nelson pip fruit industry to adjust their individual resource allocations, national and regional models must be considered inappropriate in this instance. Accordingly, the lowest level of aggregation, the single farm, was chosen as the unit of reference for this study. However, the question of which specific type of representative farm model to use in order to study the adjustment process associated with perennial crop production remains.

7/ TWEETEN, L.G., The Farm Firm in Agricultural Policy Research. In Price and Income Policies, Agric. Policy Inst. North Carolina State University, October 1965.

4.3 The Methodology Adopted

A synoptic review of the various models that have been developed for economic analysis in agricultural management has been presented elsewhere by Anderson /‾3_/. The selection of a modelling technique depends upon the problem and the specific properties of the system to be analysed. In this instance the intertemporal nature of perennial crop production demanded that the selected method be able to deal adequately with the time dimension. Further, as the purpose of the study is to derive policy statements it would seem desirable to have a prescriptive model, preferably with an optimizing routine.

A survey of the literature revealed that relatively few attempts have been made in the past to model perennial crop production. Rae /‾52 and 53_/ has used intertemporal linear programming to illustrate its applicability to orchard planning, while Hanlon et al. /‾22_/ has used the same technique to assist in the selection of apple varieties, and Abalu /‾1_/ has used a further variant of this model to investigate perennial crop investment decisions.[8/]

The general replacement model has been used by Kwong-Yuan Chong /‾35_/ to determine the optimum replacement time for rubber trees in Malaysia while Ecker /‾19_/ has used this model to determine the optimal replacement pattern of standard apple trees with dwarf trees. Finally, Winter /‾78_/ has used a simulation model to examine the influence of different planting densities and fruit sizes on a total orchard system.

While the replacement model is suitable for analysing situations involving replacement decisions involving perennial crops, an adjustment study may consider a number of options other than perennial crops. For this reason the replacement model needed to be integrated within a more general formulation. Simulation was also rejected as this technique is

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8/ For additional examples see:

POPTEAN, I., Optimizarea structurii plantatulor pomicole prin programmare liniara. Revista de Horticultura si viticultura, Nr.3 , 1974.

STORCK, H. Editor. Bericht über das 9 Betriebswirtschaftliche. Seminar fur Gartenbauberater, Fachgebiet Obstbau, 1970.

basically descriptive and unlike mathematical programming does not derive optimal strategies.

In view of the nature of the problem intertemporal linear programming (ILP) was considered the most appropriate technique to use in this instance. The ILP model allows the analyst to trace a set of optimal decision rules through time. The technique is flexible insofar as it allows the analyst to incorporate a variety of activities and permits simulation and experimentation with various policies under a variety of conditions. A detailed exposition of the technique may be found elsewhere, for example Rae [57].

In the following chapter the features of the ILP model will be discussed before giving a detailed description of the model used in this study.

SECTION B

CHAPTER 5

THE INTERTEMPORAL LINEAR PROGRAMMING MODEL[1/]

In the previous chapter we concluded that I.L.P. would form a suitable framework with which to model orchard production and analyse the adjustment problem facing these growers. In this chapter the structure of the model and the derivation of various matrix coefficients within the model will be discussed.

5.1 Features of the Intertemporal Model

Although there is essentially no difference between the static single period linear programming model (L.P.) and the intertemporal variant, there are a number of features which differentiate the I.L.P. from the ordinary L.P. Olsson [50] lists these features as follows:

(1) Each activity and each constraint must be dated in a certain period of time.

(2) Cash flows of income and expenditure occur in the model instead of the revenues and costs included in the static model.

(3) For each activity dated in a certain period of time, not only is there a link between this activity and the constraint in the same period, but also the possible link with constraints in other periods.

Thus the general form in which L.P. problems are described, namely

1/ The following synonyms are often encountered in the literature: multiperiod, polyperiod, multistage and dynamic linear programming.

$$\text{Maximise } Z = \sum_{j=1}^{n} c_j x_j$$

$$\text{Subject to } \sum_{j=1}^{n} a_{ij} x_j \leqslant b_i$$

$$x_j \geqslant 0 \text{ for all } j = 1, 2, \ldots, n$$
$$i = 1, 2, \ldots, m$$

may be rewritten to represent an I.L.P. problem as:

$$\text{Maximise } Z = \sum_{j=1}^{n} c_j^1 x_j^1 + \sum_{j=1}^{n} c_j^2 x_j^2 + \ldots + \sum_{j=1}^{n} c_j^T x_j^T$$

$$\text{Subject to } \sum_{j=1}^{n} a_{ij}^1 x_j^1 \leqslant b_i^1$$

$$\sum_{j=1}^{n} a_{ij}^2 x_j^1 + \sum_{j=1}^{n} a_{ij}^2 x_j^2 \leqslant b_i^2$$

$$\vdots \qquad \vdots \qquad \ddots$$

$$\sum_{j=1}^{n} a_{ij}^T x_j^1 + \sum_{j=1}^{n} a_{ij}^{T-1} x_j^2 + \ldots \sum_{j=1}^{n} a_{ij}^1 x_j^T \leqslant b_i^T$$

$$x_j^T \geqslant 0$$

$$\text{for } j = 1, 2, \ldots, n$$
$$i = 1, 2, \ldots, m$$
$$t = 1, 2, \ldots, T$$

Where c_j^t = the contribution per unit of activity x_j initiated in period t

x_j^t is the level at which activity x_j is initiated in year t

a_{ij}^t is the per unit requirement of activity x_j for resource b_i in period t

b_i^t is the supply of resource i in period t.

The use of I.L.P. models in agricultural studies has been described by Swanson [72], Loftsgard and Heady [36], Candler [9], Candler and Boehlje [10], Olsson [50], Boussard [6], Throsby [75], Colyer [16] and others. The use of the model has been demonstrated by Stewart and Thornton [69], Rae [53], Abalu [1], Jensen [33], Chien and Bradford [18], Willis and Hanlon [77], amongst others.

Early applications of the I.L.P. model were generally designed to maximise the present value of future incomes over some planning period. In commenting on the study by Loftsgard and Heady, Candler [9] suggested that it would be equivalent, but simpler to build a model that would maximise income at the end of the planning period. The inter-temporal model presented in this chapter is based upon that proposed by Candler [9] and described by Rae [53] with an objective of maximising a weighted sum of several individual goals such as the sum of after tax cash and the value of assets owned by the firm at the end of the planning horizon.

5.2 Structure of the Model

The general structure of the I.L.P. model is shown in schematic form in figure 5.1. By referring to figure 5.1 it can be seen that the model consists of two major sets of activities:

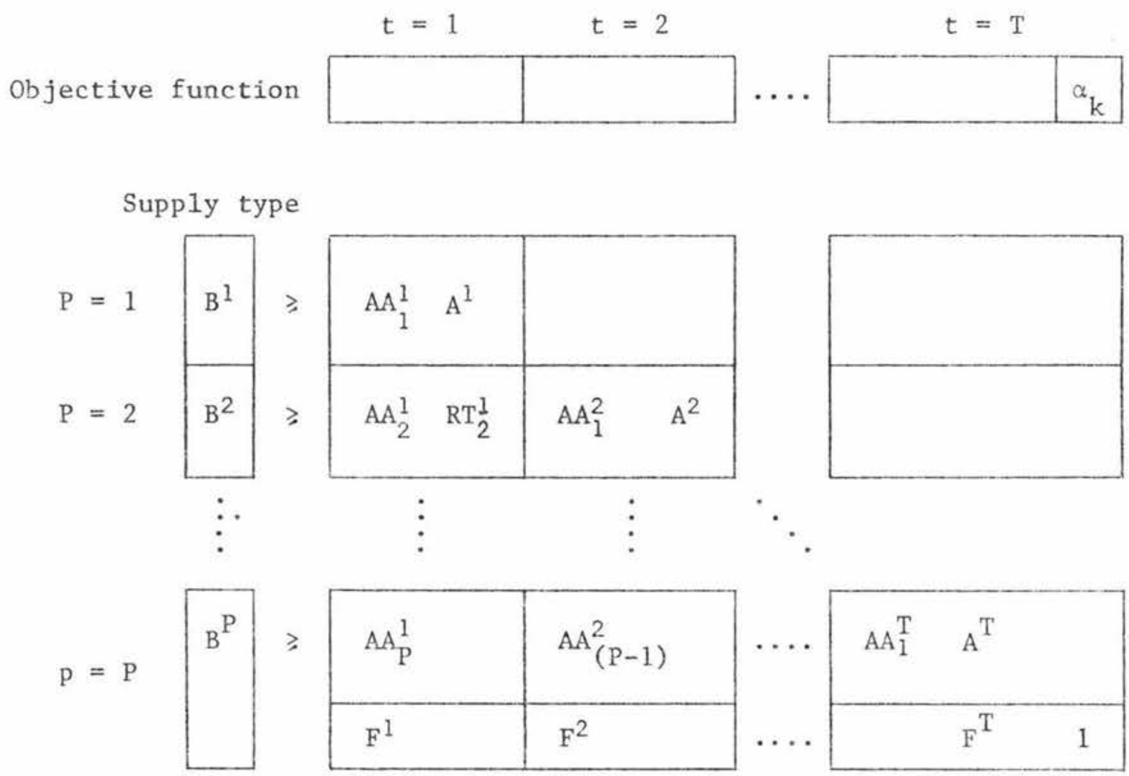
(a) A set of activities (A) to model the existing orchard activities and cash flows; and

(b) A set of "adjustment" activities (AA) to allow for the adoption of new enterprises.

As the entire matrix consisted of over 500 row vectors and 1200 column vectors it is not possible to show the entire model in this report. However, a simplified illustration of the submatrix concerned with the final year of the planning horizon is presented on page 74.

The flow of cash through the model, the objective function and the length of the planning horizon are several issues of particular importance to an understanding of the model. Therefore a discussion of these features will precede an examination of the various activities and constraints included in the model.

Figure 5.1 The General Structure of the Intertemporal Model



Where AA_p^t = submatrices of coefficients for activities initiated in year t, with a resource requirement in period p

A^t = sub matrices of coefficients for existing activities and transactions within year t

RT_p^t = submatrices of coefficients for transfer of resources from year t to period p

F^t = vector of coefficients of final asset values of activities initiated in year t

B^t = vector of resources and restrictions in period p

αk = a vector of objective function coefficients corresponding to the weights attached to the final q goals

for t = 1, 2, ..., T

k = 1, 2, ..., q

p = 1, 2, ..., P

P = T.

5.2.1 Cash flow in the model

Figure 5.2 summarises the flow of cash within the model. Cash transferred from the end of the previous year is made available for use at the start of year t. From this amount the model deducts the fixed costs such as mortgage and interest repayments, fixed insurance costs and a specified amount for personal consumption to cover such expenses as food and clothing. Having deducted the fixed costs the variable costs of production for the year t are calculated. Borrowing on mortgage or overdraft rates is permitted to overcome cash infeasibilities should cash be limiting. Under circumstances of cash surplus, the cash not required for farm production or reinvestment may be invested off the farm at a specified interest rate.

At the end of the year the tax deductible costs incurred during the year are summed, i.e. the portion of fixed costs that were tax deductible, the variable production costs and the interest paid on monies borrowed. The total tax deductions are then subtracted from the total income earned during the year to arrive at the taxable income for year t. The amount of tax payable on the taxable income is calculated and deducted from the taxable income to give the after-tax cash. Appropriate adjustments are then made for the principal components of monies either borrowed in year t or invested off the farm. The residual then gives the amount of cash available at the start of year t + 1.

5.2.2 The objective function and the length of the planning horizon

The I.L.P. model made use of an objective function which maximised the weighted sum of individual goals at the end of the planning period. As the "well-being" of farm families can be measured as some combination of annual income and asset accumulation[2/] it was decided that a suitable objective to maximise would be the sum of after tax cash and the value of assets at the end of the planning horizon subject to a given level of personal drawings each year. Accordingly, only two non-zero values

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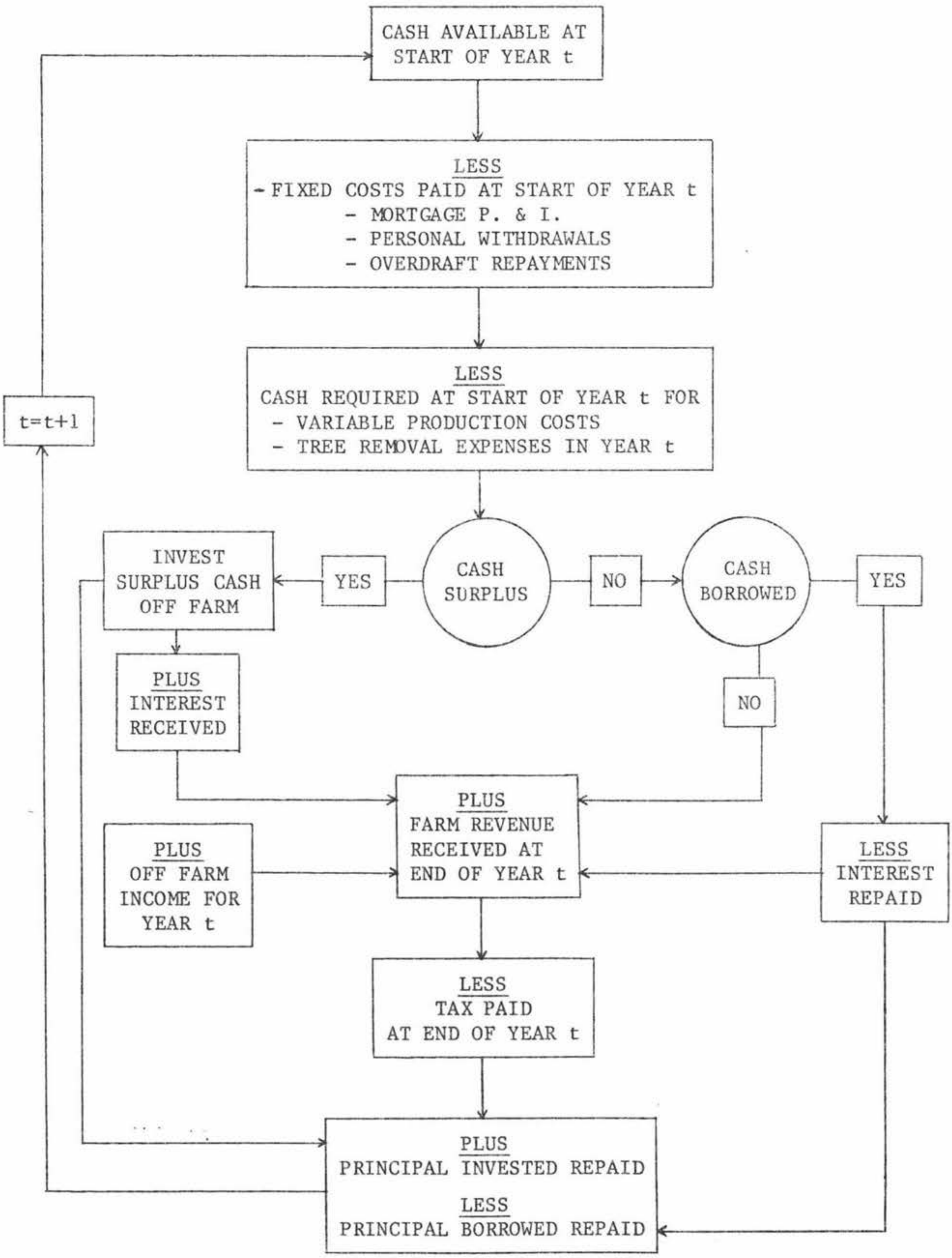
2/ See Chapter 8.

Figure 5.2 Cash Flow in the Intertemporal Model



appear in the objective function,[3/] these being the weights attached to the final cash and final assets activities.

Several methods of determining the length of the planning horizon have been suggested in the past. Townsley[4/] has suggested that the planning horizon of a development programme should consist of the number of years required to develop a stable post development situation. An adjustment problem such as the one considered in this study could therefore be solved in two parts:

(1) construct a single period L.P. model of the orchard in order to determine an optimum post development plan of orchard organization which maximized some given objective function.

(2) Fix the level of the various activities in the final year of an intertemporal L.P. model of the orchard at the optimum level determined by the static L.P. The development programme and planning horizon could then be determined by increasing the number of periods contained within the I.L.P. model until feasibility was established.

While Rae /̅53̲/ has suggested the length of the planning horizon be extended until investment decisions in the first time period become insensitive to further extensions, Haavelmo[5/] has stated that the planning horizon should not be longer than is of interest to the decision maker who, in this case, is the Moutere Hills pip fruit producer.

In considering the length of the planning horizon it was recognized that as the average age of pip fruit producers on the Moutere Hills was 40 years (Appendix A, table A.11), a maximum planning horizon of 20 years

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3/ The inclusion of one final cash activity did not, however, allow for the possibility of a cash deficit at the end of the planning period (by the non-negativity assumption). Thus the objective function was later augmented with the inclusion of a final cash deficit activity which allowed for the possibility of cash deficits which occurred when the planning horizon was reduced from 20 to 10 years.

4/ Pers. comm.

5/ HAAVELMO, T., A Study in the Theory of Investment. Chicago, 1960.

would meet the needs of these decision makers, even though this period would probably fall short of the time required to reach a new equilibrium situation. Accordingly, a model with such a planning horizon was constructed and solved for a bench mark situation. However, the model became too large and expensive to use when augmented with the various adjustment activities. Therefore, the planning horizon in the model developed was reduced to a ten year period. This was regarded as a compromise between two requirements:

(a) a period long enough to allow the study of the adjustment process; and

(b) a period which is sufficiently short to allow the model to be handled without too much difficulty.

5.2.3 The constraints

The major constraints included in the model may be grouped as follows:

(i) existing tree number constraints

(ii) land constraints

(iii) labour constraints

(iv) financial constraints

(v) variety limitation constraints

(vi) accounting constraints

(vii) final cash and asset constraints.

(i) Existing tree number constraints.

A set of constraints corresponding to the existing tree activities were formulated in order to limit reworking and interplanting to no more than the initial tree numbers.

(ii) The land constraints.

A single constraint in each year of the planning period constrained total land utilisation to no more than the area available.

(iii) Labour constraints.

Two sets of labour constraints were included in the formulation of the model. The year was first divided into three periods to reflect the major periods of orchard activity, i.e.

(a) the dormant period : June - August

(b) the growing season : September - December

(c) the harvest period : January - May.

Then, in view of the importance of labour employment throughout the harvest, this period was further subdivided into nine fortnightly periods in order to provide a second set of constraints that would determine labour requirements and picking costs throughout the harvest period.

(iv) Financial constraints.

Three financial constraints were set up to facilitate cash flow accounting and the determination of taxation. The first cash constraint limits total expenditure to no more than the cash available at the beginning of the year plus borrowings. The second restraint allows the amount of tax payable in year t to be determined. The final cash restraint permits the income earned to be divided into:

(a) a proportion covered by tax deductible costs, i.e. taxfree and therefore income which is available at the start of year t + 1 (as costs are all paid at the start of each year);

(b) a proportion to be taxed (the after tax cash component is then also made available in year t + 1).

(v) Variety limitation constraints.

In order to overcome the problem of labour bottlenecks at harvest time, a number of varieties of perennial crops are usually grown to provide an even supply of fruit throughout the harvest period. To constrain the model from choosing the most profitable variety for orchard reconstruction a set of constraints were included to restrain the proportion of the various varieties of perennial crops grown to a maximum percentage of total tree numbers.[6/]

6/ Constraining varieties on the basis of tree numbers as opposed to the quantity of fruit harvested in each fortnightly sub period of the model is preferred as the former method takes into account the problem of harvest periods beyond the planning horizon. Limiting varieties on the basis of fruit production on the other hand, would not necessarily ensure a desired distribution of fruit throughout the harvest period as new plantings may not come into full production during the planning horizon.

vi) Accounting constraints.

"Non computational" constraints may be used for accounting purposes. The I.L.P. model used such a constraint to determine the total quantity of fruit harvested each year.

vii) Final asset and cash constraints.

The final asset and cash constraints appear only once, in the final year of the model. These constraints were used to determine:

(a) the final asset value of all perennial plantings at the end of the planning period; and

(b) the final after tax cash position at the end of the planning period.

The resultant values were then transferred to the objective function of the model.

5.2.4 The activities

The activities included in the I.L.P. matrix and repeated in each year of the planning horizon can be divided into the following categories:

(i) existing orchard plantings
(ii) tree removal activities
(iii) new plantings of perennials
(iv) interplanting and reworking activities
(v) annual activities
(vi) activities to hire labour
(vii) financial and taxation activities
(viii) final cash and asset transfer activities.

(i) Existing orchard plantings.

The existing plantings of perennial crops were aggregated into 30 activities on the basis of variety, age and density of planting. The added detail to be derived from such a grouping as opposed to a grouping on the basis of variety alone was intended in order to answer questions relating to the optimum replacement of selected age groups of trees.

(ii) Tree removal activities.

Because of the cost and/or labour time involved in the removal of existing trees, a set of tree removal activities were incorporated. While these activities may appear superfluous in reconciling tree numbers their inclusion was intended to allow greater accuracy in the estimation of labour times and costs, both of which are seen as critical factors in orchard production.

(iii) New plantings of perennials.

To facilitate the restructing of orchards a number of activities were included to allow for the planting of new or additional varieties of perennial crops. In order to limit the size of the matrix only the most likely candidates were included, selection being made on the basis of the net present value of the variety. (See page 72).

(iv) Interplanting and reworking activities.

A second set of orchard adjustment activities permitted existing trees the option of being interplanted or reworked to other varieties. As existing tree activity could be reworked or interplanting with any one of a number of varieties in any year of the planning horizon, it was again necessary to restrict the number of options available to the most likely candidates in order to limit matrix size.7/

(v) Annual activities.

The inclusion of a number of activities such as off farm work and cattle fattening on an annual basis without provision for herd replacement etc., provided a further set of adjustment activities.

(vi) Activities to hire labour.

Two sets of activities were included to provide for additional labour to be hired for seasonal work and/or fruit picking. Differential rates of pay were invoked for the two classes of labour which supplemented the owner operator's contribution.

7/ For example, 30 existing tree activities given the option of being interplanted or reworked to any 6 new varieties in any year of a 10 year planning horizon implies 3600 activities.

(vii) Financial and taxation activities.

To facilitate the cash flow accounting previously described, the following activities were repeated in each year of the I.L.P. model:

- cash borrowing on either mortgage or overdraft rates;
- cash saving in the form of off-farm investment;
- taxation activities to calculate tax payable;
- a tax deduction transfer activity. Since all tax deductible expenditures must be subtracted from income earned before taxation is calculated the tax deductions transfer activity allows a sum equal to the tax deductible expenditures of that year to be subtracted from the pre tax income and transferred to the supply of cash available at the beginning of the next year.

(viii) Final cash and assets transfer activities.

This set of activities, unlike other activities, appears only once in the final year and acts to transfer the value of final assets and cash to the objective function.

5.3 The Data Used in the Model

5.3.1 Selection of the representative orchard

The use of representative farms in policy analysis has been described by Day [17], Carter [12], Plaxico and Tweenten [51], Sheehy and McAlexander [66], Sharples [65] and others. While representative farms have been criticised, first for their inability to portray intangible factors such as management, and secondly in that their static nature only allows farms to remain representative within given levels of technology (Barnard [4]), the seriousness of these criticisms depends on the use that is made of such farms, i.e. whether conclusions are to be extrapolated to a local, regional or national point of view.

In this study we are interested in a relatively homogeneous group of pip fruit producers, i.e. those pip fruit growers on the Moutere Hills who are either currently or potentially exhibiting symptoms which have resulted from a failure to adjust. Also, as any conclusions drawn from this study are intended for this select group of producers alone, a representative farm approach was seen as being the most suitable way of obtaining much of the data required for the I.L.P. model.

By combining various aspects of the approaches described by McClatchy and Campbell /‾38_7 and El Adeemy and MacArthur /‾20_7, a procedure was derived to facilitate the quantitative selection of a representative orchard.

The age structure and variety composition of orchards are two major factors which reveal the seriousness of the on farm adjustment problem, these criteria were therefore used to determine a sub-sample of problem growers on the Moutere Hills. This sub-sample, consisting of those growers with a low percentage of high valued varieties (i.e. Granny Smith, Red Delicious, Cox and Gala) and more than 60 percent of all fruit trees greater than five years of age, was then used as a sampling frame from which to select the representative problem orchard.

Using the data obtained in the Nelson Pip Fruit Industry Survey, a number of frequency distributions of important characteristics were constructed for the Mapua sub-sample. Table 5.1 shows the distribution of values occurring on these farms for some selected features which were considered important in this type of farming. The modal situation was then identified by inspection.

To isolate the farm which most nearly approached the "modal farm" the deviation of each farm from the modal situation was calculated. The farm with the lowest aggregate deviation was then selected as the representative farm. Table 5.2 lists the various characteristics considered in the selection of the representative orchard and compares the selected orchard with the sub-sample mean and modal values.

The grower thus selected was subsequently contacted. Upon agreeing to cooperate in the study a series of three interviews was conducted during which an extensive amount of farm data was collected. This data was then used to derive matrix input-output coefficients, the derivation of which will be described in the next section.

Because of the homogeneity of the Moutere Hills orchards and the particular resource allocation of the selected representative orchard it was decided to base this study on one actual representative farm as

Table 5.1 Distribution of Some Characteristics Used in the Determination of the Moutere Hills Representative Orchard (percentage of farms)

Area of pipfruit (ha)	(%)	Total area (ha)	(%)	Percentage development (%)	(%)	Off-farm income ($)	(%)
4.0 - 8.0	16.6	4.0-12.0	22.4	20- 40	5.5	0	6
8.1 - 12.0	61.4*	12.1-20.0	33.3*	41- 60	33.5	1- 500	11
12.1 - 16.0	5.5	21.0-28.0	16.6	61- 80	44.4*	501-1000	22
16.1 - 20.0	5.5	More than 28.1	27.7	81-100	16.6	1001-1500	28*
21.1 - 24.0	5.5					1501-2000	17
More than 24.1	5.5					More than 2001	16

Percentage of high valued varieties (%)	(%)	Net farm income ($)'000	(%)	Percentage equity (%)	(%)		
10 - 20	5.5	Less than 0	44.4*	20- 40	11.7		
21 - 30	38.8*	0 - 2	11.2	41- 60	17.6		
31 - 40	22.2	2.1- 4	11.2	61- 80	35.2		
41 - 50	11.4	4.1- 6	16.6	81-100	35.5*		
51 - 60	16.6	6.1- 8	-				
61 - 70	5.5	More than 8	16.6				

* = modal value.

Table 5.2 Comparison of the Representative Orchard With the Sub-sample Mean and Modal Group Values

Characteristics		Mapua sub-sample			Selected representative farm
		Mean	Median	Modal group	
Percentage development	(%)	63	63	61-80	61
Percentage high values varieties	(%)	36	33	21-30	30
Net farm income 1974/75	($)	1145	1681	Lt. 0	-2394
Apple production (bush bearing ha)		1737	1684	1720-2470	1503
Area in pip fruit	(ha)	12.14	10.92	8.09-12.04	8.65
Total area of holding	(ha)	24.68	15.78	12.14-20.03	15.78
Percent supplied to A.P.B.	(%)	97	99	90-100	99
Off farm income	($)	2773	587	1001-1500	53
Percentage equity	(%)	73	71	81-100	51
Total density of pip fruit plantings (trees/ha)		417	408	Gt.420	408

Table 5.3 Variety Composition of the Representative Orchard

Variety	Representative Orchard (tree numbers)				Mapua %
	Non-bearing	Bearing	Total	%	
Granny Smith	492	242	734	18	19
Cox	376	348	724	17	14
Red Delicious	342	176	518	12	14
Gala	159		159	4	3
Golden Delicious	71	261	332	8	9
Sturmer	42	516	558	14	14
Red Dougherty		152	152	4	6
Gravenstein		229	229	5	3
Jonathan		263	236	6	7
Others	118	49	167	4	5

opposed to a synthetic representative farm. The representative orchards variety composition shown in table 5.3 serves to further illustrate the suitability of the selected orchard used in this study.

5.3.2 Derivation of matrix coefficients

In this section we outline the procedures which were adopted to derive some of the matrix coefficients from basic farm data. Because of the size and complexity of the model it is not possible to cover the derivations of all input output coefficients in this account. However, a sub-set of the more critical coefficients has been selected for examination. These include:

(a) yields;
(b) pre-tax cash receipts;
(c) seasonal labour requirements for all activities other than fruit harvesting;
(d) labour requirements for harvesting;
(e) cash requirements;
(f) asset values of perennial crops.

(a) Yields.

Projections of perennial crop yields were required in order to determine variable costs of production, such as picking costs and transport costs, total revenue and final asset values of the various perennial crop activities. As such it was necessary to estimate the annual yield for each perennial crop activity included in the model. In order to do this the annual expected yield of pip fruit was assumed to consist of two major components:

(1) a component due to tree age; and
(2) a component due to an increase in productivity.

The contribution of each component was estimated and summed to arrive at an annual expected yield.

(1) Yield due to tree age.

In order to estimate the yield due to tree age, use was made of the cross sectional data collected in the Nelson Pip Fruit Industry Survey. To estimate the yield of pip fruit through time the following yield projection model was formulated:

$$\frac{Y_i}{N_i} = \sum_{j=1}^{n} \hat{\beta}_{ij} \frac{X_{ij}}{N_i} \qquad (5.1)$$

where Y_i = total orchard yield of variety i

X_{ij} = number of trees of variety i in age group j

N_i = total number of trees of variety i in the orchard

$\hat{\beta}_{ij}$ = average yield per tree for trees of variety i in age group j. Four age groups were used, these being 0-5 years, 6-15 years, 16-50 years, greater than 50 years.

The equations that were estimated by ordinary least squares are given in table 5.4. Figures in parenthesis are the standard errors of the estimated coefficients. Unfortunately yield estimates for all varieties listed in table 5.4 could not be used with confidence. Accordingly, informed judgement[8/] was used to supplement this empirical analysis.

(2) Yield due to an increase in productivity.

The second component affecting yield through time is the effect of changing productivity. Time series data supplied by the Ministry of Agriculture and Fisheries (see Appendix B) was used to determine an annual rate of growth in productivity for apple and pear production in Mapua.

The yield increase in productivity was calculated from the equation:

8/ Mr C. Cook, M.A.F. Horticultural Advisory Officer, Nelson (pers.comm.) and various pip fruit growers (pers. comm.)

Table 5.4 Estimated Yield Through Time by Variety

Variety	Estimated coefficients β_1	β_2	β_3	β_4	R^2
Packhams	5.52 (1.620)	-1.70 (4.293)	4.27 (1.196)	6.69 (1.317)	0.94
Red Delicious	0.315 (0.366)	2.08 (0.695)	5.92 (3.587)	0.81 (1.556)	0.72
Cox	4.25 (1.662)	5.30 (1.352)	5.78 (2.173)	-2.01 (3.676)	0.81
Delicious	-3.37 (5.524)	5.78 (6.554)	10.31 (5.622)	7.42 (0.749)	0.93
Sturmer	2.27 (3.306)	4.009 (2.436)	8.614 (2.841)	6.521 (0.907)	0.93
Dougherty	1.319 (0.805)	4.026 (2.034)	6.795 (2.472)	0.832 (2.950)	0.85
Jonathan	-7.739 (9.80)	-5.89 (8.30)	13.11 (4.25)	7.318 (0.855)	0.90
Gravenstein	-.458 (3.077)	-.290 (2.32)	12.912 (4.340)	7.355 (1.326)	0.87
Granny Smith	1.741 (0.536)	2.877 (0.611)	8.626 (0.848)	-2.14 (2.357)	0.94
Golden Delicious	-.820 (1.130)	5.143 (1.047)	8.968 (1.514)	10.385 (1.864)	0.94

$$\frac{Y}{BT} = \hat{\beta}_o + \hat{\beta}_1 t + \hat{\beta}_2 D$$

where $\frac{Y}{BT}$ = yield per bearing tree[9/]

t = a time trend variable

D = a dummy variable to recognise the biennial bearing habits of apple trees.

The following equations were then estimated:

$$\text{APPLES} \quad \frac{Y}{BT} = \underset{(0.272)}{3.599} + \underset{(0.1929)}{0.0689t} - \underset{(0.2236)}{0.135D} \qquad R^2 = 0.44 \qquad (5.2)$$

$$\text{PEARS} \quad \frac{Y}{BT} = \underset{(0.462)}{4.581} - \underset{(0.0327)}{0.0005t} - \underset{(0.3793)}{0.0661D} \qquad R^2 = 0.001 \qquad (5.3)$$

Using equations (5.2) and (5.3) the annual rate of growth in productivity was then estimated as[10/]

Apples 1.6 percent per year;
Pears 0 percent per year.

These rates were then combined with the estimated annual yields to produce a final annual yield estimate for each of the various varieties of pip fruit, i.e. the expected yield/tree/year that could be expected for each variety between 1976 and 2041 (assuming a productive life of 65 years).

9/ The percentage of bearing trees in Mapua was determined from the Official Five Year Survey of the New Zealand Fruit Industry (1958, 1963, 1968 and 1973). Intermediate years were determined by extrapolation.

As the data available for tree numbers was collated as at October 31 in the year previous to that of the yield given for that year, yields were lagged by one year to overcome the inconsistency inherent in this data.

10/ The annual increase in yield/tree due to productivity was given by the co-efficient of the time trend variable. This quantity was then expressed in terms of an annual growth rate.

(b) Pre-tax cash receipts.

In order to derive the pre-tax cash income it is first necessary to establish annual prices received. The price growers receive for pip fruit is determined by:

(1) the size distribution of the crop, which is in turn determined by (a) tree age and (b) the effect of various managerial factors; and

(2) the percentage of fruit destined for export, local market and processing.

From the growers' records and data obtained from the Nelson Co-operative Packhouse, the size distribution and export pack-out were determined for 1974 and 1975. Then based on the 1976 New Zealand Apple and Pear Board's Price List, an appropriately weighted, average price was determined for each variety of pip fruit. This average price was then further modified to reflect the changing size distribution of a pip fruit crop through time. Although a continuous price function would have been desirable for simplicity, a price differential was applied to the following age groups of pip fruit trees:

(1) less than 8 years of age to reflect the ban of export fruit from trees of this age group;
(2) 8 - 45 years; and
(3) greater than 45 years to reflect the small sized fruit from older trees.

The relevant pre-tax cash receipt was then given by:

$$R_{pj}^{t} = P_{j}^{t} \times Y_{pj}^{t}$$ 11/

where R_{pj}^{t} = the total revenue received in year t by the jth activity, initiated in year p

P_{j}^{t} = the price for the jth activity in year t

Y_{pj}^{t} = the yield in year t for the jth activity initiated in year p.

11/ For the purpose of deriving various matrix coefficients the index notation should be interpreted as follows:
- t - each year of the planning horizon
- j - each productive activity
- p - the year in which an activity is initiated.

(c) Seasonal labour requirements.

Seasonal labour requirements were determined as follows:

(a) Winter labour:

$$WL_j^t = PT_j^t + TT_j^t$$

where WL = the requirement for winter labour

PT = the time required for pruning

TT = the time required for training.

(b) Growing season labour:

$$GL_j^t = TT_j^t + S_j^t + T_j^t + C_j^t + M_j^t + F_j^t + WS_j^t$$

where GL = the requirement for growing season labour

TT = the requirement for tree training

S = the requirement for tree spraying

T = the requirement for fruit thinning

C = the requirement for cultivation

M = the requirement for mowing

F = the requirement for fertiliser application

WS = the requirement for weed spraying.

(c) Harvest season labour:

$$HL_j^t = C_j^t + M_j^t + T_j^t + P_j^t + WS_j^t + S_j^t + CT_j^t$$

where HL = the requirement for harvest season labour

P = the requirement to prop and tie trees

CT = $(0.0985 \times Y_j^t)$ = the time required to transport Y bushels of fruit to the co-operative packhouse.

(d) Determination of picking time.

In order to meet export requirements pip fruit are picked throughout the harvest period as shown in figure 5.3. To determine the demand for harvest labour, estimates of average picking rates for all varieties of pip fruit at various ages were determined from information supplied by the grower. This information was then combined with the proportion of the various varieties that were harvested in each of nine fortnightly harvest season periods. These proportions were calculated on a variety basis from the 1973 and 1974 weekly receipts of the Apple and Pear Board's depot at Mapua.

The number of hours required in the kth fortnightly period, for the jth perennial crop activity in the tth year of the planning horizon was then given by

$$PL_{kj}^{t} = \frac{PR_{kj} \times YD_{j}^{t}}{PT_{j}}$$

where PL = the number of hours required per fortnight
PR = proportion of each variety harvested in each fortnight
YD = the expected yield of each variety
PT = the average picking rate.

(e) Cash.

The cash requirement coefficients were determined as the sum of all cash costs less the cost of labour, as this cost was determined endogenously elsewhere, i.e.

$$CR_{j}^{t} = TR_{j}^{t} + TK_{j}^{t} + SC_{j}^{t} + FC_{j}^{t}$$

where CR = the cash requirement
TR = the number of tractor hours involved in each operation (e.g. spraying mowing etc.) in each year; plus the number of truck hours involved in each operation (e.g. fruit cartage) in each year; multiplied by the appropriate truck running cost/hour for the relevant year.
SC = the cost of the qth spray applied to each variety for q, herbicide, pesticide and thinning sprays.
FC = cost of fertilizer.

(f) Asset values of perennial crops.

Perennial crops in existence at the end of the planning horizon were assigned asset values equal to the present value of future net revenues

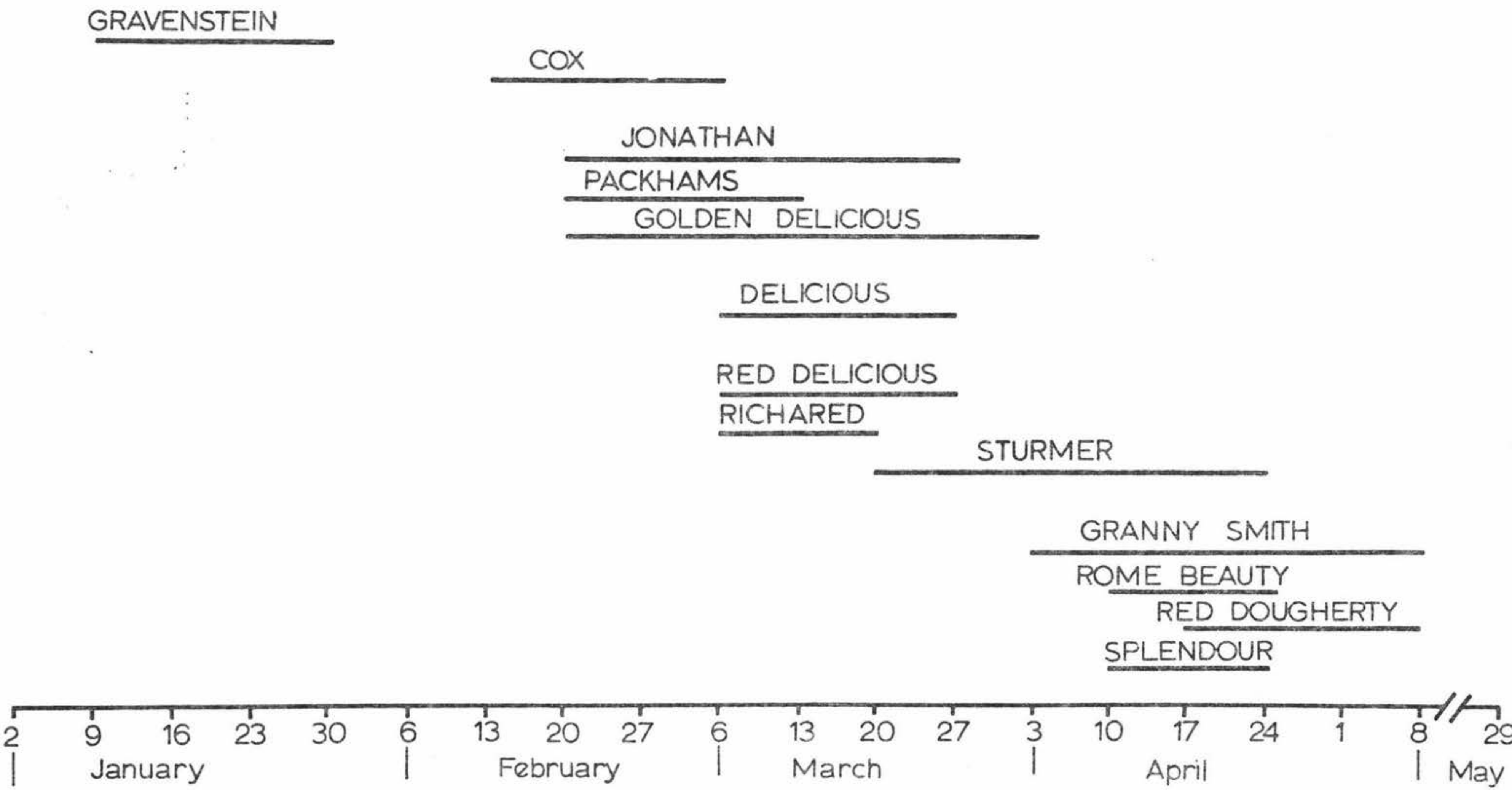


Figure 5.3 Picking Times for Pip Fruit

discounted from infinity with crop replacement at the optimum time.

The optimum replacement time for each perennial crop activity was calculated as the year in which the annual net revenue (marginal net revenue) equalled the amortized present value of net revenues from that activity.

The amortized present value over any production cycle of t years was given by:

$$A = \left[\sum_{t=1}^{n} \frac{NR_j^t}{(1+i)^t} \right] \cdot \left[\frac{i(1+i)^t}{(1+i)^t - 1} \right]$$

where NR_j^t = Net revenue of the jth activity in the tth year
i = discount interest rate.

Asset values for each activity were then derived from the following equation:

$$AV_j^t = \frac{NRm+1}{(1+i)} + \frac{NRm+2}{(1+i)^2} + \ldots, \frac{NRm+m}{(1+i)^m} + \frac{\frac{A^*}{i}}{(1+i)^{n+1}}$$

where AV_j^t = the asset value of activity j, initiated in year t
NR_m = net revenue of the activity in year m
m = age of the tree at the end of the planning horizon
m+m = optimum replacement age
A* = maximum amortized present value of activity j.

A fortran programme[12/] which was written to calculate these asset values together with a sample of the programme's output appears in Appendix C.

12/ The programming assistance given by Mr. R. Lewer is gratefully acknowledged.

5.4 Summary

In order to summarise the structure of the I.L.P. model discussed in this chapter a simplified representation of the year 10 submatrix is presented in table 5.5. Activities have been numbered as

(K)P(N)

and restraints as (K)R(S) for K= 1, ..., 10 years of the planning horizon
N = 1, ...,120 activities per year
S = 1, ..., 60 restraints per year.

To facilitate an understanding of the various tree activities the following explanation concerning activities 9P001, ..., 10P087 is given. Existing tree activities are transferred from year nine to year ten via activities 9P001, ..., 9P030. In year 10 these trees may be retained (10P001, ..., 10P030), removed (10P031, ..., 10P060), interplanted (10P074, ..., 10P082) or reworked (10P083, ..., 10P087). In addition, new trees may be planted (10P074, ..., 10P073). The requirements for trees which have been interplanted, reworked or planted in previous years are represented by activities (K)P061, ..., (K)P087, where K is the year in which the activity was initiated. This explanation of the orchard tree activities in addition to the following legend should assist in the interpretation of the matrix.

A = number of hectares/100 trees
B = resource supply
D = (1 - marginal tax rate)
F = final asset value/100 trees
H = harvest labour requirement/100 trees
L = seasonal labour requirement/100 trees
P = proportion of variety j
R = total revenue/100 trees
T = trees of variety j (T=1)
V = variable cost/100 trees
X = number of existing trees required/100 interplanted trees
Y = yield of pip fruit (bushels)/100 trees.

The revised simplex algorithm incorporated in the Burroughs TEMPO mathematical programming system was used to obtain optimal feasible solutions to the I.L.P. model. However, because of the size of the L.P.

Table 5.5 Simplified Submatrix - Year 10

		Existing orchard trees year 9	Plant new trees years 1,...,9	Interplant old trees years 1,...,9	Graft old trees years 1,...,9	Existing orchard trees year 10	Remove old trees	Plant trees in year 10	Interplant old trees in year 10	Graft old trees in year 10	Hire labour	Variety proportion	Loan 1	Loan 2	Off farm work	Off farm investment	Tax deduction transfer	Taxation activities	Final cash surplus	Final cash deficit	Final assets
RESTRAINT	R.H.S.	9P001...9P030	KP061...KP073	KP074...KP082	KP083...KP087	10P001...10P030	10P031...10P060	10P061...10P073	10P074...10P082	10P083...10P087	10P088...10P099	10P100	10P101	10P102	10P103	10P104	10P105	10P106...10P117	10P118	10P119	10P120
OBJECTIVE FUNCTION																			1	-1	1
10R001 Existing	0 =	-1				1	1		X	1											
⋮ Orchard	0 =	-1				1	1		X	1											
10R030 Trees	0 =	-1				1	1		X	1											
10R031 Land	13 ≥		A A A	A A A	A A A	A A A	-A -A -A	A A A	A A A	A A A											
10R032 Yield			Y Y Y	Y Y Y	Y Y Y	Y Y Y		Y Y Y	Y Y Y	Y Y Y											
10R033 Labour Period A	520 ≥		L L L	L L L	L L L	L L L	L L L	L L L	L L L	L L L	-1				520						
10R034 Labour Period B	720 ≥		L L L	L L L	L L L	L L L		L L L	L L L	L L L	-1				720						
10R035 Labour Period C	680 ≥		L L L	L L L	L L L	L L L		L L L	L L L	L L L	-1				680						
10R036 Harvest	0 ≥		H H H	H H H	H H H	H H H		H H H	H H H	H H H	-1										
⋮ Labour	0 ≥		H H H	H H H	H H H	H H H		H H H	H H H	H H H	-1										
10R044 Periods 1-9	0 ≥		H H H	H H H	H H H	H H H		H H H	H H H	H H H	-1										
10R045 Cash Requirement	-B ≥		V V V	V V V	V V V	V V V	V V V	V V V	V V V	V V V	V V V V V V		-1	-1		1					
10R046 Tax Deductions	B ≥		-V -V -V	-V -V -V	-V -V -V	-V -V -V	-V -V -V	-V -V -V	-V -V -V	-V -V -V	-V-V-V-V-V-V		-.08	-.10			1				
10R047 Before Tax Cash	0 ≥		-R -R -R	-R -R -R	-R -R -R	-R -R -R		-R -R -R	-R -R -R	-R -R -R	-R-R-R-R-R-R				-6000	-0.07	1	1 1 1			
10R048 Variety	0 ≥		T T T	T T T	T T T	T T T		T T T	T T T	T T T		.P									
⋮ Proportions	0 ≥		T T T	T T T	T T T	T T T		T T T	T T T	T T T		.P									
10R058 Constraints	0 =		1 1 1	1 1 1	1 1 1	1 1 1		1 1 1	1 1 1	1 1 1		-1									
10R059 Final Cash	-B ≥												1.08	1.10		-1	-1	-D -D -D	1	-1	
10R060 Final Assets	0 ≥		-F -F -F	-F -F -F	-F -F -F	-F -F -F		-F -F -F	-F -F -F	-F -F -F											1

matrix and the consequent problem of handling the large quantity of data, the GAMMA matrix generator and report writer were used to specify the data, the structure of the model and the form of the solution reports.
The results which were obtained will now be discussed in chapters 6 and 7.

CHAPTER 6

A LINEAR PROGRAMMING ANALYSIS OF ORCHARD FARM ADJUSTMENT

In this chapter the results obtained from the I.L.P. model will be presented and discussed. Given the assumptions discussed in the previous chapter in addition to the usual assumptions of linearity, additivity, divisibility and single valued coefficients these results describe an optimum adjustment path for Moutere Hill pip fruit producers. The results will be used in conjunction with the sensitivity analysis outlined in chapter 7 to form the basis of the policy recommendations which are presented in the final chapter.

6.1 Procedure

The analytical procedure which was adopted was divided into two distinct phases. The validation phase and the experimental phase. The validation phase will now be discussed.

In order to use the results of any economic model for policy recommendations it is mandatory that the research method contain both internal and external validity. In this study the external validity of the experimental design has already been covered in that part of chapter 5 which dealt with the selection of the representative farm. Internal validity of the research method was achieved by subjective validation of the I.L.P. model in addition to the use of benchmark models. A benchmark model, as opposed to an adjustment model is a variant of the I.L.P. model in which the adjustment activities have been omitted. As such the benchmark model indicates the result of orchardists maintaining the status quo, and therefore may be considered as analgous, with respect to experimental design, to the "control plot" used by scientists in field trials. Because a direct comparison could not be made between the performance of the real system and that produced by the model the approach recommended by Wright [79] was used to validate the model. In this approach subjective validation is used, the model being considered validated if it would be used by the decision maker as a basis for decision making. Accordingly the results obtained from the I.L.P. model were discussed with the representative grower and various extension personnel. These discussions, together with a comparison between the actual farm situation and the results, indicated that the model could be used with sufficient confidence to consider the model validated.

Having constructed and validated the model, experimentation proceeded with the aim of producing a set of results which would give an insight into optimal adjustment strategies for Moutere Hill pip fruit producers. The model was initially solved by assigning equal weights to the value of final assets and the after tax cash coefficients in the objective function. The results that were subsequently obtained from the adjustment model (plan A1) will now be discussed and compared with those obtained from the corresponding benchmark model (plan B1).

6.2 Results - Plans A1 and B1

6.2.1 Structural adjustment[1/]

The structural adjustment indicated in plan A1 is summarised in table 6.1. This optimum adjustment plan specifies that unprofitable varieties such as Rome Beauty, Jonathan, Gravenstein, Delicious and Golden Delicious are to be removed immediately. Non-bearing and old Sturmers (greater than 50 years of age) are also to be removed immediately. Bearing Sturmer trees (between the age of 5 and 50 years) are to be maintained until 1982/83 at which time they should gradually be removed over a two year period. Splendour, Red Dougherty and old Cox trees are to be kept for eight years in order to provide cash during the early years of the adjustment period. However, these varieties are also to be removed in the final years of the planning horizon so that they may be replaced by new Cox and Granny Smith trees. Over the entire planning horizon

1/ As the benchmark model did not include any adjustment activities such as tree removal, tree planting or reworking of orchard trees the number of trees in plan B1 remained constant throughout the planning horizon.

Table 6.1 Optimum Orchard Adjustment Programme: Plan A1

Variety	Age at 30 June 1976	Effective spacing (metre)	Interplanted or reworked	Initial tree numbers	Additions and removals						Final tree no. 1985/86
					1976/77	1980/81	1981/82	1982/83	1983/84	1984/85	
1. EXISTING TREES											
Granny Smith	1	4.8 x 4.8		36							36
Granny Smith	2	4.8 x 4.8	R/W	166							166
Granny Smith	4	4.8 x 2.7		80							80
Granny Smith	10	5.5 x 5.5		136							136
Granny Smith	2	5.5 x 5.5	I/P	210							210
Granny Smith	6	5.5 x 5.5	I/P	106							106
Cox	3	4.8 x 4.8		260							260
Cox	9	5.5 x 5.5		269							269
Cox	54	5.5 x 5.5		79					R 79		
Cox	1	5.5 x 5.5	I/P	116							116
Red Delicious	1	5.5 x 3.6		267							267
Red Delicious	6	4.8 x 3.6		94							94
Red Delicious	3	5.5 x 5.5	I/P	75							75
Richared	6	4.8 x 4.8	R/W	82							82
Gala	3	4.8 x 3.6		159							159
Golden Delicious	5	4.8 x 4.8		71	R 71						
Golden Delicious	6	5.5 x 5.5		210	R 210						
Golden Delicious	55	5.5 x 5.5		51	R 51						
Delicious	58	5.5 x 5.5		280	R 280						

NOTE: P = Plant; R = Remove; I/P = Interplant; R/W = Rework or graft

Cont./...

Table 6.1 Optimum Orchard Adjustment Programme: Plan Al - continued

Variety	Age at 30 June 1976	Effective spacing (metre)	Interplanted or reworked	Initial tree numbers	Additions and removals						Final tree no. 1985/86
					1976/77	1980/81	1981/82	1982/83	1983/84	1984/85	
Sturmer	3	4.8 x 4.8		42	R 42						
Sturmer	15	5.5 x 5.5		199				R 89	R 110		
Sturmer	54	5.5 x 5.5		317	R 317						
Red Dougherty	9	4.8 x 4.8		152						R 152	
Gravenstein	50	4.8 x 4.8		229	R 229						
Jonathan	55	4.8 x 4.8		263	R 263						
Rome Beauty	30	4.8 x 4.8		49	R 49						
Splendour	5	4.8 x 4.8		118					R 14	R 104	
Packhams	3	4.8 x 4.8	R/W	110							110
Packhams	8	4.8 x 4.8		53							53
Winter Cole	8	4.8 x 4.8		52							52
2. NEW TREES											
Granny Smith					I/P 477						678(P201)
Cox											P 1246
Red Delicious							P 620	P 1042			P 1662
Gala									P 788	P 43	831
Packhams					P 1201	P 460					1661
Winter Cole										P 831	831
TOTAL TREE NUMBERS				4331	4497	4957	5577	6530	7115	7733	9180

NOTE: P = Plant; R = Remove; I/P = Interplant; R/W = Rework or graft.

47 percent or 2060 of the initial 4331 trees should be removed and be replaced by more profitable varieties.

In conjunction with the removal programme a comprehensive planting programme was also initiated in 1976/77. Four hundred and seventy seven Granny Smith trees are to be interplanted between existing orchard trees. In addition, the planting of 1201 Packham trees is also specified. Further plantings of Packhams are then made four years later in 1980/81 with plantings of Red Delicious, Gala, Winter Cole, Cox and Granny Smith following as shown in table 6.1. In total 6909 new trees should be planted over the planning horizon bringing the final tree number to 9180 trees in 1985/86.

The structural adjustment suggested by plan A1 will reduce the number of different varieties grown from 15 to 7 and shift the age distribution of trees to the younger age groups. Table 6.2 gives the age distribution by variety of orchard trees in the final year of the planning horizon. The fact that 57 percent of the trees are of non-bearing age in 1985/86 has important implications for future cash flow as the major benefits which might be expected to accrue from this adjustment programme will still remain to be realized after the planning horizon. This point is discussed in greater detail on page 83.

Table 6.2 Age Distribution of Trees in 1985/86: Plan A1

Variety	Age of trees				Total
	0 - 5	6 - 20	21 - 50	More than 50	
Granny Smith	201	1 075	136		1 412
Cox	1 246	645			1 891
Red Delicious	1 662	436			2 098
Richared		82			82
Gala	831	159			990
Packhams	460	1 364			1 824
Winter Cole	831	52			883
TOTAL	5 231	3 813	136	-	9 180

6.2.2 Expected yields

The high percentage of young or non-bearing trees in the adjustment plan is also reflected in the difference between the expected total yields of pip fruit from plan A1 when compared with the expected yields from plan B1. (See table 6.3 below).

Table 6.3 Pip Fruit Production: Plans A1, B1 (bushels)

Year	Plan A1	Plan B1
1976/77	11 555	17 473
1977/78	13 223	19 126
1978/79	13 803	19 722
1979/80	15 589	21 301
1980/81	17 197	22 997
1981/82	21 494	25 112
1982/83	24 191	27 252
1983/84	21 293	27 927
1984/85	20 629	28 062
1985/86	18 697	29 394

These differences in yields will also help to explain the differences in labour requirements, costs and revenues for the years 1976/77 to 1985/86. It is in this direction that attention is now focussed.

6.2.3 Financial implications of adjustment

In order to achieve the orchard restructuring programme outlined above it would be necessary to obtain sufficient finance to permit personal consumption of $3000 per year, allow the existing orchard to be managed and permit the development plan to be executed. Table 6.4 summarises the financial results of both plans A1 and B1. The cumulative cash balance which is given may be viewed as the end of year bank balance.

Table 6.4 Cumulative Cash Balance: Plans A1, B1 ($)

Year	Plan B1	Plan A1
1975/76	7 000	7 000
1976/77	131	-1 715
1977/78	-5 429	-6 185
1978/79	-9 939	-9 915
1979/80	-17 456	-16 625
1980/81	-17 240	-17 668
1981/82	-15 158	-15 584
1982/83	-11 800	-13 858
1983/84	-7 595	-12 289
1984/85	-2 306	-10 359
1985/86	3 949	-10 701
Present value of final cash balance (7%)	2 007	-5 439
Present value of final assets (7%)	170 309	468 223
Present value of objective function (7%)	172 316	462 784

The negative cumulative cash balances shown for plan B1 reflect the need for borrowing in early years while the young trees planted prior to the planning horizon slowly come into bearing. The positive cash balance in 1985/86 indicates the reduced need for loan finance as orchard trees reach full bearing. The cumulative cash balance for plan A1 on the other hand, reflects even heavier borrowing that must be incurred in order to finance the various adjustment activities.

In both plans A1 and B1 the final assets and final cash coefficients of the objective function were assigned equal values. The value of the objective function was then given as the sum of the after tax cash at the end of the planning horizon and the value of future income discounted from infinity to 1985/86. In table 6.3 both components of the objective function and the value of the objective function are presented in present value terms (i.e. with respect to 1976/77). The interpretation of the value of the objective function should be clear. It is a comprehensive measure of the profitability of each orchard plan viewed with respect to an equilibrium in which orchard trees are replaced at the optimum replacement age.

Although the present value of final cash is greater for plan B1 than plan A1 the real value of the adjustment plan accrues in the years following the planning horizon. This is shown by the 274 percent increase in the present value of final assets of plan A1 over plan B1. In order to show the pattern of income and expenditure required to generate the cash balances shown in table 6.4 a summary cash flow statement is presented in tables 6.5 and 6.6 for plans B1 and A1 respectively.

The expected cash flow is presented in two parts. The entries which appear above the dashed line occur at the beginning of the year and those below the dashed line occur at the end of the year. The manager, who therefore opts to maintain his orchard in its current state and not adopt an adjustment programme, could expect to find that $14,045 would need to be borrowed in the first year of the planning horizon to supplement the initial cash balance of $7000. The loan of $14,045 would be just sufficient to cover personal drawings and farm costs for the year. At the end of the year repayments of interest and principal amounting to $15,169 when subtracted from the gross revenue earned would leave a cash balance of $131 in the bank. This amount must then be supplemented by a further loan of $21,629 at the start of the second year in order to cover the cost of expenses incurred at the start of the 1977/78 year. In this way it is possible to trace out the pattern of cash flow throughout the planning period. The manager who adopts plan B1 can therefore expect to have $3949 in the bank on 30th June 1985 while the manager who adopts the optimum adjustment plan can expect to have a deficit bank balance of -$10,701.

The annual cash balances that can be expected from plans A1 and B1 are shown in figure 6.1. Both plans show that annual cash deficits can be expected to occur for the first five years of the planning horizon. After 1980/81 plan B1 shows that cash surpluses are likely to accrue annually, while the first positive annual cash balance for plan A1 is likely to occur in 1982/83. The more variable pattern of annual cash balances in plan A1

Table 6.5 Cash Flow Summary: Plan B1

Cash flow items	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Opening cash balance	7 000	131	-5 429	-9 939	-17 456	-17 240	-15 158	-11 800	-7 595	-2 306
plus Loan 1 received	14 045	21 629	27 552	36 719	38 733	39 212	38 295	35 331	31 271	26 574
less Personal drawings	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
less Cash fixed costs	4 760	4 760	4 760	10 760[a]	4 760	4 760	4 760	4 760	4 760	4 760
less Cash farm costs	13 285	14 000	14 363	13 020	13 516	14 212	15 377	15 771	15 916	16 509
plus Gross farm revenue	15 300	17 930	19 817	22 200	24 963	28 480	32 054	34 072	36 251	38 608
less Loan 1 repaid + interest	15 169	23 359	29 756	39 656	41 832	42 349	41 358	38 158	33 773	28 700
less Tax paid					371	1 289	2 496	3 509	4 784	5 959
equals Cumulative cash balance	131	-5 429	-9 939	-17 456	-17 240	-15 158	-11 800	-7 595	-2 306	3 949

a) Incorporates the net balance resulting from the replacement of a tractor.

Table 6.6 Cash Flow Summary: $ Plan A1

Cash flow items	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Opening cash balance	7 000	-1 715	-6 185	-9 915	-16 625	-17 668	-15 584	-13 858	-12 289	-10 359
plus Loan 1 received	18 280	24 805	29 845	38 314	40 000	40 000	40 000	40 000	40 000	40 000
plus Loan 2 received					1 367	3 000	3 000	3 000	3 000	3 000
less Personal drawings	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
less Cash fixed costs	4 760	4 760	4 760	4 760	4 760	4 760	4 760	4 760	4 760	4 760
less Cash farm costs	17 520	15 330	15 900	14 639	16 981	17 571	19 655	21 382	22 951	24 881
plus Off farm income	6 000[a)]	6 000	6 000	6 000	6 000	2 964				
plus Gross farm revenue	12 028	14 604	16 317	18 753	21 087	29 212	33 855	35 471	37 807	36 367
less Loans 1 and 2 repaid + interest	19 743	26 789	32 233	41 379	44 690	46 470	46 470	46 470	46 470	46 470
less Tax paid					66	1 290	1 243	1 290	1 697	598
equals Cumulative cash balance	-1 715	-6 185	-9 915	-16 625	-17 668	-15 584	-13 858	-12 289	-10 359	-10 701

a) The opportunity cost of the manager's labour was estimated as $7000 per annum. This figure was subsequently reduced by $1000 to take into account the additional salary which would need to be paid to employ a full time manager if the owner worked off the farm for an entire year.

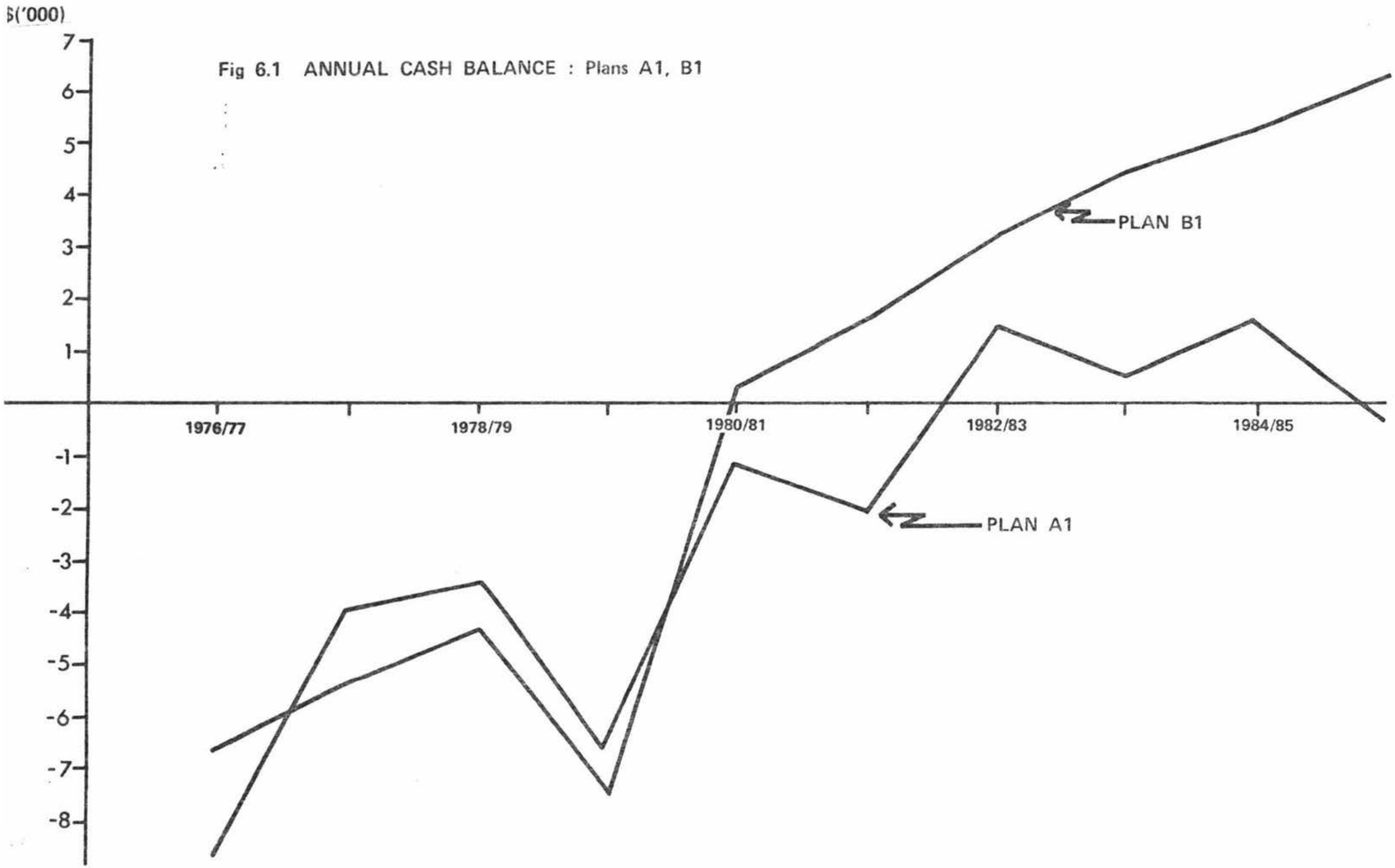


Fig 6.1 ANNUAL CASH BALANCE : Plans A1, B1

between 1980/81 and 1985/86 is due to the planting programme undertaken during these years.

6.2.4 Labour requirements

In addition to cash, labour acts as another limiting resource in orchard production. Table 6.7 lists the extra labour requirements for plans A1 and B1, which is needed to supplement the manager's contribution.

Table 6.7 Additional Labour Requirements: Plans A1, B1 (hours)

Year	Plan A1			Plan B1		
	Period I[a)]	Period II[b)]	Period III[c)]	Period I	Period II	Period III
1976/77	523	944	1462	246	56	1560
1977/78	541	716	1626	289	56	1723
1978/79	642	716	1684	297	56	1782
1979/80	608	716	1860	324	56	1937
1980/81	618	866	2039	332	56	2104
1981/82	508	647	2025	362	56	2312
1982/83	430	564	1966	386	56	2676
1983/84	925	660	1688	403	56	2742
1984/85	816	781	1657	385	56	2755
1985/86	618	1088	1442	414	56	2979

a) June - August = 14 weeks

b) September - December = 16 weeks

c) January - May = 22 weeks.

Assuming a 44 hour week, one man employed full time could work 616 hours in period 1, 704 hours in period 2 and 968 hours in period three. Accordingly, plan B1 would require either the use of contract labour or part time work of one man to assist with pruning during the winter and early spring months. The adjustment plan A1 by comparison, would demand the equivalent of an extra man to be employed throughout periods I and II. The labour provided by this additional labour unit could be supplemented from time to time by casual or contract labour. During the

Fig 6.2 HARVEST LABOUR REQUIREMENTS IN 1985/86 : PLAN B2

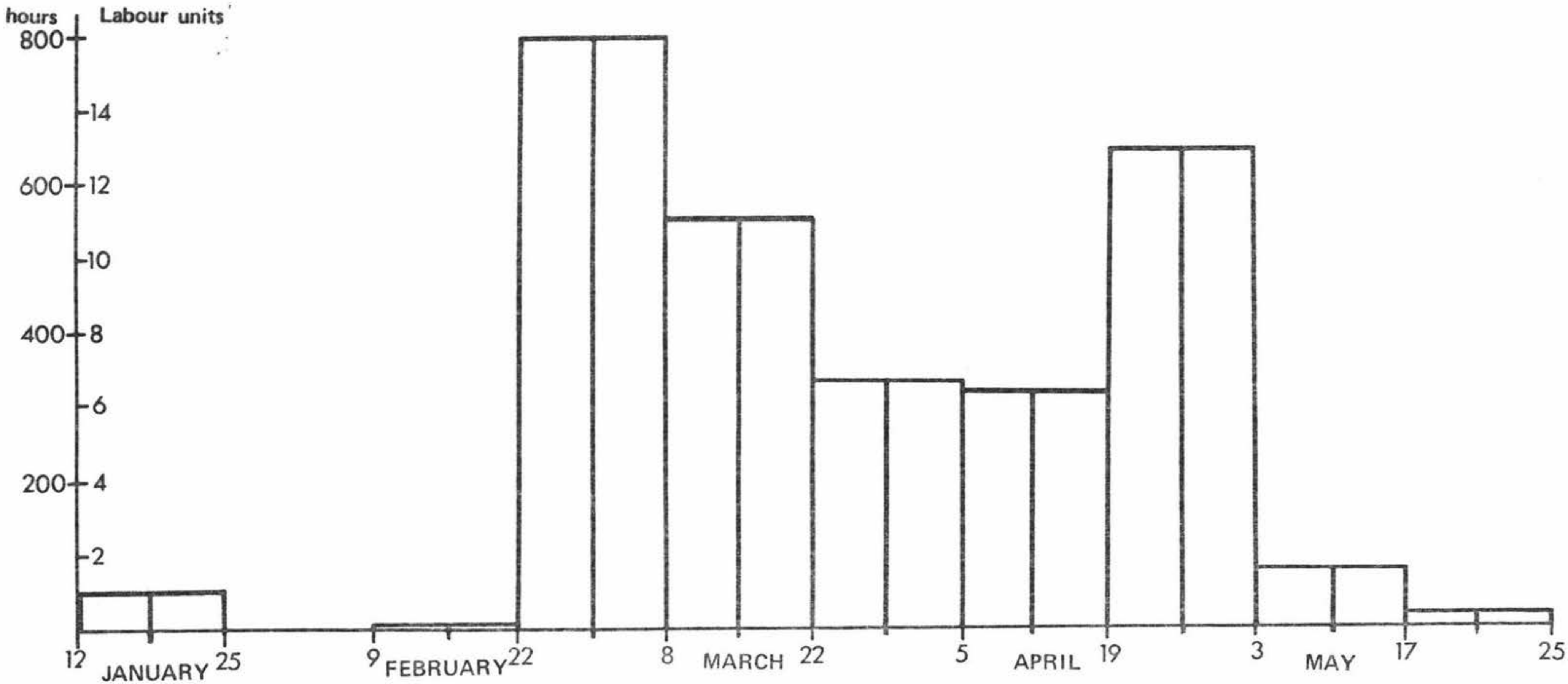
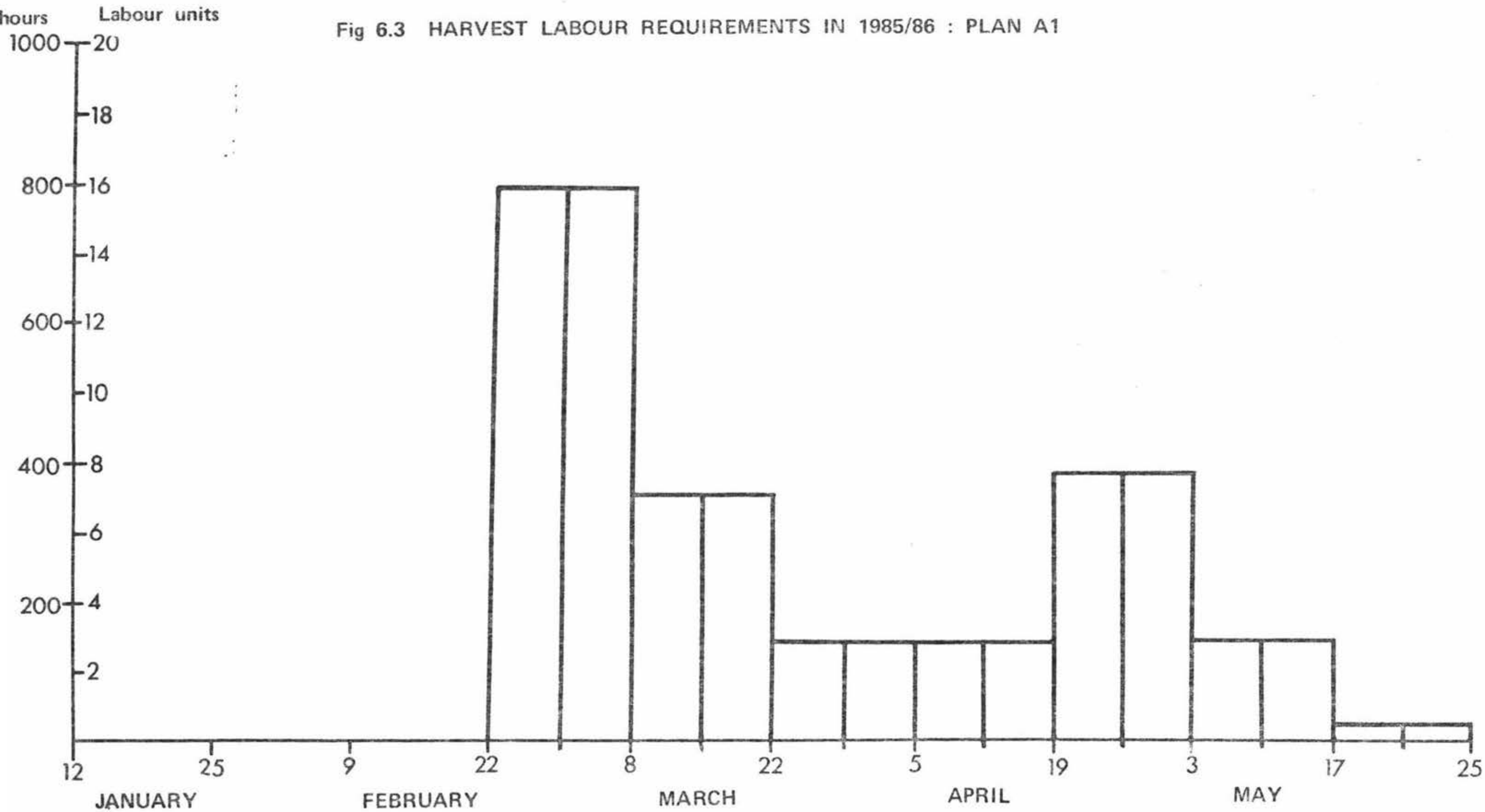


Fig 6.3 HARVEST LABOUR REQUIREMENTS IN 1985/86 : PLAN A1



harvest period, additional labour also needs to be employed to:

(a) maintain the orchard property; and

(b) harvest the fruit.

The labour requirements for the former are also indicated in table 6.7 with the equivalent of as many as three additional men being required to supplement the work of the manager for plan B1 and two men for plan A1. The lower harvest season labour requirement by the adjustment plan reflects the lower percentage of bearing trees in existence in plan A1 as a result of the tree removal and planting programme.

The labour requirement for fruit picking is shown as an additional requirement above that required for the harvest season discussed above. The weekly pattern of labour demand throughout the harvest period for the final year of the planning horizon is shown for plans A1 and B1 in figures 6.2 and 6.3, respectively. Again, the lower demand for picking labour in plan A1 in comparison with plan B1 reflects the lower yields realized in 1985/86 by the restructured orchard. It is anticipated that the weekly labour demand will even out in plan A1 as the non bearing Red Delicious trees come into bearing.

It is now possible to summarise several of the more pertinent points which have been elucidated so far. Firstly, because the benchmark orchard contains a number of young trees which have still to come into full bearing at the start of the planning horizon loan finance will be required in order to allow the existing plantings to be managed. A peak debt of \$39,212 is expected in 1981/82 after which the requirement for loan finance can be expected to decline. Secondly, adoption of the adjustment programme demands a greater use of borrowed monies for a longer period. A peak debt of \$43,000 is expected to be required from 1980/81 to at least 1985/86. In addition, the adjustment plan will require the manager to work off the farm for the first 5½ years of the planning horizon in order to supplement income at a time when cash is required for replanting. Thirdly, both cash flows indicate that equilibrium will not be attained by 1985/86. Consequently the income which can be expected to accrue after the planning horizon will be of vital importance in evaluating the adjustment strategy outlined in plan A1.

6.3 Results - Plans A2 and B2

In order to examine the effect of extending the planning horizon a benchmark model with a 20 year horizon was solved (plan B2). Unfortunately, the cost of computer processing involved in obtaining a solution to the relatively large 20 year adjustment model was prohibitive. Therefore, in order to compare the outcome of plan B2 with an adjustment situation, plan A1 was augmented to form plan A2 by manually budgeting the expected outcome for the ten years following 1985/86. Although it is recognised that plan A2 and plan B2 are not strictly comparable as plan A2 is non-optimal, a comparison of the two plans should serve to highlight the meaning of the high final assets value in plan A1. In addition, this should also allow the adjustment plan to be contrasted against the benchmark plan with greater perspective.

The expected cash flow for plans B2 and A2 is presented in tables 6.8 and 6.9 respectively, for the years 1986/87 to 1995/96. The requirement for loan finance is reduced in both plans during the second decade. In plan B2 loan finance is no longer required after 1989/90 at which time surplus cash is invested off the farm to earn interest at 7 percent. The peak debt situation seen in plan A1 continues for the first two years of plan A2 and then rapidly diminishes with loan finance being no longer required after 1992/93. During the last four years, i.e. 1992/93 to 1995/96 surplus cash is again invested off the farm.

The value of the final cumulative cash position for plan A2 now reflects the benefits of the adjustment programme undertaken during the first ten years. During the years 1986/87 to 1995/96 the cumulative cash balance increased to $105,847 in plan B2 while in plan A2 the final cash balance is estimated to reach $162,521 in 1995/96. The change in the cumulative cash balance and the level of loan requirements over the 20 year planning horizon are shown in figure 6.4 which summarises the essential features of the two plans. In both plans it can be seen that a period of severe financial difficulty is likely to exist until the mid 1980's. The benchmark plan offers an earlier return to a positive cash flow with a less severe demand on loan finance, while the adjustment plan requires heavier and more prolonged indebtedness with a considerable increase in cash flow after 1991/92. In table 6.10 the value of the objective function is expressed in its component parts for the four plans discussed in this chapter.

Table 6.8 Cash Flow Summary: Plan B2 - 1986/87 to 1995/96

Cash flow items	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
Opening cash balance	3 949	11 031	18 999	27 681	36 754	46 155	58 019	70 431	83 146	92 037
plus Loan 1 received	20 842	14 374	6 900							
less Personal drawings	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
less Cash fixed costs	4 760	4 760	4 760	4 760	4 760	3 897	3 897	3 897	9 897	3 897
less Cash farm costs	17 031	17 645	18 138	18 192	18 385	16 482	16 332	16 213	16 469	16 693
less Off farm investment				1 729	10 610	22 774	34 792	47 321	53 781	68 446
plus Gross farm revenue	40 531	42 589	44 154	44 456	44 872	45 522	45 697	45 442	45 866	46 039
plus Investment repaid + interest				1 850	11 353	24 368	37 227	50 634	57 546	73 237
less Loan 1 repaid + interest	22 510	15 524	7 452							
less Tax paid[a)]	6 990	8 066	9 021	9 552	10 070	11 871	12 493	12 930	11 375	13 429
equals Cumulative cash balance	11 031	18 999	27 681	36 754	46 155	58 019	70 431	83 146	92 037	105 847

a) The large tax payments result from income derived from trees planted prior to the commencement of the planning horizon. This reflects the fact that adjustment to some degree, had already taken place prior to 1976/77.

Table 6.9 Cash Flow Summary: Plan A2 - 1986/87 to 1995/96

Cash flow items	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
Opening cash balance	-10 701	-9 538	-4 430	5 109	20 252	37 034	57 537	80 923	105 502	130 516
plus Loan 1 received	40 000	40 000	40 000	37 743	25 928	10 884				
plus Loan 2 received	3 000	3 000	506							
less Personal drawings	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
less Cash fixed costs	4 760	4 760	4 760	4 760	4 760	3 897	3 897	3 897	3 897	3 897
less Cash farm costs	29 299	30 462	33 076	35 092	38 420	41 021	42 631	43 082	44 201	45 094
less Off farm investment							8 609	30 944	48 404	78 525
plus Gross farm revenue	43 148	51 812	63 013	74 357	84 651	93 371	99 646	101 920	108 831	117 951
plus Investment + interest							9 211	33 110	51 793	84 022
less Loan 1 and 2 repaid + interest	46 470	46 470	43 756	40 732	28 002	11 754				
less Tax paid	1 456	5 012	9 388	13 373	19 615	24 079	27 933	29 527	30 107	39 451
equals Cumulative cash balance	-9 538	-4 430	5 109	20 252	37 034	57 537	80 923	105 502	130 516	162 521

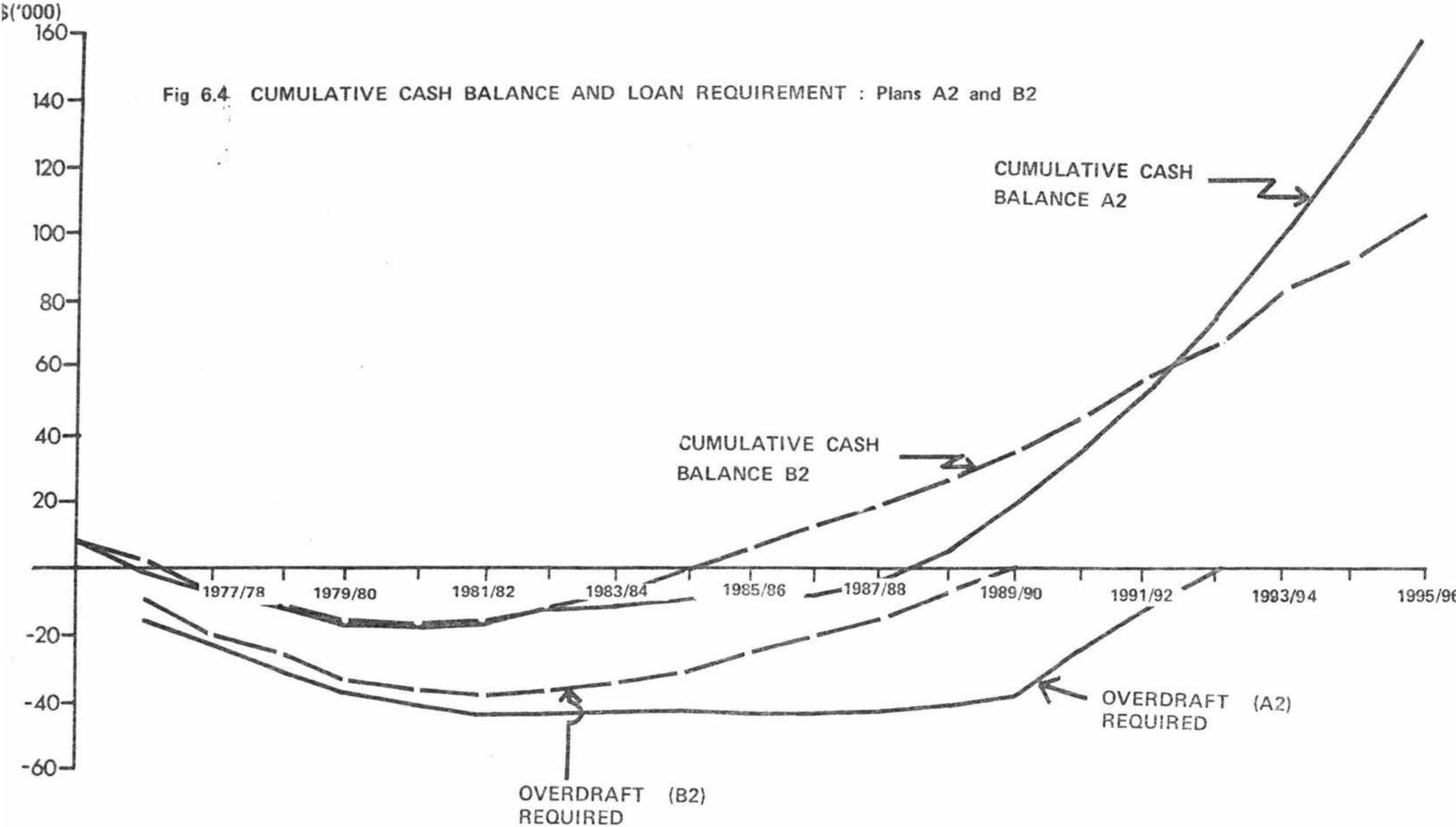


Fig 6.4 CUMULATIVE CASH BALANCE AND LOAN REQUIREMENT : Plans A2 and B2

Table 6.10 Present Value of the Objective Function: Plans A1, A2, B1, B2 ($)

Objective function component	Plan B1	Plan B2	Plan A1	Plan A2
Present value of final cash	2 007	27 352	-5 439	41 996
Present value of final assets	170 309	86 576	468 223	181 480
Present value of objective function	172 316	113 928	462 784	223 476

As the present value of final assets is the discounted value of future net income in present value terms the importance of a high final assets figure in the ten year plan is now apparent. An evaluation of these plans will now be made by taking into account not only the present cash flow but also the expected future cash flow.

6.4 An Evaluation

In this chapter the results of a linear programming analysis of farm adjustment were presented. In order to provide a basis for comparison the results of a benchmark L.P. were compared with the results obtained from an adjustment L.P. It was shown that considerable loan finance would be required whether or not the manager chose to adopt an adjustment programme. In the case of a manager opting to restructure his orchard the optimal adjustment strategy and the likely outcome was discussed and compared with the expected outcome from the benchmark situation.

An evaluation of the adjustment plan could be made in a number of ways. In table 6.11 the shadow price of tax free cash is given. The shadow price of initial cash for plan A1 is $7.81 which implies that the value of the objective function would have been increased by $7.81 if the level of initial cash had been increased by one dollar. Since the value of the objective function is defined as the net cash flow resulting from the orchard plan discounted from infinity to 1985/86, it follows that the interest rate i that discounts the shadow price of $7.81 to $1 in 1976/77 represents the expected rate of return. Accordingly it can be shown that i equals 22.8 percent for plan A1 and 5.7 percent for plan B1. It must, however, be stressed that these rates of return are based on the expected future income discounted from infinity, not the cash flow expected over the planning horizon.

Table 6.11 Shadow Price of Tax Free Cash: Plans B1 and A1 ($)

Year	Plan B1	Plan A1
1976/77	1.74	7.81
1977/78	1.61	7.24
1978/79	1.49	6.70
1979/80	1.38	6.20
1980/81	1.28	5.74
1981/82	1.22	5.35
1982/83	1.17	4.73
1983/84	1.12	4.11
1984/85	1.08	2.98
1985/86	1.04	1.78

On the basis of the rates of return discussed above, the adjustment strategy presents an attractive investment proposition. However, as less than 1 percent of the value of the objective function is realized within the planning horizon of plan A1 a further evaluation of plan A1 will be made. In figure 6.5 the differences between the annual cash balances of plan A2 and the annual cash balances of plan B2 have been plotted. It can be seen that the annual cash surplus resulting from plan B2 remains greater than the annual cash balance from the adjustment plan until 1988/89 at which time the annual cash surplus from the adjustment plan surpasses the benchmark plan. In 1994/95 the additional cash which can be expected from the adjustment plan will be in excess of $18,000 per annum.

Although the expected outcome from the adjustment model exceeds the expected outcome from the benchmark model, the results to be expected from maintaining a status quo position are likely to be considered quite

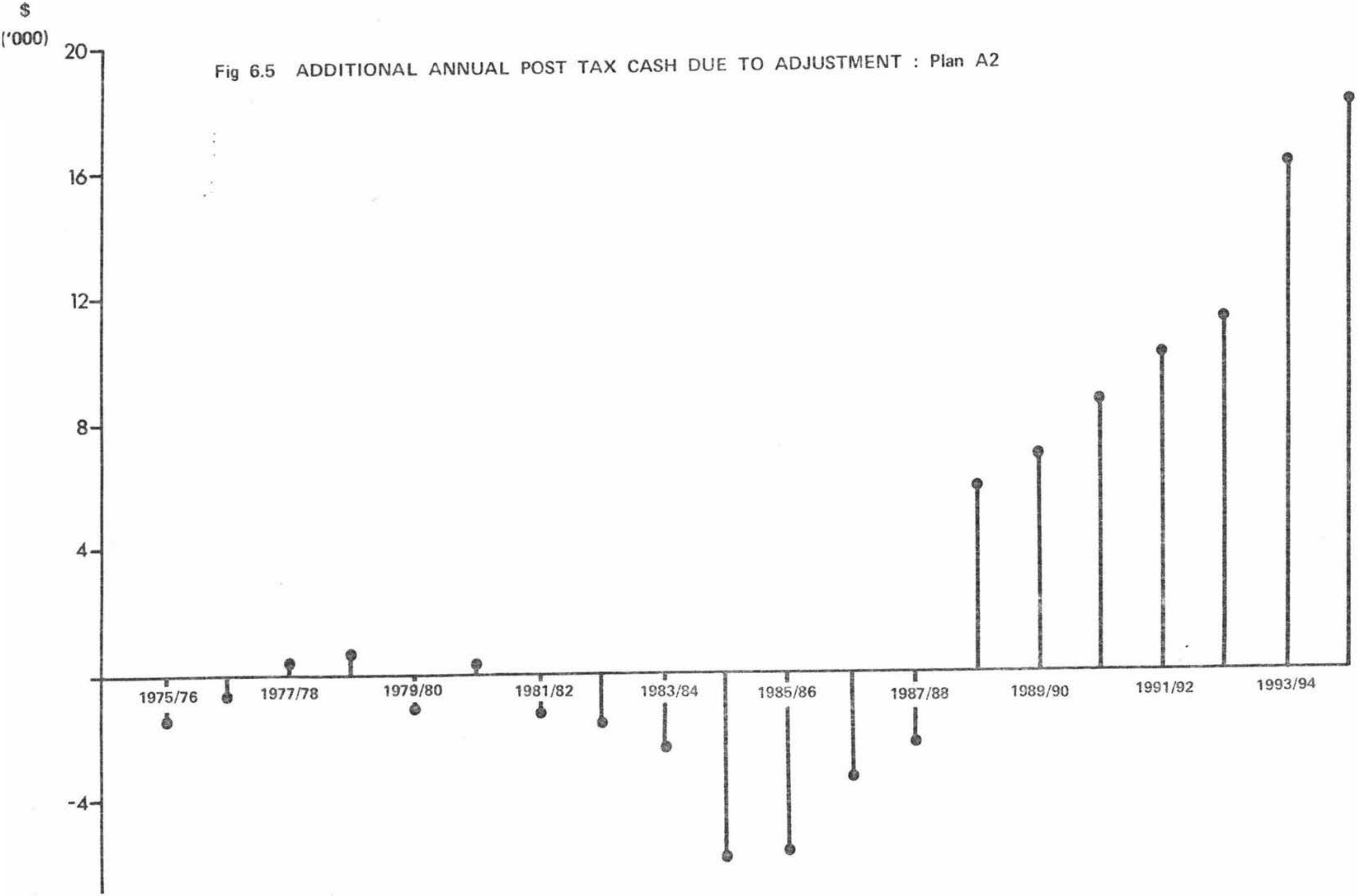


Fig 6.5 ADDITIONAL ANNUAL POST TAX CASH DUE TO ADJUSTMENT : Plan A2

satisfactory by a number of growers. The benchmark plans, in reflecting the adjustment which has already occurred on the Moutere Hills highlights the severe fluctuations in income over time which result from an unplanned, piecemeal approach to orchard tree replacement programmes.

The adjustment plans indicate that considerable potential exists for increased incomes on Moutere Hill pip fruit orchards. However, the expected delay of approximately 14 years before gaining the benefit of an adjustment programme (i.e. 1988/89) will undoubtedly confine the realisation of such benefits to those growers who are able to bridge the intervening years.

Before drawing further conclusions from the results that have been presented in this chapter it is desirable that additional analysis be undertaken to gain a greater insight into the stability of the optimal adjustment plan. The results of these analyses will be discussed in the following chapter.

CHAPTER 7

A SENSITIVITY ANALYSIS

The results that were discussed in the previous chapter were based upon the model which assigned equal weights to the value of the final assets and final cash coefficients in the objective function. It is recognised, however, that growers may not all rate final cash and final assets with equal importance. For example, some growers might rate final cash as being twice as important as the value of final assets. Also, different growers may have capital supplies other than the levels adopted in the plans already discussed. Accordingly the analysis described in the previous chapter will be extended in this chapter to examine the effect that a number of different factors might have on orchard restructuring. The situations that will be examined include the effect of a partial adjustment, the inclusion of tax losses, the significance of different goals and finally the effect of different capital supplies.

7.1 Partial Adjustment

For a variety of reasons some growers may not be prepared to undertake an extensive programme of tree planting. In order to determine the benefit which might accrue from the removal of some existing trees without the attendant adjustment activities involving tree planting or tree replacement the I.L.P. model was solved with "tree removal" as the sole adjustment activity. The resultant plan, plan A3 in which the value of final assets and final cash were weighted equally, will now be compared with plan B1 in order to determine the benefit that is likely to accrue from the removal of selected trees.

The orchard adjustment strategy shown in table 7.1 indicates that it would be profitable for the manager to immediately remove all Gravenstein, Jonathan, Rome Beauty and Golden Delicious trees greater than 50 years of age. A further removal of trees eight years later in 1983/84 would entail the removal of 317 old Sturmer trees. The overall reduction in

Table 7.1 Orchard Adjustment: Plan A3

Variety	Initial tree numbers	Tree removals		Final tree numbers Plan B3
		1976/77	1983/84	
Granny Smith	734			734
Cox	724			724
Red Delicious	436			436
Richared	82			82
Gala	159			159
Golden Delicious	332	51		281
Delicious	280			280
Sturmer	558		317	241
Red Dougherty	152			152
Gravenstein	229	229		
Jonathan	263	263		
Rome Beauty	49	49		
Splendour	118			
Packhams	163			163
Winter Cole	52			52
TOTAL TREE NOS.	4331	873	317	3422

tree numbers proposed by plan A3 is therefore 1190 or 27 percent of the initial tree numbers. The effect of this reduction in tree numbers is reflected by a reduced yield of fruit over the ten year planning horizon. The magnitude of the yield reduction is shown in table 7.2. In 1976/77 the drop in fruit harvested can be seen to fall from 17 473 bushels to 13 985 bushels, a 20 percent decrease in yield.

The financial implications of this tree removal programme is shown in table 7.3 which presents a summary of the expected cash flow from plan A3 together with the cumulative cash balance of plan B1 which has been included for comparative purposes. By comparing the cash flow derived from plan B1 in table 6.5 with the cash flow from plan A3 it can be seen that the removal of unprofitable trees has the effect of immediately reducing the total variable costs. This reduction in total variable costs

Table 7.2 Pip Fruit Production: Plans B1, A3

Year	Plan B1	Plan A3
1976/77	17 473	13 985
1977/78	19 126	15 696
1978/79	19 722	16 351
1979/80	21 301	18 010
1980/81	22 997	19 785
1981/82	25 112	21 981
1982/83	27 252	24 245
1983/84	27 927	23 497
1984/85	28 062	23 830
1985/86	29 394	25 348

leads to a corresponding reduction in the need for loan finance. Accordingly, the debt structure for plan A3 is less onerous than that outlined for plan B1. In plan A3 a peak debt of $28,211 occurs in 1978/79 and the average indebtedness over the planning horizon is $19,938. Plan B1 by comparison, reaches a peak debt of $39,212 in 1981/82 with an average indebtedness of $30,936.

The tree removal programme also has the effect of reducing gross farm revenue in comparison with the benchmark situation. For example in 1976/77 the gross farm revenue is reduced from $15,300 to $13,855, a fall of 10 percent. However, as the change in revenue is less than the change in costs the net effect of tree removal is to increase annual net income. This increase in annual income is reflected in the increased level of taxation in plan A3 and the increased level of after tax cash at the end of the planning horizon.

The overall effects of an adjustment programme which consists of tree removal alone is summarised in table 7.4. In this table the present value of the objective function for plan A3 is compared with the presented value of the objective function of the benchmark plan. Both components of the objective function show an increase in plan A3 when compared with plan B1. The increase in the present value of final cash has already been discussed.

Table 7.3 Cash Flow Summary: Plan A3

Cash flow items	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Opening cash balance	7 000	1 797	-1 738	-4 222	-9 633	-7 763	-4 293	414	5 832	12 314
plus Loan 1 received	11 165	16 893	20 963	28 211	28 130	26 964	24 664	19 645	14 577	8 176
less Personal drawings	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
less Cash fixed costs	4 760	4 760	4 760	10 760	4 760	4 760	4 760	4 760	4 760	4 760
less Cash farm costs	10 405	10 930	11 466	10 229	10 738	10 441	12 612	12 299	12 660	12 731
plus Gross farm revenue	13 855	16 507	18 419	20 835	23 630	27 181	30 809	31 759	34 026	36 484
less Loan 1 repaid + interest	12 058	18 245	22 641	30 468	30 381	29 121	26 637	21 216	15 743	8 830
less Tax paid					1 012	2 352	3 757	4 699	5 967	7 522
equals Cumulative cash balance	1 797	-1 738	-4 222	-9 633	-7 763	-4 293	414	5 942	12 314	20 132
Plan B1 Cumulative cash balance	131	-5 429	-9 939	-17 456	-17 240	-15 158	-11 800	-7 595	-2 306	3 949

Table 7.4 Present Value of the Objective Function: Plans B1, A1, A3 ($)

Objective function component	Plan B1	Plan A1	Plan A3
Present value of final cash	2 007	-5 439	10 234
Present value of final assets	170 309	468 223	17 144
Present value of objective function	172 316	462 784	181 682

The increase in the present value of final assets has resulted from the removal of those varieties which possessed negative final asset values.

7.2 Inclusion of Tax Losses

The absence of tax payments until 1980/81 indicates that tax losses could have been incurred during the first four years of the plan. Although the incorporation of tax losses was attempted, it was not possible to carry these amounts forward endogenously. Consequently in order to approximate the effect that this additional cash might have on the optimum adjustment plan (plan A1), the taxable income was calculated in each year of the plan and by carrying tax losses forward a new pattern of tax payments was exogenously determined. The difference between the tax payments indicated in table 6.6 and the tax payments thus calculated were then added to the appropriate right hand side elements in the I.L.P. matrix and the revised model optimized to produce plan A4.

The additional cash shown in table 7.5 created a number of minor changes between plans A1 and A4. The principal change between the two plans was a net increase of 113 trees. Table 7.6 indicates this change by variety. As well plan A4 specified that the 574 Granny Smith trees should not be planted until 1985/86. This is in direct contrast to plan A1's specification that 477 Granny Smiths be interplanted in 1976/77. This change in the planting programme results in a decrease in costs during the earlier years of plan A4 and a subsequent increase in costs during the latter years of the planning horizon when the new trees are introduced. The pattern of tree removal remained virtually unchanged from plan A1 to plan A4.

Table 7.5 Tax Losses and Cumulative Cash Balances: Plans A1, A4 ($)

Year	Plan A1 cumulative cash balance	Plan A4	
		Additional cash	Cumulative cash balance
1975/76	7 000		7 000
1976/77	-1 715		-2 189
1977/78	-6 185		-7 471
1978/79	-9 915		-12 238
1979/80	-16 625		-20 455
1980/81	-17 668	66	-21 712
1981/82	-15 584	1 290	-18 988
1982/83	-13 858	1 243	-15 932
1983/84	-12 289	1 290	-13 073
1984/85	-10 359	1 697	-10 229
1985/86	-10 701	598	-12 206
Present value of final cash (7%)	-5 439		-6 204
Present value of final assets (7%)	468 223		481 031
Present value of objective function (7%)	462 784		474 826

Table 7.6 Optimal Tree Planting Programme: Plans A1, A4 (tree numbers)

Year	Granny Smith	Cox	Red Delicious	Gala	Packhams	Winter Cole	Interplanted Granny Smith
1976/77 Plan A1					1201		477
Plan A4					1430		
1980/81 Plan A1					460		
Plan A4					136		
1981/82 Plan A1			620				
Plan A4			657		153		
1982/83 Plan A1			1042				
Plan A4			974				
1983/84 Plan A1				788			
Plan A4			88	860		73	
1984/85 Plan A1				43		831	
Plan A4		358				787	
1985/86 Plan A1	201	1246					
Plan A4	574	932					
Additional trees in Plan A4	373	44	57	29	58	29	-477

These differences effect a change in the value of the objective function. The additional cash has increased the value of the function by $12,042, a 2.5 percent increase. This increase is derived from an increase in the value of the final assets as opposed to any increase in the value of final cash. The final cash actually decreases somewhat due to the higher costs of production implicit in increased tree numbers.

This analysis which has taken tax losses into account serves a twofold purpose. Firstly, it provides a measure of the disparity that exists between plan A1 and plan A4, which more nearly approaches the true optimum. Secondly, it acts to illustrate the sensitivity of the initial adjustment plan to changes in available cash during the latter years of the planning horizon. Therefore, as all the plans presented in this study are based on models which do not carry tax losses forward it is recognised that these plans fail to present a true optimum. However, the plans as presented do represent an extremely close approximation to the optimum and as such are considered by the author as being suitable for practical purposes.

7.3 A Parametric Analysis

7.3.1 Alternative objectives

Although the maximization of final assets and final cash may act as a suitable objective for fruit growers in most situations an equal weighting of these goals need not necessarily be the most appropriate weight to assign such goals. For example, some growers approaching retirement and without heirs to transfer their orchard to might well wish to maximize final cash, being content to liquidate the holding for the value of the land at the end of the planning horizon.[1/] An objective function which assigned a zero value to the final assets activity would therefore be appropriate in this case.

In order to examine the sensitivity of the solution of the adjustment model to the objective function, parametric programming techniques were employed to vary the weight of the final assets activity in the objective function. It was found that 156 changes of the basis occurred for values of the final assets coefficient between 0 and 1.0. Five plans, A1, A5, A6, A7, A8 and A9 corresponding to final asset values of 1.0, 0.8, 0.6, 0.4, 0.2 and 0.0 respectively were selected to illustrate the way in which the solution changed as the weight given to the final assets activity was reduced.

The present value of the objective function for each of these selected plans is given below in table 7.7.

1/ Cook, C. (pers. comm.) Horticultural Advisory Officer, Nelson.

Table 7.7 Value of the Objective Function: Plans A1, A5 - A9

Plan	Weight of final assets	Present value of final cash	Present value of final assets	Weighted present value of final assets	Present value of objective function
A1	1	-5 439	468 223	468 223	462 784
A5	0.8	-5 173	467 900	374 320	369 147
A6	0.6	-4 548	466 956	280 174	275 625
A7	0.4	-2 589	462 827	185 131	182 541
A8	0.2	4 055	437 288	87 457	91 513
A9	0	19 029	-	-	19 029

The present value of the objective function is derived by combining the present value of final cash with the present value of final assets, multiplied by the appropriate weight. As the weight given to the coefficient of the final assets activity is decreased the importance of final cash is increased proportionately until in plan A9 the objective function maximizes the value of final cash alone. The results of the plans given in table 7.7 suggest that relatively minor changes occur for values of the final assets activity between 1.0 and 0.2. The plan which maximizes the value of final cash however, appears to have changed considerably from plan A1.

The tree reconciliation statement shown in table 7.8 summarizes the structural adjustment specified by the various plans. In general terms there is a gradation in tree numbers between plan A1 and plan A9, with the rate of planting decreasing as the weight given to the value of the final assets decreases. Relatively minor changes occur between plans A1 to A8 with respect to the number of trees planted and the years in which these plantings occur. Perhaps the most significant feature of these plans relates to the absence of reworking as an adjustment strategy in plans A1 to A7. Reworking Golden Delicious to Gala does, however, enter the optimal solution in plans A8 and A9 but at a minor level with only 142 and 162 trees being reworked in each plan. The level of tree removals fluctuates between 1800 and 2600 trees and fails to show any significant trend between the various plans. Interplanting like reworking tends to become a more

Table 7.8 Tree Reconciliation Statement: Plans A1, A5 - A9

	Plan A1	Plan A5	Plan A6	Plan A7	Plan A8	Plan A9
Initial tree number	4331	4331	4331	4331	4331	4331
No. of trees reworked to Gala[a)]					142	162
less removals	2060	2738	1876	2665	2509	1911
plus no. of trees interplanted						
Granny Smith	477	483	487	317	949	792
Packhams				194		
Gala				2		
plus no. of trees planted						
Granny Smith	201	26				
Cox	1246	1234	1225	1191	391	
Red Delicious	1662	1645	734	1588	1509	
Gala	831	823	817	792	608	
Packhams	1661	1646	1634	1393	1509	
Winter Cole	831	822	816	794	754	
equals final tree number	9180	8227	8168	7937	7542	3212
TOTAL NEW PLANTINGS	6909	6634	5713	6271	5720	792

a) As reworked trees do not involve a change in tree numbers they are not included in the actual tree reconciliation.

favoured option as more importance is placed on final cash as opposed to final assets. The reason being due to the earlier cash returns which may be expected from these strategies as opposed to the delayed pattern of returns to be expected from planting a new orchard block. This fact is supported in plan A9 where new plantings are completely omitted and the adjustment strategy revolves about the removal of the less profitable varieties, interplanting and reworking some existing trees.

The loan requirements for the various plans are shown in table 7.9. The loan requirements vary corresponding to the structural adjustments which were described above. Plans A5 through A8 show a similar demand for loan finance as that outlined for plan A1. However in plan A9 the requirement for borrowed funds is reduced because of the lower level of tree planting and the greater level of income earned off the farm.

Table 7.9 Loan Requirements: Plans A1, A5-A9 ($)

Year	Plan A1	Plan A5	Plan A6	Plan A7	Plan A8	Plan A9
1976/77	18 280	18 052	18 190	18 946	20 268	15 769
1977/78	24 805	24 584	24 735	25 851	26 857	19 472
1978/79	29 845	29 626	29 791	31 309	32 308	21 672
1979/80	38 314	38 109	38 280	40 110	41 041	27 397
1980/81	41 367	41 727	41 589	42 021	43 000	24 893
1981/82	43 000	43 000	43 000	43 000	43 000	21 991
1982/83	43 000	43 000	43 000	43 000	43 000	17 816
1983/84	43 000	43 000	43 000	43 000	43 000	12 037
1984/85	43 000	43 000	43 000	43 000	35 260	4 508
1985/86	43 000	43 000	43 000	43 000	35 260	

The percentage of time that the manager is required to work off the farm is set out in table 7.10. Again, the requirement is seen to be quite similar for plans with final assets weights ranging between 1 and 0.4. However, plans A8 and A9 which place greater emphasis on the value of final cash demands that the manager supplement farm income by working off the farm for all or most of the planning horizon.

Table 7.10 Percentage of Year Worked off the Orchard (%)

Year	Plan A1	Plan A5	Plan A6	Plan A7	Plan A8	Plan A9
1976/77	100	100	100	100	100	100
1977/78	100	100	100	100	100	100
1978/79	100	100	100	100	100	100
1979/80	100	100	100	100	100	100
1980/81	100	100	100	100	92	100
1981/82	49	50	49	17	31	100
1982/83					47	100
1983/84					100	100
1984/85					100	100
1985/86					100	100

The financial results of the various plans are summarised in figure 7.1 which plots the cumulative cash flow for each of the plans under discussion. The similarity of plans A5, A6 and A7 with plan A1 is again obvious. As the weight given to the final assets activity is decreased further, as in plans A8 and finally in plan A9, the period of indebtedness is decreased.

Because of the different pattern of adjustment specified by plan A9 a summary of the cash flow for this plan is shown in table 7.11. In addition to the reduced demand for loan finance and the greater need for work off the farm this plan shows a reduction of on farm cash costs in comparison with plan A1 as shown in table 6.6. This reduction in cash costs, especially in the latter years of the plan is a result of the lower level of tree planting in plan A9. As a result of the lower costs in plan A9, surplus cash is generated by 1985/86 with the result that $3738 is made available for investment off the farm in that year.

In this section it has been shown that the adjustment plan outlined in chapter 6 (plan A1) is somewhat insensitive for values of the final assets coefficient in the objective function between 1.0 and 0.4. As the value of this coefficient falls to 0.2 and finally to 0.0 greater emphasis is placed on adjustments which produce a return within the planning horizon.

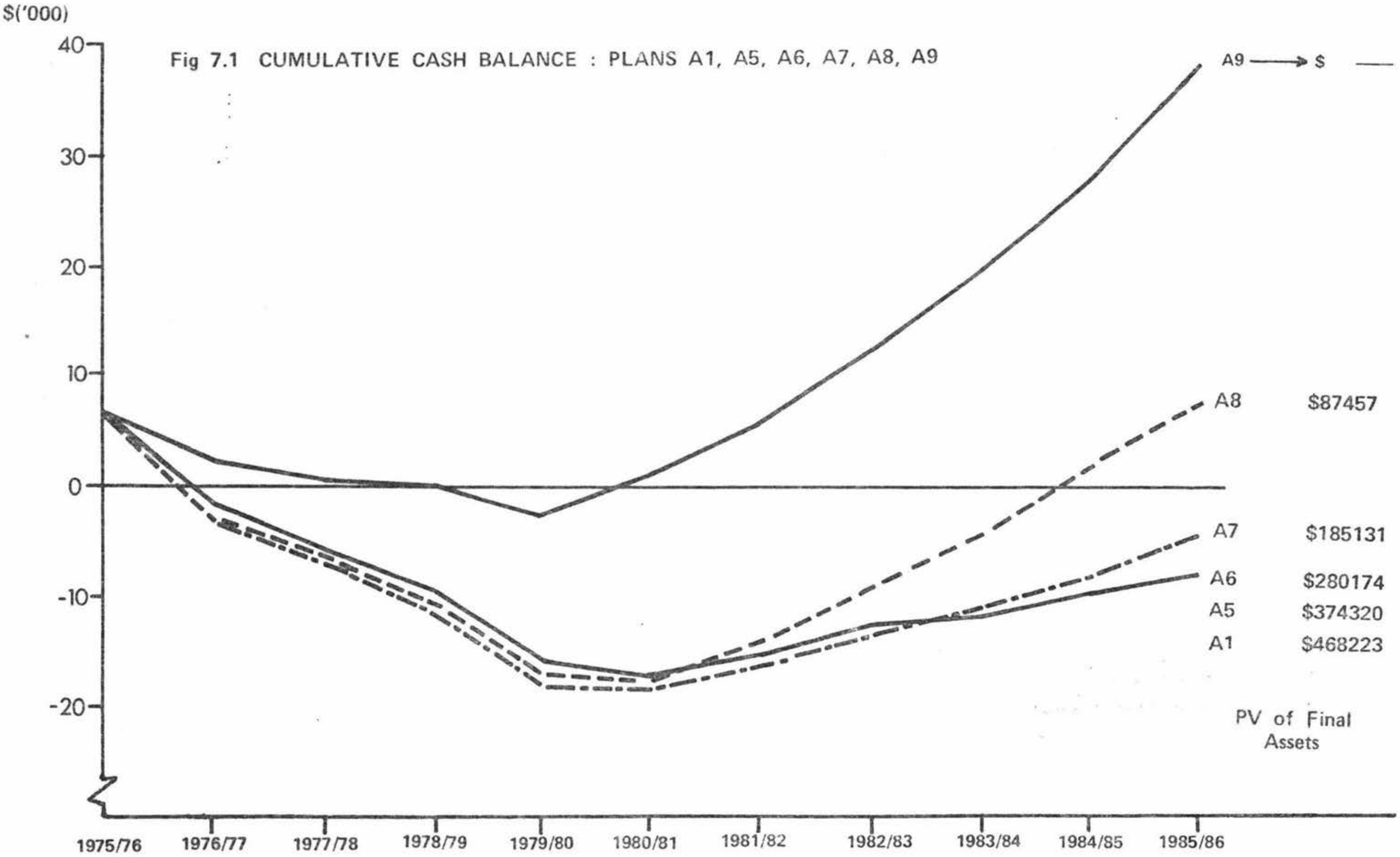


Fig 7.1 CUMULATIVE CASH BALANCE : PLANS A1, A5, A6, A7, A8, A9

Table 7.11 Cash Flow Summary: Plan A9

Cash flow items	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Opening cash balance	7 000	2 171	596	104	-2 870	788	5 886	12 200	18 770	27 181
plus Loan 1 received	15 769	19 472	21 672	27 397	24 893	21 991	17 816	12 037	4 508	
less Personal drawings	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000	3 000
less Cash fixed costs	4 760	4 760	4 760	10 760	4 760	4 760	4 760	4 760	4 760	4 760
less Cash farm costs	15 009	13 883	14 509	13 741	14 263	15 019	15 942	16 476	15 518	15 682
less Off farm investment										3 738
plus Off farm income	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000	6 000
plus Gross farm revenue	13 202	15 692	17 867	21 006	23 929	27 507	30 783	31 611	33 955	37 394
plus Investment repaid + interest										4 000
less Loan 1 repaid + interest	17 031	21 030	23 406	29 588	26 884	23 750	19 242	13 000	4 869	
less Tax paid		65	357	288	2 257	3 872	5 341	5 841	7 906	9 959
equals Cumulative cash balance	2 171	597	104	-2 870	788	5 886	12 200	18 770	27 181	37 435

For example, orchard restructuring consisted of reworking and interplanting. In addition, the level of off farm work increased in order to supplement income in the short run. This shift in adjustment strategies is also reflected in the rate of return which was computed from the shadow price of initial cash. The step function plotted in figure 7.2 shows how the rate of return decreases as the objective function gives greater weight to the value of cash at the end of the planning horizon. This decrease in the rate of return is caused by the corresponding decrease in the "value" of the investment in perennial crops which consequently effects the value of the objective function. (See table 7.7)

7.3.2 Capital restrictions

The final set of plans to be considered are based on the model with a final assets weight of 0.2 (plan A8). In this analysis the effect of capital restrictions was examined by varying the level of initial cash between -\$8000 and \$22,000. The value of the objective function for a number of selected plans within this range is shown in table 7.12.

Table 7.12 Value of the Objective Function: Plans A10,...,A15

Plan number	Initial cash (\$)	P.V. of final cash (\$)	P.V. of final assets (\$)	P.V. of objective function (\$)	Percentage change Base = Plan A8 (%)
A10	-8 000	-4 815	77 446	72 629	-21
A11	-3 000	-1 540	81 156	79 616	-13
A12	2 000	1 044	84 602	85 646	-7
A8	7 000	4 055	87 457	91 513	0
A13	12 000	6 835	90 471	97 360	+6
A14	17 000	10 863	92 009	102 872	+12
A15	22 000	14 179	94 084	108 265	+18

The orchard restructuring programmes corresponding to these plans is shown in the tree reconciliation statement in table 7.13. Changing the initial owned cash has little effect on the various adjustment strategies. The main contributor to the difference between the value of the objective

Fig 7.2 RATE OF RETURN FOR PLANS A1, A5 - A9

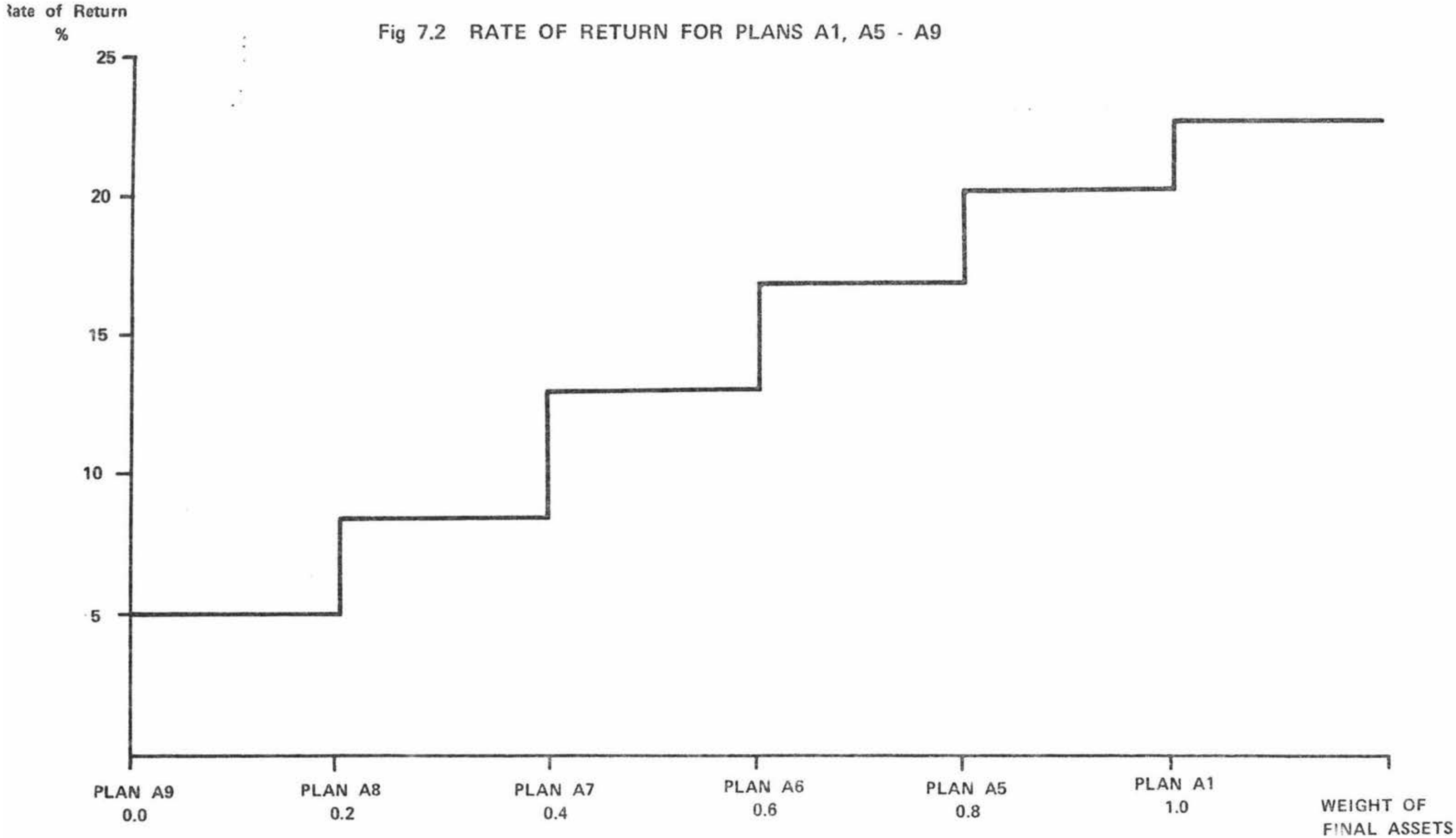


Table 7.13 Tree Reconciliation Statement: Plans A10, ..., A15

	Plan A10	Plan A11	Plan A12	Plan A8	Plan A13	Plan A14	Plan A15
Initial tree number	4 331	4 331	4 331	4 331	4 331	4 331	4 331
No. of trees reworked to							
Gala	162	162	162	142	162	162	162
Less removals	2 541	2 353	1 691	2 509	2 601	2 463	1 899
Plus no. of trees interplanted							
Granny Smith	949	949	949	949	949	949	949
Plus no. of trees planted							
Gala	580	573	584	608	712	591	591
Cox	400	181	305	391	422	386	386
Red Delicious	1 486	1 470	1 492	1 509	1 522	1 477	1 504
Packhams	1 484	1 470	1 491	1 509	1 523	1 506	1 506
Winter Cole	743	735		754	761	753	753
Equals Final tree number	7 432	7 356	7 461	7 542	7 619	7 530	7 530
TOTAL NEW PLANTINGS	5 642	5 378	4 821	5 720	5 889	5 662	5 098

function of plan A8 and the other plans shown in table 7.13 being in the rate at which old trees were removed. The level of off farm work also remained reasonably constant through these plans.

In addition to noting the changes in restructuring between the various plans in this analysis of capital restrictions, it is possible to measure the marginal productivity of initial cash supplies. As previously noted, the shadow price of initial cash is a measure of the marginal product of additional cash supplies. As such the shadow price may be expressed as a compound growth rate. The shadow price of initial cash together with the corresponding annual rate of return is presented in table 7.14. As expected, the marginal productivity of initial cash becomes smaller as the initial cash supplies become larger. An alternative interpretation of the data presented in table 7.14 indicates that the manager's initial supply of cash would need to exceed $22,000 before the total amount should not be invested in his holding if the lending interest rate for cash funds was 7.75 percent.

Table 7.14 Shadow Price of Initial Cash: Plans A10 - A15

Plan number	Level of initial cash ($)	Shadow price ($)	Rate of return (%)
A10	-8 000	2.91	11.27
A11	-3 000	2.39	9.10
A12	2 000	2.34	8.87
A8	7 000	2.28	8.59
A13	12 000	2.26	8.50
A14	17 000	2.13	7.85
A15	22 000	2.11	7.75

7.4 Summary

The linear programming analysis which has been discussed has drawn upon the results of a number of different farm plans. These plans may be summarised as follows:

Plans A1, B1	-	Equally weighted objective function coefficients
Plans A2, B2	-	Twenty year planning horizon for plans A1 and B1
Plan A3	-	Tree removal as the sole adjustment activity
Plan A4	-	Inclusion of tax losses
Plans A5 - A9	-	Alternative objectives
Plans A10 - A15	-	Various capital restrictions.

The various plans have suggested that the optimal solution remains comparatively stable for most variations in objectives and capital structures which were examined. All plans indicate that potential for increased incomes does exist with the most efficient means of increasing income consisting of the immediate removal of less profitable varieties (plan A3). However, because of the delay in implementing any adjustment in the past severe financial conditions may be expected for at least the next decade in all cases.

SECTION C

CHAPTER 8

CONCLUSIONS AND IMPLICATIONS FOR RURAL POLICY

The results of the empirical analysis discussed in the previous chapter answered the question of what low income pip fruit producers should do to improve their general welfare. In this chapter the results are examined and a number of conclusions are drawn. Discussion is then addressed to the question of how these conclusions could be implemented. An examination of both the present range of measures available to pip fruit producers in New Zealand and the policies that have been proposed to alleviate the problems of rural poverty in various overseas countries is made. Two policies are then proposed as possible measures to assist low income pip fruit producers in Nelson. In the concluding section of this chapter the implications of the suggested policies on the regional economy of the Nelson Province are outlined and some suggestions for further research are made.

8.1 Conclusions

The linear programming results discussed in chapters 6 and 7 suggest a further decline in the welfare of Moutere Hill pip fruit producers will occur within the next decade. Regardless of whether or not growers decide to undertake a development programme aimed at restructuring their orchards, it is likely that considerable loan finance will be required. The amount of finance needed increasing in proportion to the amount of development undertaken.

Although the financial prospects for the short and medium term indicate a period of severe financial difficulty, the prospects for the long term appear quite favourable. The results have shown that considerable financial gains can be expected after 1990 when perennial crops enter full bearing.

In order to evaluate the various plans that were discussed a number of criteria were used. These criteria include the rate of return on capital, the pattern of loan requirements, the present value of expected income etc. If producers were operating in an environment of certainty the task of drawing conclusions from the results of the L.P. analysis would be relatively simple. The potential increase in income noted in the adjustment model over that indicated by the benchmark model would suggest that considerable potential exists for increasing income and that if possible growers should be encouraged to maintain and develop their properties.

However, fruit growers do not operate in an environment of complete certainty so the fact that expected benefits do not begin to accrue until the late 1980's, about 14 years after the commencement of the planning horizon, leaves an extensive period of time during which the factors responsible for uncertainty could affect the original assumptions upon which the I.L.P. models were based. In addition, the added indebtedness demanded by persevering with fruit growing on the Moutere Hills is likely to be unacceptable to a number of growers regardless of the potential return from borrowing.

It should be noted that some adjustment has already occurred in plan B1. It is largely as a result of this adjustment which occurred shortly before the start of the planning horizon that the financial results from this plan are so favourable during the second decade of the planning horizon as indicated in plan B2. This fact highlights the major problem of Moutere Hill pip fruit growers, i.e. adjustment has been delayed for too long. As this study has shown that potential for increased incomes does exist the question that needs to be answered addresses itself to whether or not it is too late to rectify the errors of judgement that have been made in the past. In some cases it will be obvious that no alternative exists and growers will be forced to withdraw from the industry. In other cases where growers are able, and willing, to borrow amounts as indicated in the previous chapters orchard restructuring could still occur.

The problem that now remains is to ensure that adequate measures exist to alleviate the rural poverty on the Moutere Hills. The conclusions which have been drawn from this study indicate a need for measures which will assist two classes of growers:

(a) those growers who are able to demonstrate the potential viability[1/] of their holdings but are in need of temporary finance to continue to develop or maintain their properties; and

(b) those growers who cannot demonstrate viability, or who wish to withdraw from the industry, with a minimum of social dislocation.

Accordingly, the various measures currently available in New Zealand will be examined in the next section in order to determine the adequacy with which they are able to assist in alleviating rural poverty. Following this discussion of a number of policies which have been in force in various overseas countries will be listed.

8.2 Agricultural Policy for Low Income Producers

The New Zealand government currently provides a range of measures aimed at assisting primary producers. The most important schemes relevant to the pip fruit industry are listed below and are discussed in Appendix D.

1. Farm Purchase Schemes
2. Farm Finance and Development Schemes
3. Fertilizer and Pesticide Subsidies
4. Income Equalisation Schemes
5. Guaranteed Average Price.

All these measures have been designed with a view to promoting production by encouraging investment and alleviating the burden of fluctuating farm incomes. The farm finance and development schemes are particularly appropriate for assisting those growers who are able to, and wish to remain on their properties. Current rural policy in New Zealand therefore appears quite adequate in providing measures to assist those growers who opt to remain on their holdings. However government policy does not cater for the adjustment situation where a withdrawal from the

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1/ A number of criteria could be used to define "viability", for example the expected rate of return, the payback period, a net present value criterion etc.

rural industry is thought to be desirable. On the contrary, measures presently in vogue in New Zealand encourage growers to remain on their farms. Such policies alone could therefore perpetrate inefficiency and periodic occurrences of rural poverty that have existed on the Moutere Hills since fruit growing was initiated in this locality in 1910. (See Section 2.3) Accordingly, the remainder of this chapter will concentrate on policies which could encourage the second class of Moutere Hill growers to withdraw from the industry.

In various overseas countries a variety of policies have been suggested as ways of removing or easing the constraints on adjustment that low income sectors of agricultural industries have experienced. Harris [24] has categorised a number of the more traditional policies that have been advocated overseas as follows:

(a) To facilitate voluntary amalgamation of small farms:

- writing-off unwanted capital improvements;
- provision of finance for a potential purchaser
  for land and fixed improvements
  for upgrading/changing enterprise
  for increased working capital needs;
- removing or raising substantially limitations on
  total land holdings
  total water rights;
- purchase by government on open market of small holdings for amalgamation, land retirement or alternative use, e.g. forestry;
- pension arrangements (or negative income tax) for farmers beyond a certain age or where for other reasons departure is impracticable; pension payments deductible from value of estate with land being open for purchase by the Crown.

(b) To facilitate upgrading of low income farms where feasible:

- provision of technical assistance coupled with finance for new technology, change of enterprise, perhaps rescheduling and/or writing-off debts in certain cases.

(c) <u>To facilitate departure of low income farmers</u>:

- vocational retraining schemes to facilitate movement of young farmers;
- financial assistance for removal expenses and assistance in rehousing; optionally including living expenses for the change-over period;
- improved education opportunities for country areas (benefiting both children remaining on land and improving opportunities to leave).

(d) <u>To avoid development of new low income farms</u>:

- some limitation on new entrants to an industry without restricting inflow of more efficient managers, e.g. transferable (purchasable) quotas;
- perhaps some suggestion to financial institutions to avoid encouraging enthusiastic amateurs with limited capital and less likelihood of success.

Most of these policy measures suggest substantial assistance in the form of direct grants, loans etc. The question now arises as to whether it is desirable or indeed warranted to allocate financial resources to those who are forced by circumstances to leave an industry. It could be argued that as it is the facts of economic change which have led to their situation, the victims of change should be given some assistance to adapt to it. Nevertheless, the measures which have been listed above, because of the cost involved in implementation and the relatively low levels of financial aspiration on the part of pip fruit growers, are seen as being inappropriate as solutions to the low income of the Moutere Hill pip fruit producer.[2/] In addition, schemes to facilitate re-training are likely to fail due to the Moutere Hill grower's inate conservatism. This situation has been further demonstrated by the failure of the re-training

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2/ In 1976 growers in Mapua stated on average that they would be satisfied with a sum of $5720 per annum for personal consumption, c.f. $9760 for growers in Hawkes Bay.

programme in the Australian Rural Reconstruction scheme to achieve any degree of popularity. /̅8̲7̅ Relocation schemes are also likely to be unsuccessful as growers usually prefer to remain in their own district within a familiar environment. In view of this fact, two alternative schemes are now proposed as solutions to those Moutere Hills pip fruit growers who decide to leave their holdings.

In recent years there has been an increasing demand for small farms by people who have been city and suburban dwellers. This factor combined with the climate of the Nelson Province and the fact that a large number of "cottage industries" have already developed about Nelson, suggests that a real opportunity might exist for growers if they were able to subdivide their holdings into smaller lots.[3/] By subdividing the holdings into one or more smaller farms, the grower would have the option of remaining on a reduced lot in his own dwelling or re-locating to another area if he wished.

8.2.1 Subdivision of land

An amendment to the appropriate legislation permitting the sub-division and sale of Moutere Hills orchards into 2, 4 or 8 hectare lots would permit the orchardist to reduce his indebtedness and invest the surplus proceeds off the farm. Table 8.1 shows that the interest earned by such an off-farm investment in addition to the earnings of an off farm job would enable the grower to increase his current standard of living while remaining in the farm dwelling.

The adoption of such a policy would meet the growing demand for small farms for commercial, semi-commercial and non-commercial purposes. It would reduce the production of pip fruit on the Moutere Hills and stimulate an influx of people into the district. Low income pip fruit producers would be able to remain in the district in their own homes, thus avoiding the social dislocation which often arises when farm adjustment measures are implemented.

3/ A.B. Ward, Reader in Agricultural Economics, Massey University, (pers. comm.)

Table 8.1 Results of Subdivision of 20 ha Orchard and Sale of Land

Proceeds of land sale	2 ha lot at $5000 per ha	$10,000
	8 ha lot at $5000 per ha	40,000
		$50,000
Less indebtedness[a)]		27,500
		$22,600
Interest earned on investment at 8 percent		1,800
Off farm employment		7,000
		$8,800
Less taxation on $8800		2,903
Annual after tax cash		$5,897

a) Source: Appendix table A.47.

The results of the linear programming analysis (plan A9, page 107) when compared with the results shown in table 8.1 indicate that the subdivision of Moutere Hill land could offer a feasible alternative form of adjustment, particularly for older growers without heirs. However, before any decisions were taken a detailed investigation, which is beyond the scope of this study, of all the ramifications of subdivision would need to be made.

A second method whereby the desired orchard adjustment may be effected is via the implementation of an Annuity Scheme.

8.2.2 Annuity scheme

Annuity schemes are essentially devices for converting stocks of wealth into income flows. Farm families frequently receive incomes which are significantly below those of non-farm families and yet may hold substantially greater stocks of net worth. This net worth, farm income analomy is often referred to as the "live poor, die rich" paradox of rural poverty, where farmers live poor in cash but die rich in assets.

A number of schemes for converting farmers' wealth into income flows operate in several European countries. One of the most commonly cited schemes involves a forward sales contract arrangement under which the farmer mortgages his property in exchange for an annuity based on the net worth of the property with the mortgagee assuming title to the property only after the death of the farmer. The advantage of such a scheme lies in the fact that the primary producer is able to remain, work on his property and receive the income from it in addition to an annuity payment representing part of his net worth. The combination of annual income and the annuity payment has been variously termed "well being" by Carlin and Reisel [11] and "full income" by Sexton and Duffus [64]. The latter terminology is preferred by the author and has been adopted in this study.

In table 8.2 the data collected in the Nelson Pip Fruit Survey is used to determine the average full income for each district of the Nelson Province. Assuming an average life expectancy of 75, the number of years, on average, that farm operators have before death can be computed. By converting the equity to an annuity (using an interest rate of 8 percent) we obtain an amount which may be added annually to net income.

The following model summarises the derivation of full income as shown in table 8.2.

$$Y_t^* = Y_t + E_t \cdot A_n \qquad (8.1)$$

where Y_t^* is the measure of full income in time period t

Y_t is net income less the return to equity capital in time period t; and

E_t is the grower's equity capital (his net worth) in time period t; and

A_n is the factor which converts $1.00 to an n year annuity at a given rate of interest i, where n is the life expectancy of the operator beyond time period t. Hence:

$$A_n = \frac{i\ (1+i)^n}{\left[(1+i)^n - 1\right]}$$

These results indicate that the financial position of the Moutere Hills growers could be considerably improved if a mechanism could be found to allow growers to consume their equity during their life time. It is therefore recommended that the New Zealand government give serious consideration to the establishment of an agency through which growers would

Table 8.2 Full Income by District - 1974/75 ($)

Item	Nelson	Mapua	Motueka
Average age of operator	39	40	46
Average equity	93 915	101 722	134 319
Return to equity	-1 580	-1 110	10 406
Net income	3 153	3 919	13 974
N.I. less return to equity (A)	3 153	3 919	3 568
Annuity (B)	8 011	8 728	12 035
Full income (A + B)	11 164	12 647	15 603
Average no. of operators	1.27	1.58	1.61
Full income of operator	8 790	8 004	9 691

have the opportunity of entering into such a forward sales contract as outlined above. On the death of the grower, the agency would be required to realize the asset by placing the asset before a public auction. The agency would be allowed to subdivide the property before the realization occurred, provided that the entire lot was liquidated within a set time limit following acquisition.

Such a scheme would have the advantage of producing higher current consumption levels (including non-pecuniary income gained from remaining in a familiar environment) but at the same time create losses for the farmer's heirs. These benefits are not dependent upon a subsidy of any kind and in time could alleviate the problems of rural poverty on the Moutere Hills.

8.3 Implications for the Nelson Province

The twofold recommendations outlined as a result of this study propose that low income growers on the Moutere Hills be grouped into two classes of growers. Firstly, those growers with potentially viable holdings and secondly, those growers with potentially non-viable holdings or those who may wish to withdraw from the industry. It was found that current rural policy in New Zealand, while adequately meeting the needs of the first class of grower was severely deficient in providing measures which could assist those growers in class two. Accordingly, two additional policy measures were suggested for further consideration. These measures, i.e. the subdivision and annuity schemes would assist those growers categorized as class two and would be considerably less expensive to implement than the more traditional forms of assistance generally advocated for those sectors of agricultural community disadvantaged by the winds of change. The resources required to set up an annuity scheme would be relatively small while the alternative of permitting the subdivision of land for immediate sale would involve minimal costs.

It is recognized that in the course of such an adjustment process the regional economy of the Nelson Province would suffer the loss of that farm income generated by the low income sector of the pip fruit industry. It has been beyond the scope of this study to estimate the net effect of such an adjustment on the regional economy. However it is not expected that the loss in export receipts would exceed the cost of supporting the industry particularly in view of the loan requirements specified by the L.P. analysis in chapters 6 and 7. The influx of small holding farmers to the province would doubtless create a new agricultural intrastructure. In addition, recent surveys (see [45] for example) have indicated that the resource use of small holdings can often be more efficient and productive than the more extensive holdings due to the greater intensity of labour, capital and farming skills used.

In table 8.3 the loss in export earnings which could result from a withdrawal of low income pip fruit growers from the Moutere Hills is estimated. The estimates are based on data obtained from the Nelson Pip Fruit Survey and the New Zealand Ministry of Agriculture and Fisheries.

The policies which have been proposed for further investigation are seen as feasible alternative solutions to the Moutere Hills problem. It is suggested that future research could be directed towards an examination of the following issues:

1. Extension and counselling needs for agricultural adjustment;
2. A survey of part time job possibilities in Nelson; and
3. The potential demand for tourist facilities about the Moutere Hills.

Table 8.3 Estimated Loss in Export Receipts

1975/76	Average yield per orchard	10 248 bushels
	Quantity exported (65% export packout)[a)]	6 661 bushels
	Loss in export receipts per orchard[b)]	$32 476
	Loss in export receipts from the Moutere Hills[c)]	$974 280
	Loss as a percentage of potential receipts	10%[d)]

a) Source: Jenner, K., Nelson Variety Value 1976, M.A.F. Nelson.

b) Average New Zealand export earnings in 1975/76 = $4.88 (f.o.b.)

c) Assuming that 30 growers would withdraw from fruit growing.

d) Using M.A.F. projected yields, by 1982 this percentage would increase to 14 percent.

In this study it has been shown that the failure of farmers to adjust to a changing environment can lead to problems of regional resource allocation. This failure to adjust at an adequate rate can lead to costly and often unfortunate situations, as in the case of the Moutere Hills. The final question which still remains is the rate at which adjustment should occur. At this stage we could do well to heed the advice of William Shakespeare who, when contemplating change, suggests:

> "If it were done when 't is done, then 't were well
> It were done quickly."
>
> Shakespeare, Macbeth (I, vii)

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APPENDIX A

AN ECONOMIC SURVEY OF PIP FRUIT GROWERS IN THE NELSON PROVINCE 1972/73 to 1974/75

Table A.1 Method of Entry Into Fruit Growing (%)

Method of starting	Nelson	Mapua	Motueka
Bought established orchard	41.7	57.1	33.3
Inherited established orchard	25.0	23.8	38.9
Married into orchard family	8.3	4.8	-
Bought bare land	16.7	-	11.1
Other	8.3	14.3	16.7

Table A.2 Grower's Enthusiasm for Fruit Growing Compared With Ten Years Ago (%)

	Nelson	Mapua	Motueka
More enthusiastic	16.7	38.1	11.8
The same	33.3	33.3	35.3
Less enthusiastic	41.7	23.8	53.0
Don't know	8.3	4.8	-

Table A.3 Grower's Occupation Prior to Becoming a Fruit Grower (%)

	Nelson	Mapua	Motueka
Agricultural/horticultural	33.3	40.0	66.7
Professional	-	15.0	11.1
Technical	8.3	5.0	11.1
Labourer	8.3	10.0	-
Student	16.7	15.0	11.1
Other	33.3	15.0	-

Table A.4 Source of General Instruction in Agriculture or Horticulture (%)

	Nelson	Mapua	Motueka
Family	16.7	47.6	38.9
Secondary school	8.3	4.8	-
Technical Institute	-	4.8	11.1
Diploma	25.0	-	5.6
Degree	-	-	-
None	50.0	42.9	44.4

Table A.5 Source of Specialised Instruction in Fruit Growing (%)

	Nelson	Mapua	Motueka
Secondary school	8.3	-	11.8
Technical Institute	-	25.0	11.8
Diploma	8.3	-	5.9
Degree	-	-	-
None	83.3	75.0	70.7

Table A.6 Value of Information Received (rank*)

Source of information	Nelson	Mapua	Motueka
MAF advisers	5.5	9	9
FF assistance	10	10	10
A and P Board services	5.5	6	7
Local accountants	3	3	2
Private consultants	1	1	1
Commercial firm reps.	4	2	3
MAF scientific officers	2	5	8
Other growers	9	7	4
Technical literature	7	4	5
Family members	8	8	6

* A ranking of 1 to 10 is used, where 10 indicates greatest value and 1 least value.

Table A.7 Amount of Practical Experience in Fruit Growing Prior to Managing the Orchard (%)

	Nelson	Mapua	Motueka
Less than 1 year	33.3	29.1	47.0
2-4 years	16.7	19.3	23.5
5-10 years	16.7	33.9	17.7
More than 10 years	33.3	14.6	11.8

Table A.8 Highest Stage of Formal Education Completed (%)

	Nelson	Mapua	Motueka
Less than School Certificate	33.3	52.4	47.0
School Certificate	33.3	23.8	23.5
University Entrance	16.7	9.5	11.8
Diploma	16.7	-	5.9
Degree	-	9.5	5.9
Postgraduate Degree	-	4.8	5.9

Table A.9 Number of Relatives who are Fruit Growers (%)

	Nelson	Mapua	Motueka
0	66.7	71.4	47.0
1 - 3	33.3	28.6	41.2
4 - 8	-	-	11.8

Table A.10 Growers Satisfaction With Various Aspects of Orcharding (%)

	Nelson	Mapua	Motueka
Satisfied with present income			
Yes	16.7	23.8	13.3
No	83.3	76.2	86.7
Satisfied with reputation			
Yes	91.7	95.2	93.4
No	8.3	4.8	6.7
Satisfied with pip fruit yields			
Yes	58.3	47.6	73.3
No	41.7	52.4	26.7
Satisfied with size of business			
Yes	91.7	81.0	93.4
No	8.3	19.0	6.7

Table A.11 The Age of the Orchard Manager (%)

	Nelson	Mapua	Motueka
Less than 25 years	-	4.8	-
25 - 40 years	41.7	47.6	25.0
41 - 50 years	58.3	28.6	37.5
51 - 60	-	9.5	31.3
More than 60 years	-	9.5	6.3

Table A.12 Business Structure of Farms (%)

Business structure	Nelson	Mapua	Motueka
Sole ownership	33	33	22
Partnership	34	15	16
Company	17	43	56
Other	16	9	6

Table A.13 Average Land Use - 1974/75 (ha)

Land use	Nelson	Mapua	Motueka
Pip fruit	10.11	12.01	13.47
Stone fruit	0.08	0.04	0.12
Other orchard	0.08	-	0.08
Other hort.	3.64	0.04	1.45
Pasture	11.49	7.28	21.08
Agric. crops	0.93	1.17	1.37
Waste	5.74	2.50	5.78
Other	3.56	0.76	1.01
Total Area	35.63	23.80	44.35
Apples - bearing	5.9	7.77	9.83
- non-bearing	2.5	3.64	3.64
Pears	1.65	0.60	0.0

Table A.14 Distribution of Sample Farms by Total Area 1974/75 (%)

Farm area (ha)	Nelson	Mapua	Motueka
0 - 4.04	0	9	9
4.04 - 8.09	17	5	0
8.10 - 12.14	8	19	17
12.15 - 16.18	17	29	6
16.19 - 24.28	17	5	6
24.29 - 32.37	8	24	6
32.38 - 40.47	0	5	17
Over 40.47	33	14	50

Table A.15 Composition of Apple Tree Numbers by Major Varieties 1974/75 (%)

Variety	Nelson	Mapua	Motueka
Granny Smith	19	19	26
Golden Delicious	8	9	13
Delicious	4	6	5
Red Delicious	15	14	14
Sturmer	20	14	13
Dougherty/Red Dougherty	4	6	6
Cox's Orange	16	14	10
Gala	3	3	3
Gravenstein	4	3	5
Jonathan	5	7	3
Others	2	5	2

Table A.16 Composition of Pear Tree Numbers by Major Varieties 1974/75 (%)

Variety	Nelson	Mapua	Motueka
Packham	21	34	62
Winter Cole	22	20	14
Winter Nelis	12	11	3
Williams Bon Cretian	23	11	18
Others	22	24	3

Table A.17 Distribution of Pip Fruit Trees by Age of Tree 1974/75 (%)

Age	Apples			Pears		
	Nelson	Mapua	Motueka	Nelson	Mapua	Motueka
0 - 5 years	33	36	31	3	7	6
6 - 15 years	32	24	24	21	13	39
16 - 50 years	10	10	16	6	33	47
Over 50 years	25	30	19	70	47	8

Table A.18 Proportion of Apple Trees by Major Variety That are of Non-bearing Age - 1975 (%)

Table A.19 Percentage Change in Apple Tree Numbers, 1972/73 - 1974/75 by Major Variety (%)

Variety	Nelson	Mapua	Motueka	Nelson	Mapua	Motueka
Granny Smith	46	53	35	83	25	22
Golden Delicious	37	36	16	1	3	-6
Delicious	0	5	0	-10	-7	-5
Red Delicious	57	63	57	89	45	56
Sturmer	13	17	21	1	0	-4
Dougherty	50	54	46	29	84	5
Cox	20	26	22	-7	-3	5
Gala	91	76	100	74	167	158
Gravenstein	33	13	21	36	-25	14
Jonathan	0	4	0	-31	-36	-36
Other	0	30	1	-86	3	-31

Table A.20 Proportion of Total Pear Trees of Non-bearing Age by Major Variety - 1974/75

Table A.21 Percentage Change in Pear Tree Numbers 1972/73 - 1974/75

Variety	Nelson	Mapua	Motueka	Nelson	Mapua	Motueka
Packham	9	19	7	29	0	30
Winter Cole	0	0	0	-37	-12	0
Winter Nelis	0	0	0	-1	49	-4
W.B.C.	0	0	17	-68	-52	-27
Other	7	3	0	-4	53	-82

Table A.22 Density per Hectare of Non-bearing/Bearing Pip Fruit - 1974/75

Fruit	Nelson		Mapua		Motueka	
	Non-bearing	Bearing	Non-bearing	Bearing	Non-bearing	Bearing
Apples	422	370	481	402	420	370
Pears	271	301	578	316	274	336
Pip	171	365	476	392	412	365

Table A.23 Average Total Density of Pip Fruit Plantings - 1974/75

Fruit	Nelson	Mapua	Motueka
Apple	383	422	390
Pear	299	316	331
Pip	380	417	387

Table A.24 Distribution of Sample Farms by Density of Apple Plantings - 1975 (%)

Density (trees/total apple hectares)	Total apple trees			Non-bearing apple trees		
	Nelson	Mapua	Motueka	Nelson	Mapua	Motueka
0 - 247	8	0	0	8	0	0
248 - 321	8	10	18	17	10	18
322 - 395	50	24	29	25	10	24
396 - 447	8	24	47	8	24	29
448 - 494	8	14	6	25	5	24
495 - 543	17	19	0	8	19	6
Over 543	0	10	0	8	33	0

Table A.25 Type of Orchard Ground Cover (%)

	Nelson	Mapua	Motueka
Cultivated	33.3	14.3	-
Grassed down	66.7	47.6	72.2
Grassed and cultivated	-	38.1	16.7
No response	-	-	11.1

Table A.26 Extent of Chemical Weed Control Used (%)

	Nelson	Mapua	Motueka
Strip spray	50.0	61.9	55.6
Trees	16.7	14.3	5.6
Trees & borders	16.7	19.0	16.7
Very little spray	8.3	-	-
No spray	8.3	4.8	22.0

Table A.27 Distribution of Sample Farms by Percentage Pip Fruit Irrigated (%)

% of pip fruit irrigated	Nelson	Mapua	Motueka
100	25.0	4.8	27.8
99 - 50	-	4.8	16.7
49 - 1	16.7	14.3	16.7
Zero	58.3	76.2	38.9

Table A.28 Method of Irrigation Used

	Nelson	Mapua	Motueka
Overhead spray	16.7	-	16.7
Trickle	25.0	28.6	38.9
Flood	-	-	5.6
None	58.3	71.4	38.9

Table A.29 Fruit Thinning Techniques (%)

	Apple thinning			Pear thinning		
	Nelson	Mapua	Motueka	Nelson	Mapua	Motueka
Hand	50.0	28.6	5.6	16.7	33.3	5.9
Chemical	8.3	14.3	5.6	-	4.8	-
Hand and chemical	41.7	52.4	72.2	-	-	-
None	-	4.8	16.7	83.3	61.9	94.1

Table A.30 Major Insect Pests (%)

	Nelson	Mapua	Motueka
Leaf Roller	63.6	71.4	22.2
Mite	-	-	-
Leaf Roller and Mite	9.1	9.5	22.2
Scale	9.1	9.5	5.6
Codlin Moth	-	-	5.6
No response/none	18.2	9.5	44.4

Table A.31 Major Diseases (%)

	Nelson	Mapua	Motueka
Black Spot	16.7	33.3	22.2
Black Spot Fire Blight Powdery Mildew	58.3	42.9	38.9
Canker	8.3	9.5	-
No response/none	16.7	14.3	38.9

Table A.32 Cooperative Packhouse Membership (%)

Cooperative packhouse membership	Nelson	Mapua	Motueka
Yes	58.3	66.7	72.2
No	41.7	33.3	27.8

Table A.33 Apple Yields per Bearing Tree by Major Variety - 1974/75 (bush)

Variety	Nelson	Mapua	Motueka
Granny Smith	4.3	4.9	6.8
Golden Delicious	8.1	6.6	7.0
Delicious	5.0	8.2	5.9
Red Delicious	4.2	2.5	5.8
Sturmer	5.2	6.7	9.4
Dougherty	5.5	4.1	9.7
Cox's Orange Pippen	4.1	4.8	8.0
Jonathan	2.9	6.4	4.6
Other	3.9	5.3	2.4
Yield per total hectare	1280	1574	2131
Yield per bearing hectare	1737	2310	2935
Yield per bearing tree	5.8	5.7	7.6

Table A.34 Pear Yields 1974/75 (bush.)

Yield	Nelson	Mapua	Motueka
Per total hectare	1882	1391	1111
Per bearing hectare	1957	1448	1195
Per bearing tree	7.1	4.5	3.5

Table A.35 Distribution of Sample Farms by Pear Production per Bearing Hectare - 1974/75 (%)

Yield (bu/bearing hectare)	Nelson	Mapua	Motueka
0 - 989	55	43	76
990 - 1729	0	29	6
1730 - 2470	27	19	6
2471 - 3212	18	5	6
More than 3212	0	5	6

Table A.36 Distribution of Farms by Total Apple Production - 1974/75 (%)

Total yield (bush.)	Nelson	Mapua	Motueka
0 - 5000	17	0	6
5001 - 10000	33	9	11
10001 - 15000	25	29	17
15001 - 30000	8	57	44
More than 30000	17	5	22

Table A.37 Distribution of Sample Farms by Apple Production per Bearing Hectare - 1974/75 (%)

Yield (bu/bearing hectare)	Nelson	Mapua	Motueka
0 - 989	25	0	0
990 - 1729	8	14	12
1730 - 2470	33	38	12
2471 - 3212	8	24	29
3213 - 3953	25	19	29
More than 3953	0	5	18

Table A.38 Distribution of Growers by Net Farm Income - 1974/75 (%)

Net farm income ($)	Nelson	Mapua	Motueka
Under 0	33.3	44.4	21.4
0 - 1999	16.7	11.1	0.0
2000 - 4999	8.3	22.2	14.3
5000 - 9999	41.7	16.7	28.6
10 000 and above	0.0	5.6	35.7

Table A.39 Distribution of Farms by Gross Farm Receipts - (three year average) (%)

Gross farm receipts ($)	Nelson	Mapua	Motueka
0 - 9 999	8	0	7
10 000 - 19 999	50	33	22
20 000 - 29 999	17	28	0
30 000 - 39 999	17	22	14
40 000 - 49 999	0	6	22
50 000 - 59 999	0	0	14
Greater than 60 000	8	11	21
Number of farms	17	11	16

Table A.40 Distribution of Farms by Off-farm Income - (three year average) (%)

Off farm income ($)	Nelson	Mapua	Motueka
0 - 499	50	41	43
500 - 999	33	29	21
1000 - 4999	17	24	22
Greater than 5000	0	6	14

Table A.41 Distribution of Total Farm Cash Costs - (three year average)(%)

Total farm cash costs ($)	Nelson	Mapua	Motueka
0 - 9 999	25	11	22
10 000 - 19 999	42	44	14
20 000 - 29 999	25	17	7
30 000 - 39 999	0	17	29
Greater than 40 000	8	11	28

Table A.42 Distribution of Farms by Total Capital - 1974/75 (%)

Farm total capital	Nelson	Mapua	Motueka
$'000			
0 - 99.9	58	47	29
100 - 149.9	17	24	21
150 - 199.9	17	18	36
Greater than 200	8	11	14

Table A.43 Imputed Costs - 1974/75 ($)

Cost item	Nelson	Mapua	Motueka
Labour			
- operator	4844	4688	4152
- family partners etc	2027	3213	3482
TOTAL LABOUR	6871	7901	7634
Depreciation			
- plant & machinery	1158	1594	2665
- improvements	980	1278	1401
TOTAL DEPRECIATION	2138	2872	4066
Interest on capital			
- land	3093	2429	2885
- improvements	4047	5112	5887
- plant & machinery	959	1294	2313
- working capital	607	819	1087
TOTAL INTEREST	8706	9654	12172
TOTAL IMPUTED COSTS	17715	20427	23872

Table A.44 Distribution of Farms by Equity Ratio - 1974/75 (%)

Equity ratio	Nelson	Mapua	Motueka
0 - 39.9	8	12	0
40 - 59.9	8	12	0
60 - 79.9	17	41	43
80 - 89.9	17	6	14
90 - 99.9	50	29	36
100	0	0	7

Table A.45 Indebtedness and Interest Paid, 1972/73 - 1974/75 ($)

Year	Nelson	Mapua	Motueka
Total indebtedness			
1972/73	12644	17566	21128
1973/74	16715	27224	23816
1974/75	22459	27390	25794
Indebtedness by term liabilities only			
1972/73	10738	12939	13800
1973/74	13673	20447	16347
1974/75	15881	20127	16635
Interest paid			
1972/73	673	713	754
1973/74	1037	1020	1063
1974/75	1313	1299	911

Table A.46 Distribution of Farms by Total Indebtedness - 1974/75 (%)

Total indebtedness ($)	Nelson	Mapua	Motueka
0 - 4 999	8	23	29
5 000 - 9 999	33	6	7
10 000 - 19 999	25	6	14
20 000 - 29 999	17	29	0
30 000 - 39 999	0	18	29
Greater than 40 000	17	24	21

Table A.47 Indebtedness and Equity Ratio - Farm Averages 1974/75

Item	Nelson	Mapua	Motueka
Indebtedness that is long term (%)	70	73	64
Indebtedness ($)	22459	27390	25794
Capital ($)	116375	129112	160113
Equity ratio (%)	81	78	83
Interest paid	1313	1299	911

APPENDIX B

Table B.1 Pip Fruit Production and Tree Numbers - Mapua, 1954-75

Year	Total apple yield (bu.)	Total apple tree nos.	Total pear yield (bu.)	Total pear tree nos.	Bearing apple trees (%)	Bearing pear trees (%)	Average yield/ bearing apple tree (bu.)	Average yield/ bearing pear tree (bu.)
1954	598 800	196 900	40 200	13 800	.87	.66	3.47	4.41
1955	673 600	199 500	60 300	15 500	.87	.67	3.88	5.76
1956	669 000	203 300	59 000	16 400	.87	.68	3.78	5.25
1957	524 000	206 300	46 700	17 800	.86	.69	3.49	3.77
1958	701 500	194 000	57 500	17 800	.86	.70	4.19	4.56
1959	885 200	212 500	78 000	21 100	.85	.72	4.87	5.13
1960	697 000	218 800	42 700	21 000	.85	.73	3.74	2.76
1961	811 900	211 000	87 700	22 000	.84	.75	4.55	5.31
1962	958 700	224 400	87 000	22 000	.83	.76	5.09	5.16
1963	709 000	223 300	70 000	22 900	.83	.77	3.80	3.93
1964	723 600	224 600	71 400	23 500	.84	.80	3.83	3.78
1965	659 100	228 000	73 300	24 000	.84	.82	3.41	3.70
1966	761 100	184 800	86 400	21 200	.85	.85	4.83	4.79
1967	669 100	189 500	63 600	21 000	.85	.87	4.12	3.46
1968	717 100	191 800	89 600	19 600	.86	.89	4.34	5.12
1969	789 900	195 700	73 000	19 400	.84	.90	4.80	4.14
1970	874 700	203 800	77 300	18 900	.81	.92	5.25	4.44
1971	822 000	213 400	96 200	18 700	.79	.93	5.12	4.46
1972	-	-	-	-	-	-	-	-
1973	905 968	236 300	65 232	12 800	.74	.95	5.12	5.34
1974	940 194	247 566	50 868	11 806	.73	.96	5.13	4.46
1975	982 422	269 082	48 708	11 556	.72	.97	5.00	4.32

Source: Ministry of Agriculture and Fisheries Annual Statistics
Official Report of the N.Z. Fruit Industries Survey (various).

APPENDIX C

ASSET VALUATION PROGRAMME - LISTING AND OUTPUT

```
$SET AUTOBIND
$BIND = FROM FORTCODE/=
$SET SEQ LINEINFO
C*          A PROGRAM FOR GENERATING ASSET VALUES OF PERENNIAL CROPS OF
C*          VARIOUS AGES WITH OPTIMUM REPLACEMENT TIMES.
C*
C*          THE DIMENSIONED VARIABLES ARE ---
C*
C*          REV    = MATRIX CONTAINING CASH FLOWS
C*          PV     = PRESENT VALUE OF CASH FLOW
C*          AMORT  = AMORTIZATION FACTOR
C*          AMVAL  = ANNUITY
C*          REVC   = CASH FLOW (I) VECTOR
C*          VAR    = VARIETY OF CROP
C*          CPV    = CUMULATIVE PRESENT VALUE
C*
C*          OTHER INPUT VARIABLES ---
C*
C*          RI     = DISCOUNT INTEREST RATE
C*          NY     = NUMBER OF YEARS
C*          NV     = NUMBER OF VARIETIES
C*
C*
      REAL REV(65,10),PV(65),AMORT(65),AMVAL(65),REVC(65),VAR(10),CPV(6
     *),ASSET2(10,11),DUM(10),ASSET3(11)
C*
C*         READ INPUT DATA
C*
      READ(1,1)RI,NY,NV
      READ(1,3) (VAR(I),I=1,NV)
      READ(1,2) ((REV(I,J),J=1,NV),I=1,NY)
      DO 10 I=1,NV
      DO 9 J=1,NY
      PV(J) = 0.0
      CPV(J)= 0.0
      AMORT(J)=0.0
      AMVAL(J)=0.0
      BIG = -10000.0
      BIGCPV  =0.0
      BIGYR   =0.0
9     ASSET   =0.0
C*
C*         DETERMINE PV AND ANNUITY FOR VARIETY (I)
C*
      CALL COPY(REV,I,REVC,NY,NV,0)
      DO 11 J=1,NY
      PV(J) = REVC(J)/(1+RI)**J
      IF(J.EQ.1)CPV(J)=PV(J)
      IF(J.GT.1)CPV(J)=CPV(J-1)+PV(J)
      AMORT(J)=(RI*(1+RI)**J)/(((1+RI)**J)-1)
      AMVAL(J)=AMORT(J)*CPV(J)
      IF(AMVAL(J).LE.BIG) GO TO 11
      BIG = AMVAL(J)
      BIGCPV = CPV(J)
      BIGYR = J
11    CONTINUE
      ASSET = (((BIG/RI)/(1+RI)**(BIGYR + 1))) + BIGCPV
      WRITE(6,4)
      WRITE(6,5)RI,VAR(I)
      WRITE(6,6)
      DO 20 K = 1,NY
20    WRITE(6,7)K,REVC(K),PV(K),CPV(K),AMORT(K),AMVAL(K)
      WRITE(6,8)BIGYR,ASSET
C*
C*         DETERMINE ASSET VALUES FOR CROPS AT VARIOUS AGES
C*
      DO 30 KK=1,11
      DO 50 II = 1,NY
      PV(II) = 0.0
50    CPV(II) = 0.0
      DO 40 JJ= KK,BIGYR
      PV(JJ) = REVC(JJ)/(1+RI)**(JJ-(KK-1))
      IF(JJ.EQ.1)CPV(JJ)=PV(JJ)
40    IF(JJ.GT.1)CPV(JJ)=PV(JJ) + CPV(JJ-1)
```

```
      ASSET2(I,KK) = (((BIG/RI)/((1+RI)**(BIGYR+2-KK)))) + CPV(BIGYR)
      ASSET3(I) = (((BIG/RI)/((1+RI)**(BIGYR+2-KK)))) + CPV(BIGYR)
      NN = KK-1
      WRITE(6,12)NN,ASSET3(I)
30    CONTINUE
10    CONTINUE
      DU 60 KIK = 1,NV
      DU 61 J=2,11
 61   DUM(12-J)=ASSET2(KIK,J)
 60   WRITE (3,13) DUM
1     FORMAT(F5.3,2I3)
2     FORMAT(9I5)
3     FORMAT(9A5)
4     FORMAT(/1H136X,'ORCHARD  TREF  VALUATICN  AND  REPLACEMENT SCHEDU
     *E'/37X,51(1H=)///)
5     FORMAT(/1H 8X'DISCOUNT  RATE  =',F5.3,//9X,'VARIETY',10X,'=',A6),
6     FORMAT(/1H 9X'YEAR',7X,'NET REVENUE',7X,'PV   OF',8X,'CUMULATIVE'
     *,6X,'AMORTIZATION',6X,'AMORITIZED',/37X,'NET REVENUE',5X,'PRESENT V
     *ALUE',8X,'FACTOR',11X,'NET REVENUE'//)
7     FORMAT(1H 10X,I2,12X,I5,10X,F7.1,7X,F10.1,10X,F6.4,9X,F7.1,)
8     FORMAT(/1H 27X,'OPTIMUM REPLACEMENT AGE  =',I3//28X,'ASSET VALLE O
     *F TREE  =',I6//)
 12   FORMAT(1H 17X,'ASSET VALUE OF THREE AT THE END OF YEAR',I3,' =',I6,
 13   FORMAT(12X,10I6)
      LUCK 3
      STOP
      END
```

ORCHARD TREE VALUATION AND REPLACEMENT SCHEDULE

DISCOUNT RATE =0.070

VARIETY = PACK

YEAR	NET REVENUE	PV OF NET REVENUE	CUMULATIVE PRESENT VALUE	AMORTIZATION FACTOR	AMORTIZED NET REVENUE
1	-404	-377.6	-377.6	1.0700	-404.0
2	-255	-222.7	-600.3	0.5531	-332.0
3	-264	-215.5	-815.8	0.3811	-310.9
4	-226	-172.4	-988.2	0.2952	-291.7
5	-232	-165.4	-1153.6	0.2439	-281.4
6	-121	-80.6	-1234.3	0.2098	-258.9
7	257	160.0	-1074.2	0.1856	-199.3
8	393	228.7	-845.5	0.1675	-141.6
9	494	268.7	-576.8	0.1535	-88.5
10	593	301.5	-275.3	0.1424	-39.2
11	850	403.8	128.5	0.1334	17.1
12	992	440.5	569.0	0.1259	71.6
13	1095	454.4	1023.4	0.1197	122.4
14	1237	479.7	1503.1	0.1143	171.9
15	1265	458.5	1961.6	0.1098	215.4
16	1292	437.6	2399.2	0.1059	254.0
⋮	⋮	⋮	⋮	⋮	⋮
60	500	8.6	8541.8	0.0712	608.4
61	450	7.3	8549.1	0.0711	608.2
62	450	6.8	8555.8	0.0711	608.1
63	450	6.3	8562.2	0.0710	607.9
64	450	5.9	8568.1	0.0709	607.8
65	450	5.5	8573.6	0.0709	607.6

OPTIMUM REPLACEMENT AGE = 58

ASSET VALUE OF TREE = 8683

ASSET VALUE OF TREE AT THE END OF YEAR 0 = 8522
ASSET VALUE OF TREE AT THE END OF YEAR 1 = 9523
ASSET VALUE OF TREE AT THE END OF YEAR 2 = 10444
ASSET VALUE OF TREE AT THE END OF YEAR 3 = 11439
ASSET VALUE OF TREE AT THE END OF YEAR 4 = 12466
ASSET VALUE OF TREE AT THE END OF YEAR 5 = 13571
ASSET VALUE OF TREE AT THE END OF YEAR 6 = 14642
ASSET VALUE OF TREE AT THE END OF YEAR 7 = 15410
ASSET VALUE OF TREE AT THE END OF YEAR 8 = 16095
ASSET VALUE OF TREE AT THE END OF YEAR 9 = 16728
ASSET VALUE OF TREE AT THE END OF YEAR 10 = 17306

APPENDIX D

PRESENT MEASURES ASSISTING THE PIP FRUIT INDUSTRY

1. Farm Purchase Schemes

The Rural Banking and Finance Corporation will consider applications from persons wishing to purchase their first farm or from persons wishing to amalgamate smaller uneconomic holdings to make existing units economic. Also the Post Office operates a farm ownership account which is designed to help students and farm workers purchase a farm.

2. Farm Finance and Development

The Inland Revenue Department allows a wide variety of developmental expenditures to qualify as tax deductions, for example, clearing land of timber and the construction of dams. In order to encourage investment in plant, machinery, and certain buildings (e.g. packing sheds), a taxation allowance is given in the year the asset is first used. The allowance may be a first year depreciation allowance (22 - 40 percent) or an investment allowance (40 percent) which is additional to the first year depreciation and has no effect on the book value.

The Rural Banking and Finance Corporation will also provide finance for development assistance for replanting and other improvements, including essential equipment. Provision also exists for seasonal finance where necessary and the refinancing of onerous short-term debts incurred in the change-over to preferred varieties which are not yet fully productive; or where a major liquidity problem is inhibiting the viability of an otherwise soundly structured orchard. The Rural Bank also operates a Farm Mortgage Guarantee scheme to encourage lenders to invest their funds in farm mortgages, the Rural Bank guaranteeing farm lenders against loss should the borrower fail to repay a loan.

3. Fertilizer and Pesticide Use

A subsidy of $25/tonne is payable on New Zealand and imported fertilizers in addition to a subsidy payable on transport of lime and fertilizer from the works, merchants, or the port of entry to the farm gate. A pesticide rebate of six cents a bushel of fancy grade pip fruit was also introduced to ensure that growers have the ability to apply an adequate spray programme.

4. Income Equalisation Schemes

The income equalisation scheme is designed to even out fluctuations in growers' incomes and allow for a build-up of funds for farm development. Under the scheme growers deposit amounts up to their annual assessable farm income. Such deposits are retained in farm income equalisation reserve accounts in the grower's name and is eligible for interest at 3 percent per annum. Deposits are tax deductible and withdrawals are assessable in the year in which they are made.

5. A Guaranteed Average Price

The New Zealand Apple and Pear Marketing Board provides growers with an average guaranteed price for pip fruit. An independent body, the New Zealand Apple and Pear Prices Authority, sets the average price to be paid by the New Zealand Apple and Pear Board each year. The Board then sets the price for individual varieties, grades and sizes of fruit. This scheme has also successfully stabilised average prices and aggregate incomes in the past. [55]