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discussion paper no. 3

Prospects for Asian Pears in New Zealand

Technical : Marketing : Financial

Department of Horticulture
Landscape
and Parks

Lincoln College, University College of Agriculture

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FOREWORD

This discussion paper is based on an honours thesis prepared by M Van Workum, as part of a B Hort Sc Honours degree and supervised and edited by G F Thiele.

Asian pears are not yet a commercial crop in New Zealand and most trial plantings are only two or three years old. As a result the information contained in this paper is largely a summary of overseas literature, some of which has been interpreted from the Japanese horticultural industry.

Cultural recommendations have been based partly on the Asian experience and by relating Japanese environmental conditions to those of New Zealand. The Marketing section analyses present supply and price patterns in key Asian markets and reveals a potential market slot for New Zealand production in the March - August period coinciding with the northern hemisphere off-season. Pilot marketing trials in New Zealand of imported fruit have been inconclusive. Because of the high quality demanded in most Asian markets, potential producers must realise that a high level of production expertise will be necessary to achieve a high percentage export packout. Local demand for non export fruit is so uncertain that conservative financial estimates are imperative. The financial sector of this paper parametises output data to provide a risk analyses for those comtemplating the production of Asian pears.

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ABSTRACT

Evidence is presented to justify the interest in New Zealand for Asian pears as a prospective new crop with export potential.

Plant material from Japan is under quarantine in New Zealand. Seventeen varieties have been released for bulking up and testing under research and commercial conditions.

The New Zealand industry is relying initially on Japanese and Californian knowledge. Japan produces 82% of the world's supply of Asian pears.

Emphasis is being placed on selection of varieties suitable for New Zealand requirements. Appearance, quality, flavour, shape and storage ability will be important in supplying what is a very high standard Asian market.

It is suggested that post-harvest handling will need to be of a high standard similar to that for nectarines.

The New Zealand Apple and Pear Marketing Board is likely to market the New Zealand crop. This is logical as the Board already markets pipfruit in potential Asian pear markets and has worldwide expertise in distribution, handling and promotion.

Hong Kong and Singapore are likely to be major markets. Taiwan, the Philippines, Malaysia, U.S.A. and Germany are prospective markets. Japan and Korea have a restriction on New Zealand pipfruit due to the presence of codling moth.

The financial analysis with a cash flow and development budget prove that Asian pears are a worthwhile investment.

Success of the New Zealand Asian pear industry will depend on co-ordination between producer, researcher and marketer to ensure high quality fruit of the variety and standards required by particular markets are met.

1.0 INTRODUCTION

This study outlines the present situation and future prospects for Asian pears within New Zealand. It is sub-divided into three parts:

Section 2.0: Technical review - discusses the culture of Asian pears using Japan and U.S.A. as the major sources of information. Emphasis is placed on the initial development period of Asian pears in New Zealand, including climatic conditions, rootstocks, varieties and pest and disease control factors.

Section 3.0: Marketing - this section documents the present world production and trade of Asian pears, and discusses the likely organisation of a New Zealand industry. Emphasis is given to prospective export markets and their particular requirements.

For an industry that will be based primarily on exporting, post-harvesting techniques will be of initial importance. Details of fruit quality, maturity, packaging and storage requirements are outlined.

Section 4.0: Financial analysis - this section uses two financial assessment methods:

i) A 10-year cash flow for a 1-hectare development of Asian pears is outlined. Only costs direct to the establishment and production of the crop are included (i.e. overhead cost, land, machinery and buildings are excluded). It is assumed that an existing orchardist is expanding into Asian

pears on land that he currently owns, and also has the necessary machinery and plant for the development.

ii) A development budget for an Asian pear orchard of 6 hectares (5 ha planted) is included. This analysis shows the effect of including land, buildings, machinery and plant on the financial position of the owner for the development of a new 6-ha Asian pear orchard.

2.0 TECHNICAL

2.1 ORIGIN AND HISTORY

The cultivated varieties of Chinese and Japanese pears were developed from *Pyrus ussuriensis* and *Pyrus pyrifolia* (serotina), and possible other native species, according to Kikuchi (1948).

The culture of "Misunashi", the Japanese water pear, dates back to 693 AD in written records, but these early plantings were little more than cultivated groves of the wild species *P. serotina* (Rehder) (Machida, 1979).

By the middle of the Edo period in 1735, only a few named garden varieties were recorded. However, commercial production received a major boost with the introduction of two important new cultivars, Nijisseki and Chojuro in 1895 (McKenzie, 1980). The earliest forms were commonly rather small, round, very firm and gritty fruit with rough russetted skins and insipid taste. The two new cultivars represented a major step forward in fruit size and quality. The flesh was notably free from grittiness, crisp textured, very juicy and sweet.

The culture of pears in China dates back 2,500 - 3,000 years and since these early days cultivar development and systematic classification of species and cultivars has been continuous. Now there are a total of 3,500 cultivars of pears in China (Tsuin Shen, 1980).

Synonyms for Asian pears are: Oriental, Chinese, Japanese, Salad, Nihon, Apple, Misunashi and Nashi pears.

They differ from *Pyrus communis*, the European pear, in that they remain crisp and juicy when fully ripe and the flavour is distinctive. The fruit is normally left to ripen

fully on the tree.

The trees are ornamental, with bright white flowers, leathery green leaves and attractive autumn colour. Like other pipfruit, they are deciduous. The climatic and cultural requirements are similar to *P. communis* (Stebbins and Walheim, 1981).

2.2 CLIMATIC CONDITIONS

With the exception of the need for good shelter from wind exposure, Asian pears seem to be reasonably adaptable to growing conditions. In Japan, the main growing districts have fairly high summer rainfall, indicating that the crop is tolerant of and may in fact require a good supply of moisture over the growing season. In the U.S.A., it is being grown quite satisfactory in dry, desert-like climates with irrigation. New Zealand fruit-growing districts are generally drier than Asian pear areas in Japan, and will require irrigation.

Tables 1 and 2 allow some comparison between Japanese and New Zealand fruit-growing climates. In Figure 1, equivalent New Zealand latitudes are included.

About half of Japan (North-east Honshu and Hokkaido) has a broadly similar climate to many fruit-growing regions in New Zealand, although Japan has a more continental climate (Fig. 1).

The higher summer rainfall in Central and Northern Honshu results in lower sunshine hours compared with the Bay of Plenty, Gisborne, Hawkes Bay, Nelson and Blenheim (Table 1). Average summer temperatures of more than 13^{o}C are desirable (Seike, 1973).

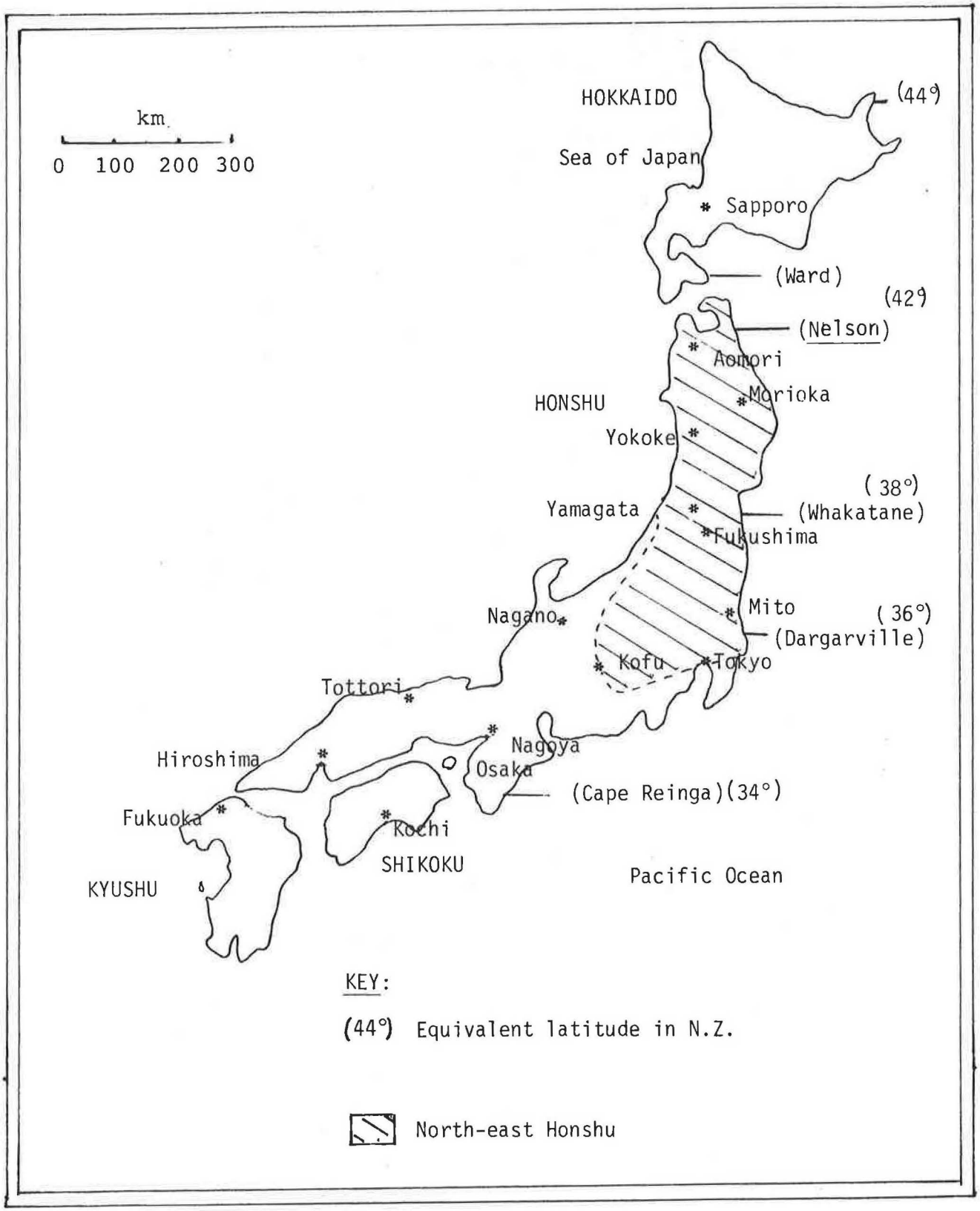


Figure 1: Asian pear growing districts in Japan.
(Source: Hunt, G. (1982): Nashi, unpublished mimeograph. Part B, Project A assignment, Lincoln College)

Table 1: Climatic conditions of Asian pear districts in Japan and pipfruit growing areas in New Zealand.

Major Area	No. of snow-days	Average Monthly Temperatures* (°C)								Average summer relative humidity (%)
Japan		Jan.	March	April	May	July	Sept.	Oct.	Nov.	
Tottori	14	1.6	7.6	12.6	16.9	25.5	22.3	16.9	12.3	81
Mito	1	0.7	6.4	11.9	15.9	23.3	22.0	16.1	12.3	87
Fukushima	13	-1.4	5.1	10.8	15.6	24.2	24.2	14.9	10.8	80
New Zealand			Average Monthly Temperatures (N.Z. seasonal equivalents)							
Nelson	0	6.7	9.8	11.8	14.0	17.0	15.6	12.8	9.9	72
Hastings	0	7.7	9.7	10.5	12.2	16.7	15.6	15.9	13.3	83
Canterbury	0	6.0	7.3	8.6	10.1	15.4	14.0	15.7	12.3	84

*Months according to Northern Hemisphere season.
(Ref. Hunt, G., 1982 - Project A 'Nashi' (source not quoted).

Table 2: Rainfall and sunshine hours of Asian pear-growing districts in Japan and pipfruit growing areas in New Zealand.

Major Area	Average Monthly Rainfall* (mm)							Annual rainfall (mm)	Total Average sunshine hrs
Japan	April	May	June	July	Aug.	Sept.	Oct.		
Tottori	73	41	183	57	154	205	57	2042	1330
Mito	98	154	158	95	369	271	43	1377	1110
Fukushima	77	90	121	109	146	152	38	1143	1180
New Zealand	Average Monthly Rainfall (mm) (N.Z. seasonal equivalents)								
Nelson	79	71	66	64	66	81	86	967	1570
Hastings	73	51	43	40	52	80	74	992	
Canterbury	53	45	40	41	37	15	53	795	

*Months according to Northern Hemisphere season.
(Ref. Hunt, G., 1982 - Project A 'Nashi' (source not quoted).

On the basis of relative humidity, spring to autumn temperatures and summer rainfall, Auckland, Bay of Plenty and Northland approach the coastal climates from Yokoke to Yamagata (Table 2). Nagano, a large Asian pear producing area has a similar spring to autumn climate to Nelson and Gisborne (Hunt, 1982). Tottori is the largest Asian pear growing district in Japan. With the exception of Nelson, humidity is comparable between the two countries.

Wilton (1983b) reports that Japanese winter chilling requirements are in the region of 900 - 1,000 hours below 7°C (i.e., similar to apples and European pears). If this level of winter chilling is required, then we could expect delayed dormancy problems in our milder, more northern districts such as coastal Bay of Plenty, Auckland and Northland.

Evidence from California suggests that Asian pears may have somewhat less winter chilling requirements than other pipfruit, in which case they should be quite adaptable to most New Zealand fruitgrowing districts. *Pyrus pyrifolia* has also been used in breeding programmes with *P. communis* to confer low winter chilling characteristics to pears, indicating that in general Asian pears may not be as sensitive to winter chilling problems as other pipfruit.

Cold resistant varieties from Hokkaido extend the climatic range into colder areas. Some of these varieties imported into New Zealand should prove useful for colder New Zealand districts (Hokkan, Hokuho, Hokusei). Most Asian pear cultivars, properly matured, will withstand winter temperatures as low as -20°C without serious injury (Seiki, 1973).

Flowering occurs a little earlier than European pears, but later than most stonefruit. Sites which are prone to late-spring frosts should be avoided, or provision made for frost protection. Wilton (1983b) suggests that sites which set regular peach crops without frost protection will also set Asian pears without frost protection.

Wind protection will be necessary to ensure good tree growth, minimise fruit blemish, and prevent pre-harvest fruit drop. Japanese growers report that strong winds as the fruit approaches harvest will cause heavy fruit drop. Summer typhoons, with wind velocities of 20 m/sec at 100 km from the centre are the likely maximum wind speeds experienced in districts subject to typhoon conditions.

Winds of this velocity are common in New Zealand. Therefore, for most districts, shelter will be needed in excess of that provided for other pipfruit. Growers should adopt intensive sheltering practices similar to those used for kiwifruit, being careful to ensure adequate air drainage to avoid increasing the frost problem.

As with other fruits, hail will cause severe damage, so sites prone to hail should be avoided.

2.3 ROOTSTOCKS

The best soils for Asian pears are deep, fertile, free-draining, easily worked and not too heavy. In these soils, *Pyrus pyrifolia* (*P. serotina*) seedlings will be the most suitable rootstock. In Korea, *P. pyrifolia* is recommended (McKenzie, 1980).

In the U.S.A., many of the soils used for Asian pears are heavy calcareous clay soils and vigorous rootstocks such as *Pyrus betulaefolia* and *P. calleryana* are favoured. *P. pyrifolia* is not used in the U.S.A. because of its susceptibility to pear decline (Griggs and Iwakiri, 1977b).

Rootstocks suitable for Asian pears are as follows:

Pyrus pyrifolia (P. serotina)

* The main rootstock used in Japan.
* First choice wherever soils are suitable, needs good drainage - better than the traditional pear-growing soils used for European pears, but similar to those used for MM106 apple rootstock.
* Grown from seed, seedlings are very vigorous, so if planted too early may grow excessively large by budding time, hence grafting will be necessary.
* Its growth habit suggests it could be very precocious and crop from a young age.
* Does not tolerate a wet or heavy soil.
* Incompatible with European pears, causes black end of fruit.

Pyrus betulaefolia

* The birch-leafed pear, from Central and Northern China.
* Preferred rootstock in the U.S.A.
* Good tolerance of heavy and wet soils.
* Second major rootstock used for Asian pears.
* Used in Korea because of its resistance to 'Yuzuhada' (a physiological disorder causing rough skin) (McKenzie, 1980).
* Used in North and North-west regions of China because of its resistance to cold injury and tolerance of drought and alkaline soils (McKenzie, 1980).
* Raised from seed; seedlings are less vigorous than *P. pyrifolia* and in order to get to budding size the seedlings would need to be planted out earlier than *P. pyrifolia*.

* Seedlings are heterogeneous (Westwood, 1968).
* In California, gives a vigorous tree which may take a year longer than other rootstocks to start cropping (Griggs and Iwakiri, 1977b).
* Adaptable to clay and sand soils and to some diseases and insects (Table 3) (Lombard and Westwood, 1977).
* Has a high nutrient uptake of N, P, K (Lombard, Westwood, 1977).
* Crops heavily and maintains good fruit size as the tree matures.
* Hardier than *P. calleryana*.
* In New Zealand, it should be considered as second choice to *P. pyrifolia* for use where soil texture and drainage characteristics are marginal for *P. pyrifolia* (e.g. clay soils).
* Incompatible with European pears.

Pyrus calleryana

* The South China pea pear.
* Used in China and the U.S.A. and a few in Japan.
* Characteristics are similar to *P. betulaefolia*, but is less tolerant of wet soils in poorly drained areas.
* Less vigorous than *P. pyrifolia*.
* Does not tolerate soils with high pH and high lime content (Westwood, 1982).
* Susceptible to freeze damage, trees should be low-budded and planted in the orchard with the bud union 7.5 - 10 cm below ground level (Westwood, 1982).
* Has a high uptake of nutrients, potassium, calcium, boron (K, Ca, B) (Lombard, Westwood, 1977).

Pyrus communis

* Seedlings; William Bon Chretien and Winter Nelis are widely used in the U.S.A.
* Less vigorous than *P. betulaefolia* and *P. calleryana*.
* Satisfactory in most U.S.A. areas, but tend to lose vigour with maturity, hence attaining good fruit size is difficult.

* Planting 1 year old nursery trees, most varieties produce fruit in their fourth year (Griggs and Iwakiri, 1977b).
* Prefer sandy soils and good tolerance to wet or dry soils (Lombard and Westwood, 1977).
* Susceptible to fire blight (*Erwinia amylovora*).
* Problems with biennial bearing.
* Now losing favour in the U.S.A. to *P. betulaefolia* which has better tree vigour and maintains fruit sizes as trees mature.
* More susceptible to pear decline.
* Does not like alkaline soils.
* White (1983) reports that U.S.A. growers are now working their W.B.C. stocks over to Asian pears and expects Asian pears to perform better in New Zealand on this stock than they have in the U.S.A.

Quince

* Asian pears are incompatible with quince and would require a compatible interstock for propagation on this rootstock.
* Trees will be very weak growing.
* Give low yield performance and suffer poor fruit size.
* Not recommended.

2.4 PROPAGATION

The main rootstocks are raised from seed, which may be sown fresh without drying. Once dried (usually the case in New Zealand), the seed develops dormancy. Dormancy may be broken by cold stratification for 45 to 90 days in damp peat at 2°C prior to sowing. Seedlings lined out in the spring should be large enough to bud in the following autumn. Seedlings from seed sown fresh in the autumn could

Table 3: Horticultural characteristics and relative susceptibility of *Pyrus betulaefolia* and *P. calleryana* to various problems.

Variable	*P. betulaefolia*	*P. calleryana*
Tolerance to:		
Wet soils	Very good	Very good
Dry soils	Very good	Good
Lime-induced chlorosis	Fair	Fair
High nutrient uptake	N, P, K	K, Ca, B
Fruit quality of grafted scion	Poor (Anjou) Very Good (Seckel)	Very good
Fruit size of grafted scion	Very large	Large
% of standard tree size	120	95
Yield efficiency	Poor	Very good
Susceptibility[z] to:		
Fire blight	0	0
Pear decline	0	2
Winter injury	2	3
Pear root aphid	0	0
Root lesion nematodes	3	0
Phytophthora rot	-	1
Soil preference	sand to clay	sand to clay

[z]Scale: 0 = not susceptible, 3 = susceptible.
(Source: Lombard and Westwood, 1977: Pear rootstock and *Pyrus* research in Oregon. *Acta Hort.* 69: 117-122.

(Shen, T. 1980. Pears in China, *Horticultural Science* 15(1): 1-17.

be grafted the following spring if large enough.

Pyrus pyrifolia seedlings can be very vigorous and if budded too early in the autumn may over-grow the bud. In delaying budding care must be taken not to leave it too long in case the bark becomes difficult to lift. As with other pipfruit, trees are usually planted in the field as 1 year old whips.

2.5 FERTILISATION

In Japan, the recommended fertilisation of Nijisseiki pears is 160, 130 and 120 kg per hectare per year of nitrogen (N), phosphate (P_2O_5) and potassium (K_2O) respectively. This is applied twice a year, just after harvest and early spring. Mulching with rice straw is common (Uraki, 1982).

The climate of Japanese pear growing areas is wet and hot during summer and therefore the soils are easily leached while the fruit is growing, hence growers tend to apply more manure and chemical fertilisers (Uraki, 1982).

Under New Zealand conditions, a fertilisation programme similar to that used for European pears should be adequate. Table 4 shows fertiliser soil test readings which are considered satisfactory for European pears.

Table 4: European pears - soil test.

pH	Calcium (Ca)	Potassium (K)	Phosphorus (P)	Magnesium (Mg)
5.8-6.5	5-10	7-10	60^+	12-15

2.6 VARIETIES

2.6.1 Imported Varieties

The first varieties of Asian pears were imported into New Zealand from Japan by Mr Malcolm Clow (Tauranga nurseryman) in 1977 followed by DSIR imports in 1978.

Of the 35 varieties for which import permits have been issued since 1977, only 17 have been released from quarantine, 1 in 1979, 5 in 1980, 1 in 1982 and 10 in 1983 (Table 5).

Of these varieties, Hokusei, Hokkan and Hokuho are available for evaluation only to DSIR and cannot be obtained commercially as yet.

None of the other varieties released from quarantine are subject to Plant Variety Rights or patent protection. Apart from the three listed above, all the cultivars introduced by the DSIR are made available immediately to the industry via the New Zealand Nurserymen's Association (NZNA). Varieties introduced by other importers are made available by the importer in accordance with the Plant Quarantine Act.

The initial slow release through quarantine was because all except two varieties were found to be virus infected. Heat therapy treatment to eliminate the viruses added 1-3 years to their time in quarantine (White, 1981).

Maintaining very strict quarantine regulations is essential to prevent the entry of new diseases/pests into New Zealand.

Table 5: Asian pear varieties imported into New Zealand.

Variety	Source	Importer	Year Imported	Released in N.Z.
Bong Ri	Korea	D.H.P.	1979	1983
Choju	Japan	D.H.P.	Permit issued	
Chojuro	Japan	D.H.P.	1978	
Dan Bae	Korea	D.H.P.	1981	1983
Doitsu	Japan	D.H.P.	1981	1983
Gion	Japan	D.H.P.	1980	1983
Hakko	Japan	D.H.P.	1979	1983
Hayatama	Japan	D.H.P.	1979	1983
Heishi	Japan	D.H.P.	1981	
Hosui	Japan	Clow	1977	1980
Hokkan	Japan	D.H.P.	1981	1983
Hokuho	Japan	D.H.P.	1981	1983
Hokusei	Japan	D.H.P.	1981	1983
Hwa Hong	Korea	D.H.P.	1981	1983
Inamura-aki	Japan	D.H.P.	1980	
Kikusui	Japan	D.H.P.	1979	1982
Kimizukawase	Japan	D.H.P.	1980	
Kosui	Japan	Clow	1977	1980
Kumoi	Japan	D.H.P.	1980	
Niitaka	Japan	D.H.P.	1981	
Nijisseiki	Japan	Clow	1977	1980
Okusankichi	Japan	D.H.P.	1980	
Pal Dal	Korea	D.H.P.	1979	1980
Ping Ding Li No. 7	U.S.A.	P.D.D.		
Seiyoki	U.S.A.	Duncan and Davies	1981	
Shinko	Japan	D.H.P.	1981	
Shinseiki	Japan	D.H.P.	1978	1979
Shinsui	Japan	Clow	1977	1980
Suisei	Japan	D.H.P.	1980	
Tama	Japan	D.H.P.	1980	
Tsu-Li	U.S.A. (Chinese)	Duncan and Davies		
Wase-aka	Japan	D.H.P.	1980	
Wha Hong	Korea	D.H.P.	Died	
Yakumo	Japan	D.H.P.	1978	
Yi-Li	U.S.A. (Chinese)	L.H.R.C.	1978	

D.H.P. = Division of Horticulture and Processing, D.S.I.R.

P.D.D. = Plant Diseases Division, D.S.I.R.

L.H.R.C. = Levin Horticultural Research Centre, M.A.F.

Clow = Privately imported by Mr M. Clow, Nurseryman, Tauranga.

(Source: White, A., 1981 - "Progress with Asian Pears". The Orchardist of New Zealand, Sept. 1981.)

A wide range of varieties have been imported for three main reasons:

1) Experience with other crops indicates that varieties developed in other countries often perform differently when grown in New Zealand.

2) Because of New Zealand's interest in exporting, varieties require the ability to withstand packing, storage and transport over great distances, and often varieties developed for home market consumption are not suitable.

3) A range of varieties more suitable for growing in our southern regions have been introduced. Varieties such as Hokuho, Hokkan and Hokusei have been selected for their late blossoming characteristics and suitability for areas where spring frosts occur (Wilton, 1981).

2.6.2 New Crop Scheme

Varieties recently imported into New Zealand on release from quarantine have been put immediately into a two-phase bulking-up programme to produce trees for establishing plantings under the New Crop Scheme as soon as possible. The objective of this scheme is to establish small blocks of potentially important varieties over a wide range of conditions to speed up commercial assessment of the new crop.

One phase of the bulking-up programme is using an accelerated multiplication technique by budding all year round under controlled environmental conditions. The other phase is using a shoot proliferation technique developed by

the Tissue Culture section of Plant Physiology Division, DSIR. Both techniques are performing well with the material already released from quarantine, although more information on the rates of genetic draft and mutation is required before the trees from the tissue culture programme can be used in commercial plantings (White, 1981).

Based on the New Crop Scheme trial plots have been established in districts with most potential for Asian pears. Initial plantings were made in 1981 on five DSIR Research Orchards: Kumeu, Te Puke, Havelock North, Nelson and Earnscleugh (White, 1981).

To further aid assessment, the DSIR has established field trials on private orchards on a contract basis. The first plantings occurred in 1981 and 1982 on orchards in:

* Nelson (2) (J. Fon and Hoddy's Orchard).
* Christchurch (W. Mottram).
* Hawkes Bay (2).
* Bay of Plenty.

The DSIR intends to extend contracted trial plantings on growers' properties to other districts during 1983 or 1984, to include:

* Central Otago.
* Taranaki.
* Waikato.
* Auckland (Wilton, 1983).

The DSIR Contract with Private Growers

* 5 Varieties: Hosui, Nijisseiki, Shinseiki, Shinsui and Kosui; 10 trees of each variety on each property.
* No propagation material from these trees is to be taken without approval of the DSIR. Prunings must be collected and given to the DSIR or approved nurserymen to aid in the bulking up of propagation material.
* Trials established for variety evaluation purposes, DSIR has first access to the fruit.
* The DSIR may continue to use the fruit from these trees for experimental purposes until a written release is issued.

The contract does not specify a training system for the trees. Most growers are using the central leader system but J. Fon (Riwaka, Nelson) is using a Tatura trellis.

2.6.3 Propagation Material Availability

Commercial plantings of Asian pears have been hindered by the unavailability of scionwood. The first major release of trees and budwood is to occur in 1984 by the importer Mr Clow of what are thought to be the most promising varieties: Hosui, Kosui, Nijisseiki and Shinsui. Since their release from quarantine in 1980, Mr Clow (Tauranga nurseryman) has been bulking up budwood in anticipation for their release in 1984 when it is expected that 22,000 trees and 40,000 buds of these four varieties will be available

(Lyford, 1983). (Most of the 22,000 trees to be released have been pre-ordered.)

To assist with the bulking-up programme, Mr Clow has contracted with 10 major nurseries throughout New Zealand, via the NZNA, for the distribution of propagation material.

Major points of Mr Clow's contract:

1) Asian pear trees will be sold for $13.50 each, equivalent to the price of avocado and persimmon trees.
2) Asian pear trees are to be sold in minimum orders of 100 trees, from these 10 nurserymen.
3) Growers, growing rootstocks and requiring propagation material of these four varieties, will be able to purchase buds for $4.00 each. For this cost, the nurserymen will bud/graft the rootstocks on the grower's property to his specifications.

These controls have restricted the growth of the industry and helped to ensure that only quality budwood is used.

Many growers have planted rootstocks of *Pyrus pyrifolia* or *P. betulaefolia*, obtained from W. Parker, Te Puke, Nurseryman, for $1.60 each as seedlings 8-10 cm high grown in small containers.

These should be grown on in a nursery area, budded or grafted later and planted out in the field as 1 year old whips.

The availability of rootstocks is likely to increase rapidly from 1985-88 as more nurserymen begin propagating (Table 6), hence the price is likely to decline.

Table 6: Predicted growth of the New Zealand Asian pear industry.

Year	Trees (available)	Rootstocks (available)
1981	100 *	
1982	300 *	5,000 1+
1983	400 *	20,000 1+
1984	22,000 2+	40,000 +
1985	20,000 +	80,000 +
1986	30,000 +	100,000 +
1987	60,000 +	100,000 +
1988	150,000 +	80,000 +

* Trees planted by DSIR or contract growers by the DSIR for trials.

1+ Rootstocks, W. Parker (R.D. 2, Te Puna, Tauranga, Nurseryman) had available, mainly distributed to other nurserymen throughout New Zealand for growing on lines (Parker, 1983).

2+ Trees due for release by Mr Clow (R.D. 6, Tauranga Nurseryman) via 10 selected nurserymen (Simpson, 1983).

+ Estimates of likely increases in trees and rootstocks.

The initial high cost of trees, $13.50 (of the four varieties Mr Clow holds), will mean many growers will buy rootstocks and bud/graft them to reduce costs to $5.60. But growing these on for 2 years will cost the grower $2-$4.00 each, increasing overall cost to $8.60, so a significant saving of $3.90 is made per tree (freight excluded). As the supply of trees increases, their price is likely to decrease, so initially higher numbers of rootstocks will be planted by growers and nurserymen as growing-on lines, but later greater

numbers of trees will be planted, from 1988 onwards.

Simpson (1983) suggests that prices of trees for varieties not subject to Mr Clow's contract should be priced from $4.50 - $6.50 each (only slightly higher than normal pipfruit to cover the extra costs incurred in propagation).

2.6.4 Variety Characteristics

The Japanese produce a wide range of varieties which spreads the season of production from 20th July to 10th November (Fig. 2). Kimizukawase is the earliest maturing variety and Okusankichi the latest. The season peaks from August-October.

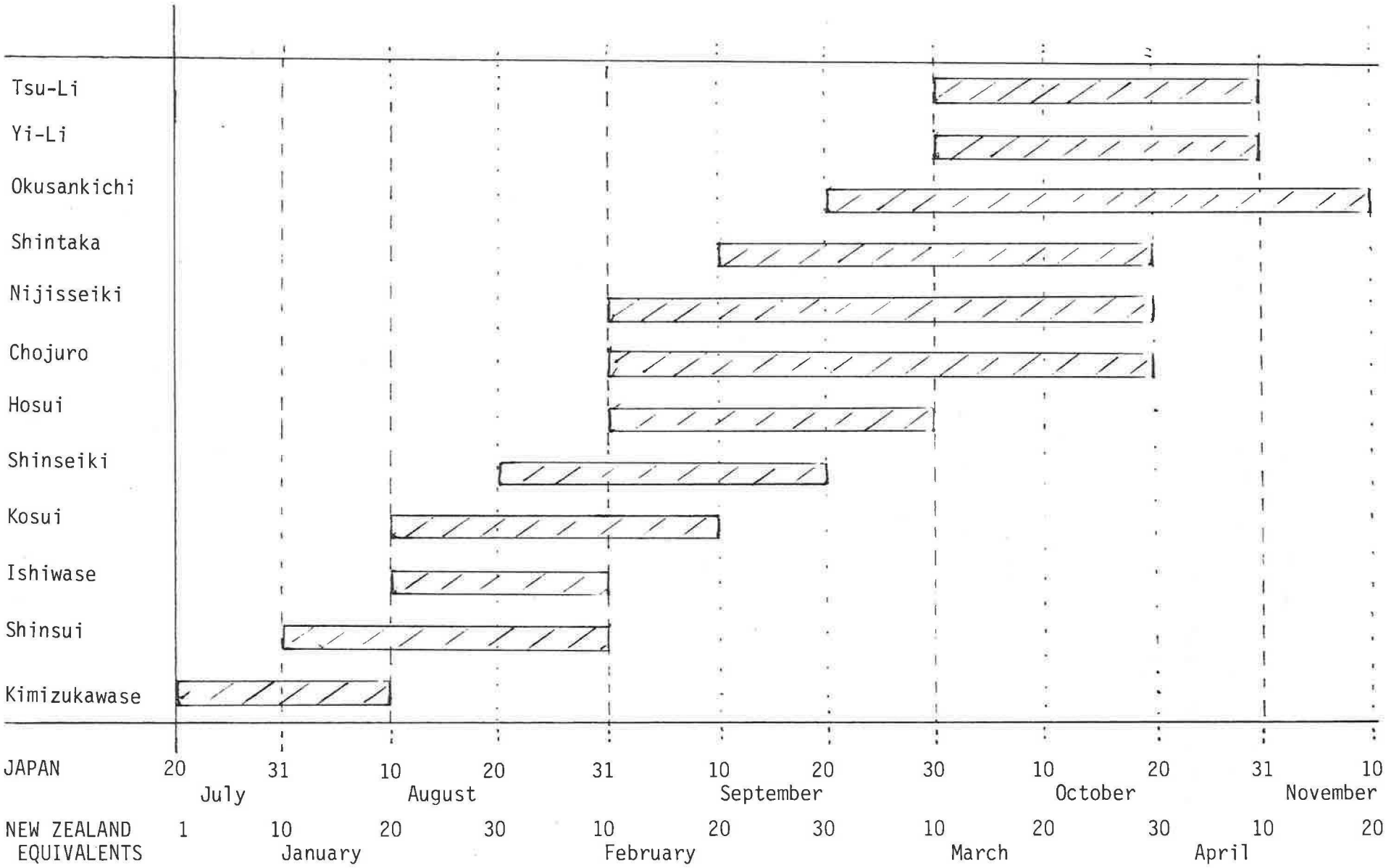
Japanese horticulturalists classify their varieties according to skin colour and russeting:

* Green-skinned varieties usually are free of russeting and some turn yellow upon ripening.
* Russet-skinned varieties are brown, yellowish-brown or greenish-brown.

The following descriptions and recommendations are based on information available from Japan and the U.S.A. (apart from the 5 varieties which fruited in New Zealand in 1983).

The varieties which have fruited in New Zealand are: Shinsui, Kosui, Shinseiki, Hosui and Nijisseiki. All have produced fruit up to and above the quality standards recognised in Japan (White, 1983).

Figure 2 : Harvest periods of the main Asian pear varieties.



(Source: Kitson, 1982)

Registered dates are those when the varieties were officially recognised in their country of origin, while release dates apply to varieties free from quarantine in New Zealand.

2.6.4.1 Early Season:

Shinsui (Kikusui x Kimizukawase)

* Registered 1965.
* Best quality early season Japanese variety.
* Fruited 1983 season in New Zealand, matures mid-January.
* Ripens 10 days earlier than Kosui in Japan.
* Fruit russet brown, small to medium size, flat, round shape.
* Flesh very sweet, juicy, moderately gritty.
* Excellent quality (although resistance to blackspot and productivity is less than with some other varieties).
* 30% of new plantings in Tottori Prefecture (main Asian pear district in Japan).
* Should be included in plantings.
* Initial distribution of wood by M. Clow.

Kosui (Kikusui x Wasekozo)

* Registered 1959.
* Fruited 1983 season in New Zealand, matures late January to early February.
* Fruit partial golden russet, medium size, very sweet, tender crisp flesh, very juicy, excellent quality.
* Flower bud formation is sometimes often not at its maximum, resulting in lower yields.
* A major variety in Japan, along with Hosui and beginning to supersede Nijisseiki.
* Recognised in Japan as best quality commercial variety.

* Should be included in plantings.
* Initial distribution of wood by M. Clow.

Hayatama (Kimizukawase x Gion)

* Registered 1968.
* Earliest Japanese variety to mature. Probably early January in New Zealand.
* Fruit is russet brown, small to medium size, firm sub-acid flesh, poor keeping quality.
* Variety most likely only of use for the local market.
* Importer - DSIR - released 1983.

Hakko (Yakumo x Kosui)

* Registered 1972.
* Same season as Shinsui, late August in Japan, ripens slightly earlier than Kosui.
* Fruit greenish yellow, large size, flesh sub-acid, good quality.
* A new Japanese variety, not as popular as Shinsui but worth trying.
* Importer - DSIR - released 1983.

2.6.4.2 Mid-Season:

Chojuro

* Discovered 1889 as a chance seedling.
* Smooth golden russet type with gritty texture.
* Medium size, sweet, very gritty, stores well.
* Strongly resistant to pear scab (*Venturia nashicola*) and blackspot (*A. kikuchiana*).
* In Japan, it is losing popularity because it is an old variety.
* Not recommended.

Nijisseiki (20th Century)

* Discovered 1888.
* Main mid-season variety, ripens 10-15 days after Chojuro, follows after Hosui, late February.
* Clear, greenish-yellow skin, free from grittiness, good eating quality.
* Susceptible to blackspot.
* Medium size, moderately sweet and juicy.
* Fruited in New Zealand in 1983.
* Most important traditional variety in Japan, still popular, but declining in favour of Kosui and Hosui.
* Known to store well in C.A. storage.
* Should be included in plantings.
* Initial distribution by M. Clow.
* This variety has been imported into New Zealand before M. Clow's introduction, so material is being heat-treated for virus and upon confirmation of the fruit type, wood will be available in 1983.
* In Japan, this variety is bagged as the clear yellow skin is very subject to fruit skin rubbing not only on the tree, but also during handling and transport.
* Is the only variety exported from Japan.

Choju (Asahi x Kimizukawase)

* Registered 1976, russet type.

Hosui (Kikusui x Yakumo) x Yakumo

* Registered 1972
* Fruited at Havelock North Research Orchard.
* Mid-season variety, maturing mid-February.
* Full golden brown russet type.
* Medium to large fruit size, high flavour, very sweet, tender, crisp, very juicy.
* Excellent quality.
* The most important new cultivar in Japan.

* Its cultivation is easier than Shinsui and Kosui.
* Should be included in plantings.
* Initial distribution by M. Clow.
* Very high water content - subject to water core problems and reputed to last only one week after harvest.

Kikusui (Taihaku x Nijisseiki)

* Mid-season variety, matures mid-February.
* Fruit green-yellow, medium size.
* Flesh soft, high flavour, excellent eating quality.
* This variety is being planted in the U.S.A., worth trying.
* Importer - DSIR - released 1982.

Shinseiki

* Fruited in New Zealand, season similar to Kosui.
* Fruit yellow, thin skin, medium size, firm flesh, sweet, medium eating quality.
* Skin is very susceptible to damage.
* Should be included in plantings as a pollinator.
* Importer - DSIR - released 1979.

Doitsu

* Mid-season variety.
* Fruit brown russet type.
* Flesh sweet, juicy, coarse, gritty, fair quality.
* Grown in California.
* Probably no commercial value in New Zealand.
* Importer - DSIR - released 1983.

Gion (Chojuro x Nijisseiki)

* Mid-season variety.
* Not widely planted in Japan. Little information available.
* Importer - DSIR - released 1983.

2.6.4.3 Late Season:

Mishirazu (chance seedling of Chinese pear)

* Chinese pear-shaped, yellowish green
* Large size, average weight 370 gm.
* Flesh coarse, juicy, sweet, not so good quality.
* In Japan, matures mid-October (early March, New Zealand). Stores about 2 months, keeps well in cold storage.
* Well adapted to a wide range of soils and cold climatic conditions.
* Leading cultivar in Hokkaido, Japan.
* Very cold-resistant, temperatures down to -28°C.

Hokusei (Mishirazu x Nijisseiki)

* Registered 1966.
* Late season variety, developed for cold resistance, matures probably early March.
* Fruit yellow, medium size (250 gm), sub-acid, good quality, coarse flesh.
* Stores well (keeps 3-4 weeks in common storage).
* May be of interest for colder regions.
* Importer - DSIR - released 1983, but only available for experimental testing.

Hokkan (Chojuro x Mishirazu) x Nijisseiki

* Late season, cold-resistant variety from same programme as Hokusei (early March, New Zealand).

* Fruit green yellow, flesh sweet, crisp - tender, juicy, good quality.
* Best quality of cold-resistant series.
* Stores about 30 days.
* Importer - DSIR - released 1983, only available for experimental testing.

Hokuho (Mishirazu x Chojuro)

* Large (290 gm) late-season, cold-resistant variety.
* Fruit yellow, russetted, coarse, juicy sub-acid flesh, thick skin, rough with the russet.

* Stores about 15-20 days.
* Very productive.
* Importer - DSIR - released 1983, only available for experimental testing.

Niitaka

* Full russet type.
* Very large size, good quality, sub-acid flesh.
* Stores well.

Shinko

* Full russet type.
* Medium size, sub-acid.
* Stores well.

Okusankichi

* Traditional cultivar.
* Brown-russetted fruit.
* Very large, firm, sweet, medium quality.
* Keeps well in storage.

Dan Bae, Hwa Hong, Bong Ri

* Three of the best Korean varieties.
* Descriptions not available.
* Importer - DSIR - released 1983.

Kosui and Hosui have better eating qualities than Nijisseiki, which in turn has better quality than Chojuro. Wilton (1981) reports that Hosui commands double the price of Chojuro. Kosui and Hosui have a price advantage over Nij isseiki as they do not require fruit bagging. Seike (1973) outlined the characteristics of the main Japanese pear cultivars (Appendix 1). Appendices 2 and 3 show fruit characteristics of Asian pears recorded at Davis, California.

2.6.5 Major Commercial Varieties in Japan

The two major varieties, Nijisseiki and Chojuro, were predominant in the 1960s, but in the 1970s new varieties such as Shinsui, Kosui and Hosui gained favour. It is expected that these three varieties will constitute 30% of the total planted area in the 1980s.

Table 7 shows changes in planted area of the major varieties from 1929 to 1981.

2.6.6 Breeding of Asian Pears in Japan

The first commercial varieties developed in Japan were Chojuro and Nijisseiki (20th Century) in 1889 and 1888 respectively.

Table 7: Changes in planted area of Asian pear cultivars (ha) in Japan.

Cultivar	1929	1936	1947	1953	1958	1974	1981 (a)
Chojuro (b)	5,042	5,376	2,168	3,087	4,876	5,936	5,303
Nijisseiki (c)	844	1,527	1,978	3,363	5,503	6,675	7,054
Wase-aka	1,637	1,446	854	748	575	-	-
Okusankichi	1,141	1,115	666	554	453	123	97
Yakumo		232	257	526	770	456	482
Kikusui		248	202	480	270	168	134
Shinsui (d)						705	2,435
Kosui (e)						1,414	4,024
Hosui (f)						361	2,160
Shinko				71		271	315
Total	11,138	12,169	7,076	9,873	14,700	18,773	24,732

(a) Estimate.
(b) A leading variety of russet fruit type.
(c) A leading variety of green fruit type.
(d) Variety released from Fruit. Res. Sta. in 1965.
(e) Variety released from Fruit Res. Sta. in 1959.
(f) Variety released from Fruit Res. Sta. in 1974.

(Ref. Machida, Y., 1979, 'trend of Breeding Works for Japanese Pear in Japan'. Japan Agr. Res. Quarterly 13(4): 234-237.)

New cultivars combining the resistance to disease of Chojuro and the fruit quality of Nijisseiki have been in demand. A systematic breeding programme was started in 1915 by Kikuchi and has continued ever since at the National Fruit Tree Research Station, Japan (Machida, 1979).

Varieties to be developed by the first hybridization programme were Kumoi and Suisei, released 1955, and Kosui in 1959. Released from the second hybridization programme in 1965 was Shinsui, a russet type ripening 10 days earlier than Kosui. After a further 8 year adaptability test, Hakko and Hosui were released in 1972 and in 1976, Choju, a very early maturing russet type, was released (Machida, 1979). A measurement of flesh firmness was proposed as a simple method of quantitative expression of texture, rather than assessment of density of stone cell clusters (Machida, 1979).

2.6.6.1 Breeding Process: About 10-20 intraspecific crosses are made each year to improve current cultivar characteristics.

Approximately 100 seedlings are produced from a cross, 50% are culled at the 25 cm stage in the glasshouse for susceptability to blackspot (resistance is a recessive character). The balance are then planted out in the field for testing. Assessment and selection on the fruit is carried out as follows:

1) Texture - Magness-Taylor penetrometer must be less than 2.4 kg, a correlation between the pressure test and level of stone cells exist.

2) Brix test greater than 12%.

3) pH must be less than 4.8.

4) Fruit size must be in the order of 250-300 gms.

5) Fruit shape - oblate and even.

6) Self life must be longer than 7 days when picked at full maturity.

7) No preference between clear and russet skin types.

8) Self compatability is required.

Assessment is made in the field for resistance to pear scab (*Venturia nashicola*) and rust (*Gymnosporangium haraeanum*) along with cropping factors.

For assessment, seedlings are planted at about 2,500/ha (5 m x 0.8 m). On average, one new cultivar is selected from every 2,000 seedlings over a time period from the original cross of about 10 years.

2.6.6.2: Breeding Recommendations for New Zealand: In the long-term, New Zealand will need to develop a range of late-maturing varieties with good keeping qualities for export to the Northern Hemisphere markets during their early summer period.

Dr Kajiura in Japan has found that late-maturing varieties from the northern regions contain the characters for long storage. Japanese breeders have concentrated their attention on the large-fruited, early maturing types which characterise the species in the southern islands of Japan, but these do not have the same long-term storage characteristics of the northern selections.

Dr Kajiura claims that it would be difficult to introduce late maturity and long storage factors into the high quality new varieties and suggests using the late maturing, long storage variety Okusankichi in crosses with Hosui, Kosui and Kikusui (White, 1982).

2.7 PLANTING SYSTEMS

In Japan, a pergola system giving a continuous single layer canopy at 1.6 m height, with trees at 6 x 6 m spacings, is widely used. This system gives very high fruit quality, protection against wind and snow damage. A canopy height of 1.6 m means that ladders are not required. Japanese trials indicate that yields are about 20% higher from trellised systems compared with free standing open centre trees, and that fruit size, for a given crop loading, is better from the single layer canopy tree. Increased orchard establishment cost is the main disadvantage. The wide tree spacing (6 x 6 m) means a relatively long initial non-productive period occurs.

Wilton (1981) reports that more intensive plantings (2 x 4 m), trained on an upright support, central leader system, are under test at Japanese research stations.

In the U.S.A., Asian pears are traditionally grown as free-standing vase-shaped trees, similar to European pears or apples. Recent plantings are tending towards closer hedge-rows.

Possible planting systems for New Zealand will be similar to those used for apples and may be broadly grouped into trellis or non-trellis systems.

2.7.1 Trellis Systems

(a) Pergola

* A New Zealand equivalent of the Japanese system.
* To overcome the problems of low initial yield associated with the low density (6 x 6 m) spacing used in Japan, it will be necessary to decrease the "in row" tree spacing to raise tree density to that of an intensive or semi-intensive orchard.
* Adopting a 2-leader tree configuration and training these two leaders at right angles to the row direction as in the Tatura trellis, it should be possible to bring "in row" spacing down to the 2 - 2.5 m range, yet still retain what is physiologically a very similar tree to the radial leader tree from Japan.
* Trees should be headed at about 1 m above ground and taking the two leaders up on a 20-30^{o} slope above horizontal to meet mid-row.
* Between-row spacing could be 5-6 m.

(b) Tatura Trellis

* Standard Tatura system similar to that described for stonefruits.
* Tree spacings 1-1.5 m x 5-6 m.
* Two leader Y-shaped tree with leaders sloping 60^{o} above the horizontal, maximizes light and available area. 1 ha planted gives a 2-ha canopy.
* Would require more ladder work than pergola system.
* Rows planted north-south to give best daily sunlight.
* In-row pollinators necessary, pollination may be a problem.

The trellis systems are expensive to establish, but should improve fruit quality and, in the case of the more horizontal systems, make thinning and harvesting easier. Wilton (1980) comments that in terms of maximising early yields, the Tatura trellis concept of wide rows and close in-row spacing may be the best option for this crop.

Lyford (1983) suggests that as with other pipfruit and kiwifruit in New Zealand, too much emphasis is placed on comparing the different training systems, while the selection of rootstocks and varieties are the two major factors influencing orchard profitability.

Nevertheless, training systems, rootstock and variety selections cannot be considered in isolation.

2.8 POLLINATION

As with European pears, Asian pears will require pollinators to be included in the orchard layout.

In Japan, considerable importance is placed on the need for cross-pollination. Often hand pollination is used due to the scarcity of pollinating insects. White (1981) reports that Shinsui, Nijisseiki and Hosui are self-incompatible. Shinseiki and Kosui are suitable pollinators of these three varieties, but Shinseiki has lower fruit quality.

In California, it is claimed that Kikusui and Shinseiki range from partly to nearly commercially self-fruitful under the most favourable conditions. Chojuro, Nijisseiki, Kikusui, Shinseiki and Okusankichi have overlapping blossom periods and produce adequate amounts of viable pollen.

(c) Lincoln Canopy

* Standard system as described for apples.
* Tree spacings 2.4 m x 4-4.5 m.
* Even fruit colour and maturity.
* Trees close to the ground, low labour and potential machine harvest.

(d) Ebro

* System as described for intensive apple planting.
* Tree spacing 2.4-3.0 m x 3.6-4.2 m.
* High establishment cost, but high density means returns are faster.

2.7.2 Non-Trellis

(a) Intensive

* Hedgerow plantings.
* Tree spacing 1-2 m x 4.5 m.
* Would require detailed management practices to keep the tree's growth habits under control, possibly suitable for less vigorous rootstocks.

(b) Semi-Intensive

* Central leader, tree spacing 3-4 m x 4.5-6 m.
* Problem centre of tree bears few fruit.
* Maximum dollar return for dollar spent.

(c) Axe

* Spindle bush system.
* Tree spacing 2 m x 5 m.
* May not be particularly well suited to Asian pears due to their relatively strong tree vigour.

The free-standing systems offer the advantage of lower establishment costs, but may suffer greater problems with fruit quality and cost more to thin and harvest.

Hence, with the exception of Nijisseiki and Kikusui, combinations of these three varieties interplanted in an orchard, should serve as satisfactory pollinators for each other (Griggs and Iwakiri, 1977b). European pears, Williams Bon Chretien (Bartlett) are reported to pollinate Asian pears provided their blossom periods coincide.

In California, Bartlett pears' blooming period overlaps Asian varieties, and is an effective pollinator (Griggs and Iwakiri, 1977b) (Appendix 4).

The Chinese varieties Ya-li and Tsu-Li are self-incompatable. Their blossom period coincides with other varieties such as Shinseiki, Chojuro, Nijisseiki and Kikusui, providing good cross pollination (Table 8).

Table 8: Cross pollination of Asian pear varieties (40% fruit set).

Variety to be Pollinated	Pollinators
Shinseiki	Chojuro, Nijisseiki, Kikusui, Ya-Li, Tsu-Li, W.B.C.*
Chojuro	Doitsu
Nijisseiki	Shinseiki, Ya-Li, Tsu-Li W.B.C.
Doitsu	Shinseiki, Tsu-Li
Kikusui	Doitsu, Tsu-Li, W.B.C.
Kumoi	Shinseiki, Nijisseiki, Kikusui, Tsu-Li
Ya-Li	Nijisseiki

*W.B.C. (Bartlett pear in the U.S.A.)

(Source: Asian Pear Varieties in California, test conducted at Davis, 1965-1976. Griggs, Iwakiri, 1977b.)

Wilton (1983) suggests that in New Zealand where solid blocks of a single variety are being planted, the quantity of pollinator trees can be minimised by using the standard 1:8 ratio of every third tree in every third row. Commence planting the pollinators in the second row from the headland, and the second tree from the end of the row. This pattern allows each tree to be adjacent to a pollinator.

In hedge row plantings there is some evidence that bees tend to work up and down a row. Therefore, it is suggested that every 6th or 7th tree in the row should be a pollinator. At least one strong hive of honey bees is required to each 0.4 ha of trees (Griggs and Iwakiri, 1977b).

2.9 THINNING

Fruit thinning is a standard practice with Asian pears to improve fruit size. Practically all cultivars set clusters of 3-6 fruits on a single spur. Generally clusters are thinned to one fruit (occasionally 2, depending on the tree loading).

In Japan, the aim is for a fruit size of around 350 g. A fully grown tree of Nijisseiki would be expected to carry about 700 fruits of this size (Wilton, 1980). White (1982) reports that fruit thinning occurs 2-8 weeks after full bloom, and is the most critical management factor affecting fruit quality (appearance and size). A rule-of-thumb guideline is 13-20 fruits per square metre of pergola, with 20-30 average sized leaves per fruit.

Uniformity of fruit, with a round oblate shape, is preferred. A range of shapes from oval to oblate occur along with misshapen fruits as a result of inadequate seed numbers, insect and pest damage and somatic mutations. Flower location in a cluster affects fruit shape. Primary and secondary flowers produce rather flat fruit, whereas sixth and seventh flowers produce a longer fruit. Selection of the third or fourth fruitlets during thinning is recommended. Chemical thinning is not yet practised in commercial orchards in Japan. Recent research (Miki *et al.*, 1981), using 10 ppm Bendroquinone 5 days prior and up until flowering, resulted in almost complete flower abscission. When applied after flowering, 100 ppm was required to induce fruitlet abscission on Nijisseiki. Flower abscission was greatest in the varieties Hakko, Kikusui, Nijisseiki x Ya-Li and Seiryu and less in Shinsui, Shinsetsu and Gion.

In the meantime, pending further research, hand-thinning will need to be used by New Zealand growers. Appendix 5 shows the schedule of thinning and other orchard management practices annually for an Asian pear orchard.

2.10 PRUNING

Japanese pear trees generally have a spur-bearing habit similar to apples and pears, and regular shortening back of lateral shoots to 25 cm is required to regenerate new growth and stimulate spur formation. This pruning also serves as an economical method of fruit thinning in the pre-blossom period.

Intensive spur pruning is generally identical with the regulated system used on European pears in other countries (McKenzie, 1980). However, additional summer pruning is sometimes practised, especially on strong growing trees or on some cultivars which tend to produce relatively few spurs (e.g. Kosui).

In general, Asian pear twigs are thicker and more rigid than those of European pears, and can carry heavier weights without breaking or bending. Long, vertical shoots are removed entirely, but upright shoots of moderate vigour are often tied down to the trellis to induce fruit-bud formation.

The principles of pruning are similar whichever training system is used. Hosui, Shinsui and Nijisseiki are spur-type bearers and are pruned on a spur-replacement cycle. Kosui bears most of its fruit on second-year wood, so it is long pruned, as it tends to produce relatively few spurs (McKenzie, 1980).

In Japan, hard winter and summer pruning is required to ensure the correct leaf to fruit ratio (see Section 2.9 , Thinning). This ratio needs to be adjusted when using different training systems. If the same leaf/fruit ratio as used for the pergola system is used for the central leader and palmette systems, vegetative growth will be favoured over fruit development (White, 1982). The productive life of an individual spur is about 8-10 years, so only 10-12% of spurs need to be replaced each year.

2.11 FRUIT BAGGING

Fruit bagging is an essential operation in some districts in Japan for the control of *Alternaria kikuchiana* (Blackspot) on the variety Nijisseiki. It also helps in the control of some insect pests, and results in the blemish-free, smooth-skinned appearance of this variety. For varieties not susceptible to *A. kikuchiana*, bagging is not required, although it may be used to enhance fruit appearance. Full russet varieties are generally not bagged.

Bagging is the most labour-intensive of any operation on Asian pears, and is done twice; once after fruit thinning and a second time later in the season when the fruit outgrows the smaller bag (1,680 hours per hectare on the Nijisseiki variety; see Appendix 6).

White (1983) comments that it is unlikely bagging will be necessary in New Zealand for full russet varieties and even clear-skinned varieties. The reasons are two-fold:

i) *A. kikuchiana* is not recorded in New Zealand.

ii) Fruit from clear-skinned varieties in New Zealand appears clearer and less russeted than non-bagged fruit observed in Japan (possibly due to New Zealand's lower humidity and lower summer temperatures).

2.12 DISEASES AND PESTS

2.12.1 Major Diseases of Asian Pears

Pear Scab	- *Venturia nashicola*
Rust	- *Gymnosporangium asiaticum*
Blackspot	- *Alternaria kikuchiana*
Canker	- *Physolospora piricola*
Trunk Canker	- *Phomopsis fukushui*
Black rot	- *Botrysopheoria dothidea*
Nectria Canker	- *Nectria cinnabarina*
Fireblight	- *Erwinia amylovora*

Of the diseases, *Botrysopheoria dothidea*, *Nectria cinnabarina* and *Erwinia amylovora* are present in New Zealand (Wilton, 1983).

Pear blackspot is a serious disease in Nijisseiki culture and is controlled by bagging and 10 applications of organic copper sprays. Most of the cultivars with russet-type skin are resistant to blackspot. Pear rust disease on foliage (especially the leaf stalks) is found in all Japanese pear cultivars (McKenzie, 1980).

Asian pears are susceptible to fireblight (*Erwinia amylovora*) infection. Although most varieties are not as susceptible as European pears, a similar Bacteriocidal programme will be necessary during the blossom period to control the disease in New Zealand. Fireblight is absent from Japan (Griggs and Iwakari, 1977b).

Trunk canker (*Phomopsis* spp.) causes tree death especially under wet and cold conditions, and in recent years it has been found with increasing frequency in some cultivars such as Shinsui and Kosui.

A form of canker caused by *Nectria cinnabarina* may attack branches. In New Zealand, this disease has been recorded as causing twig dieback in peaches and nectarines in Hawkes Bay and other districts further south (Wilton, 1983). Wilton (1983) comments that Black rot (*Botryospheoria dothidea*) is relatively uncommon on pip-fruit in New Zealand, but is associated with fruit rot in kiwifruit. It has a wide host range, including many shelter belt species, where it tends to become saprophytic on decaying twigs. In Japan, black rot disease may cause serious damage to pear trees by attacking fruit, leaves and branches. Varieties such as Chojuro and Nijisseiki are susceptible, but Doitsu, Ishiiwase, Kikusui, Kumoi and Shinseiki are reported as being highly resistant to black rot (Plant Inventory No. 163, 1964) (Griggs and Iwakari, 1977b).

2.12.1.1 Reports of Fireblight on Asian Pear Stock in New Zealand: Although reported to be more resistant to fireblight than European pears under California conditions, fireblight has severely attacked 1 year old *Pyrus pyrifolia* seedlings on a Hamilton property during the 1982 spring. The seedlings grew vigorously and developed fireblight symptoms following warm wet weather in the November/December period. Few trees actually died, but many lost a substantial portion of their top and had to be cut back hard below the resulting cankers. Regrowth was strong and by the end of the growing season many trees were a metre or more in height. European pears on quince rootstock adjacent to the Asian

pear seedlings were unaffected by this fireblight outbreak (Wilton, 1982).

Nurserymen propagating Asian pears will have to pay careful attention to fireblight control in unfavourable weather conditions (wet weather with mean temperatures of 15°C or above). There is a danger of topworked trees being lost through fireblight attack on rootstock sucker growth arising below the graft. This risk could be minimised by:

* grafting as low to the ground as possible;
* rubbing out any rootstock shoots as soon as they appear;
* applying a full fireblight spray programme;
* good shelter to minimise wind damage to foliage;
* control of leaf chewing and sucking insects.

Damage could be associated with seedling juvenility.

Mature wood may be less susceptible than the seedling growth below (Wilton, 1982).

Appendix 7 shows recommended fireblight control measures for European pears.

2.12.2 Major Pests of Asian Pears

Oriental fruit moth	-	*Grapholitha molesta*
Oriental pear moth	-	*Monema florescens*
Codling moth	-	*Carpocapsa pomonella**
Peach fruit moth	-	*Carposina niponensis*
Citrus red mite	-	*Pananychus citri*

Two-spotted spider mite	-	*Tetranychus urticae**
European red mite	-	*Panonychus ulmi**
Kanzawa spider mite	-	*Tetrancychus kanzawai*
Reddish oraesia	-	*Oraesia excavata*
Akebia leaf-like moth	-	*Adris tyrannus amurensis*
Brown-winged green bug	-	*Plautra stali*
Brown-marmorated stink bugs	-	*Halyomarpha mista*
Oystershell scale	-	*Quadraspidiotus* spp.
Pear lace bug	-	*Stephanitis nashi*
Pear sucker	-	*Psylla pyrisuga*
Pear psylla	-	*Psylla pyricola Foerster*
Comstock mealy bug	-	*Pseudococcus comstocki**
Pear aphid	-	*Shizuphis piricola*
Totoricids	-	*Adoxophyes orana fasciata*
Leaf roller (light brown apple moth)	-	*Epiphyas postvittana**

(* Major pests likely to occur on Asian pears in New Zealand.)

The codling moth (*Carpocapsa pomonella* Linnaeus) is the principal insect pest of Asian pears, but is absent in Japan. It is a constant threat from petal fall until harvest, and a regular insecticide programme must be used, similar to that for apples and pears (Griggs and Iwakiri, 1977b).

The pear psylla (*Psylla pyricola* Foerster) is another pest of pear trees. Although the Asian varieties are subject to attack, they suffer much less damage than European pears (Griggs and Iwakiri, 1977b).

2.12.3 Sensitivity to Spray Chemicals

Asian pear cultivars appear sensitive to spray chemical injury and caution will be required in selecting the chemicals and formulations.

White (1983) reports that leaf scorching problems have been experienced on Asian pears in New Zealand, with Saprol and Malathion emulsions.

Japanese spray programmes include the following chemicals:

Fungicides	Insecticides/Miticides
Difolitan	Lorsban W.P.
captan	fenitrothion
thiophanate methyl	diazinon
mancozeb	dichlorvos
Thiram/ziram mixture	Dipterex
Bayleton	carbaryl
8-hydroxyquinoline copper	maldison
	Plictran
	Neoran
	Kelthane
	Mineral oil

In Japan, spray programmes make extensive use of 8-hydroxyquinoline copper (Oxine-copper). This is an organic copper compound with the copper ion linked with a chelating agent. Although more expensive than copper oxychloride it is less phytotoxic than inorganic copper compounds. Appendix 8 shows a recommended spray programme for Nijisseiki pears in Tottori, Japan.

2.12.4 Bird Protection

Wilton (1980) reports that bird damage is a number one problem for Japanese Asian pear growers (a more serious problem than in cherries).

Isolated blocks of Asian pears in Japan are protected with netting. As bird numbers in Japan appear relatively sparse compared to New Zealand, bird damage in dry seasons could be a major problem to be faced by New Zealand producers.

2.13 WEED CONTROL

The following details have been extracted from Japanese recommendations on chemical weed control:

simazine	1.5-3 kg/ha
Casoron G.	8-10 g m^2 (avoid contact with foliage or stem)
paraquat	1.5-2 kg " " " " "
diquat	1.5-2 kg " " " " "
Strel	20-30 l/ha " " " "
diuron and terbacil	1.5-3 kg/ha (do not apply to young trees)
amitrole and diuron	2-4 kg/ha " " " " "
Asulan	15-20 lg/ha " " " "
diuron	1.5-3 kg/ha " " " "

Japanese test reports had the following comments on herbicides:

Linuron 50%, 3 kg/ha satisfactory.
Diuron 20%, plus Paraquat 24% at 4-5 kg/ha - satisfactory.
Asulan - not suitable because of phytotoxicity.
Ioxyril - not suitable because of phytotoxicity.
Glyphosate - suitable but avoid drift.
Dalapon/Diuron/MCPA granules were found to be phytotoxic.
(Wilton, 1983).

2.14 PHYSIOLOGICAL DISORDERS

The main physiological disorder of fruit of Japanese pear (*P. serotina*) is hardened fruit, and is called "Yuzuhada" in the 'Nijisseiki' variety and "Ishinashi" in the 'Chojuro' variety. The symptoms are similar to watercore in apples or flesh spot decay which, in turn, is similar to internal cork of apples at harvest time in Japan. The most serious problems are the hardened fruit and watercore, which cause losses in market value (Kawamata, 1982).

1) Fruit Hardiness: Yuzuhada and Ishinashi Disorders.

Ishinashi (stony pear) symptoms are evidently hardening of the fruit at the calyx end, and unevening of the fruit surface at ripening. It is closely related to the calcium level in fruit and the pH of the soil. The amounts of glucose and starch are higher in infected fruit, while total sugars, reducing sugars and fructose levels are lower. Applications of calcium peroxide to the soil annually decrease the occurrence of Yuzuhada by improving the soil and result in better quality fruit.

2) Watercore (Water pear)

Appearance of water-soaked translucent flesh occurs in Nijisseiki and Hosui varieties. Symptoms appear when cellular breakdown is stimulated by the activation of some cell wall degrading enzymes. Simultaneously, accumulation of sugar is stimulated, probably through the inactivation of sugar-degrading enzymes in the disorder tissue (Yamaki *et al.*, 1977).

Over-ripe Hosui fruit is susceptible, therefore keeping to the optimum harvest period is essential. Also, preventing water shortages and nutrient deficiencies during fruit development will reduce the occurrence of watercore.

3) Flesh Spot Decay

Appears as a small brown spot in intercellular areas of the parenchyma cells, near the end of the vascular system (Kikusui variety). These spots are not visible on the surface of fruit (only in the flesh) and cause the fruit to have a bitter taste, unfit for consumption (Koto *et al.*, 1972).

4) Black End

Caused by a parasitic fungus producing a rusty white mould in the calyx area or lower half of the fruit. This spreads to other parts causing a blackish discolouration of the skin. Prevent by: good soil drainage, applications of balanced fertilisers (not too heavy in nitrogen), and avoid chemical damage to the fruit.

5) Water-burn (rainburn)

Skin spots enlarge under excess moisture conditions (the skin of Nijisseiki fruit is blackened by the rain). Two periods when problems occur are when fruitlets are first covered with bags and as the fruit ripens. The main problem seems to relate to the use of bags to cover the Nijisseiki fruit.

2.15 FRUIT MALFORMATION

(a) Symptoms of malformed fruit:

Fruit in which seeds are distributed only on one side, and are bigger than normal.

Other factors causing malformed fruit -

(i) Inclined fruit, one side of the fruit does not develop as fully as it should due to poor pollination. Normally, no seed is found in the inclined side of the core.

(ii) Streaked fruit where a few channels run lengthwise on the surface.

(iii) Triangular fruit, where the base of the peduncle is an apex and the fruit forms a triangle.

(b) Major malformation generating elements:

* imperfect pollination,
* tree is over-vigorous,
* fruit sets in a poor position,
* when a small flower sets a fruit.

(c) Counter-measures:

(i) Ensure perfect pollination to increase the number of seeds. The number of seeds that should grow is 2 in each core section - a total of 10 seeds in sections for Nijisseiki, 12-14 seeds in 6-7 sections for Kosui, and 10 seeds in 5 sections for Hosui (Note: Hosui is weak in forming seeds compared with Kosui).

(ii) Attention to tree vigour and fruit setting position. More malformed fruits were found on assessment of the Nijisseiki variety on vigorous lateral branches and particularly on the main branch and inside of the canopy area. Choose a branch that is moderately vigorous as a lateral branch. Basal parts of the main and secondary branches do not set fruit.

(iii) There is a need to control the excess growth of branches of varieties like Shinsui and Hosui at the early stages.

(iv) Fruit thinning after the shape of the fruit is confirmed. For the variety Sansui, thin fruits to 1 per cluster 14 days after pollination and carry out a final thinning 15 days later. If the tree is over-vigorous, delay the final thinning of the area with a large occurrence of malformed fruits.

3.0 MARKETING

3.1 ORGANISATION OF THE NEW ZEALAND INDUSTRY

One of the major questions facing the development of this potential new crop in New Zealand is, who will handle the marketing of Asian pears?

The Ministry of Agriculture and Fisheries' (MAF) reply to this question was affirmative, that the New Zealand Apple and Pear Board (NZAPMB) would handle the marketing of this crop (Orchardist, 1982). Mr K.W. Kiddle, Board Chairman, has stated that until the Board receives fruit to market, the situation could not be completely solved (Orchardist, 1982).

The Government may have to step in and introduce legislation or act as a co-ordinator to reach a final decision once sufficient quantities are available for marketing.

The NZAPMB Act, 1948, clearly states that the functions of the Board are:

> "To make provision for the acquisition and marketing by it of apples and pears, to provide for the fixing of prices to be paid for apples and pears so acquired by it, and to make provision for the regulation of the marketing of apples and pears."

The NZAPMB are going ahead with research on the marketing of Asian pears.

The Asian Pear Development Committee has recently been formed to co-ordinate the future development of Asian pears in New Zealand. It comprises representatives from the Board, MAF and DSIR, as follows:

Chairman: Mr John McCliskie (Board Member)
Mr John Paynter (Board Member)
Mr Allan White (DSIR, Havelock North)
Mr John Wilton (MAF, Auckland)
Mr Bill Drewett (Board Member)
Mr Dean Soldera (Board Member)
Mr Dave Cranwell (Board Member)
(NZAPMB Newsletter 3, 1978)

The Committee will be collating and disseminating to the industry relevant information on planting and establishing new orchards, recommended varieties, cultural techniques, harvesting and post-harvest handling of the fruit.

This information will be issued in the form of a progressive series of bulletins: No. 1 May 1983 covered background, varieties and marketing aspects, while No. 2 October 1983, covered growing conditions, propagation, planting systems and pollination aspects.

3.1.1 Advantages of the N.Z.A.P.M.B.

1) The Board already has a worldwide reputation for providing quality produce with its history of marketing apples and pears.

2) The Board has created an 'image' on world markets for its produce with the strategy, "Top Quality from New Zealand".

3) In 1982 the Board exported 50.8 per cent of apples and pears produced in New Zealand, distributing them to 45 countries throughout the world.

Table 9: The percentage of total exports of apples and pears, 1982, and their countries of distribution.

	% of Total Exports 1982
EEC and other Europe	67
North America	15
South-East Asia	10
Middle East	3
Caribbean/Venezuela	2
Pacific and Other	3
	100

(Source: NZAPMB Annual Report, 1982)

At present, 10 per cent of exports go to the South-East Asian markets. These include: Hong Kong, Indonesia, Philippines, Singapore, Sri Lanka, Taiwan and Thailand. All are potential markets for Asian pears.

4) In 1980, the Board opened an office in Singapore, reflecting the potential this market offers as the Board is aiming to increase New Zealand's market share for existing pipfruit.

5) The NZAPMB has facilities presently used for apples and pears, so that in the future it may be possible to utilise some of these facilities for Asian pears. The Asian pear season will extend from mid-January to late March for the varieties currently in New Zealand.

6) The NZAPMB has the expertise not only in the marketing of pipfruit, but overall

co-ordination and organisation of year-round activities which are vital for any developing industry.

Figure 3 shows the distribution system of apples and pears in New Zealand.

3.1.2 An Alternative

Increasingly, the philosophy of individual growers marketing in isolation is losing support, and the idea of collaboration amongst producers and exporters in exploiting markets for mutual benefit is gaining support. This movement repeatedly gains support from evidence of the disastrous effects of competition amongst exporters in order to make sales in limited overseas markets (e.g. boysenberry industry). The strength of an industry is the strength of its weakest member.

The answer is control .... but what sort of control?

As Asian pears become more widely known in New Zealand, many commercial firms presently exporting other crops are keen to be involved with Asian pears - such as Turners and Growers, N.Z. Fruitgrowers' Federation, and others.

As seen with the kiwifruit industry, the licensing of exporters by the Kiwifruit Authority (KEA) has beenreasonably successful. If this type of control is desired, then maybe the Asian pear industry could be established on similar lines (Fig. 4).

Figure 3: Product flow in the apple marketing system.

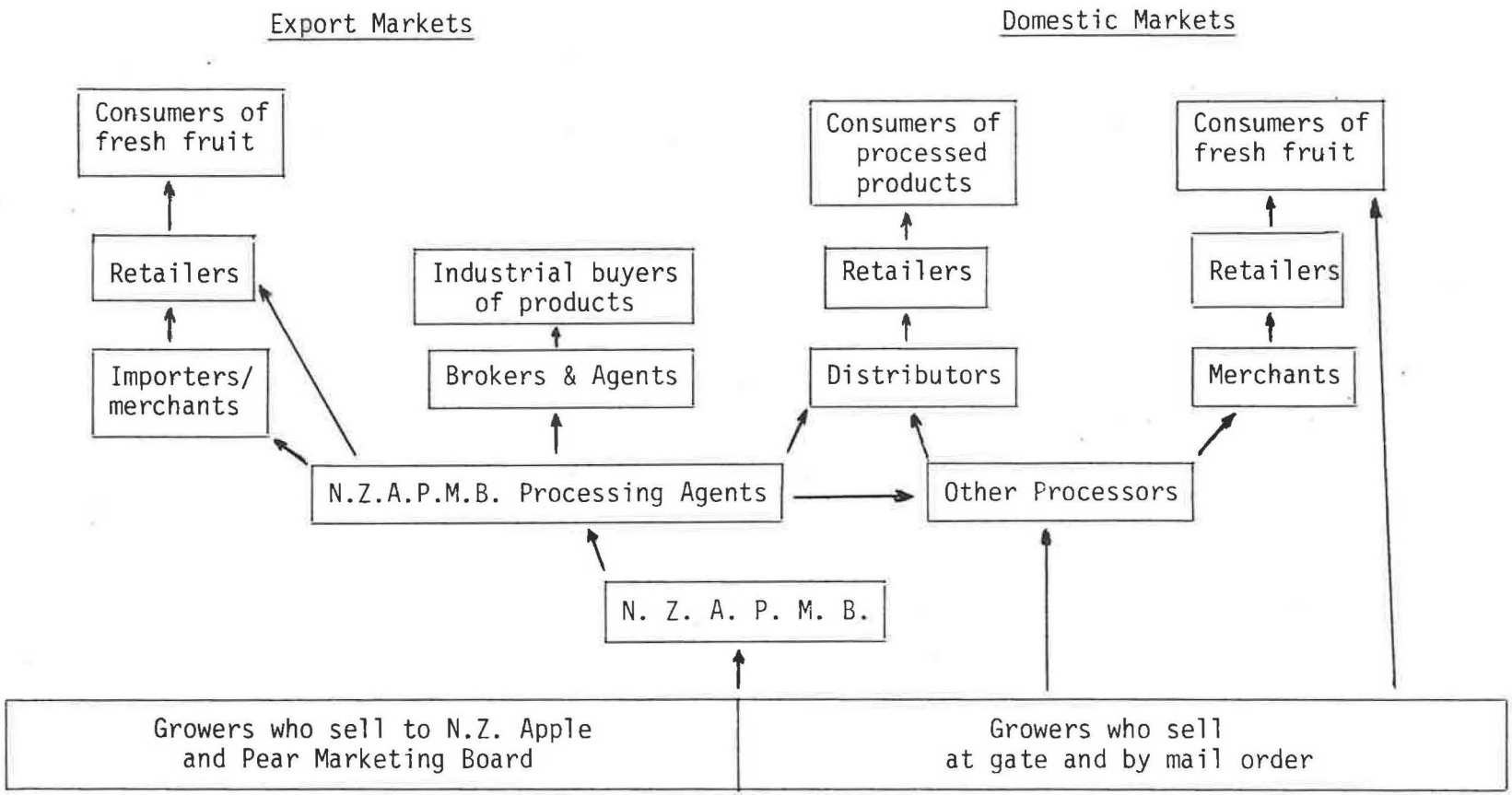
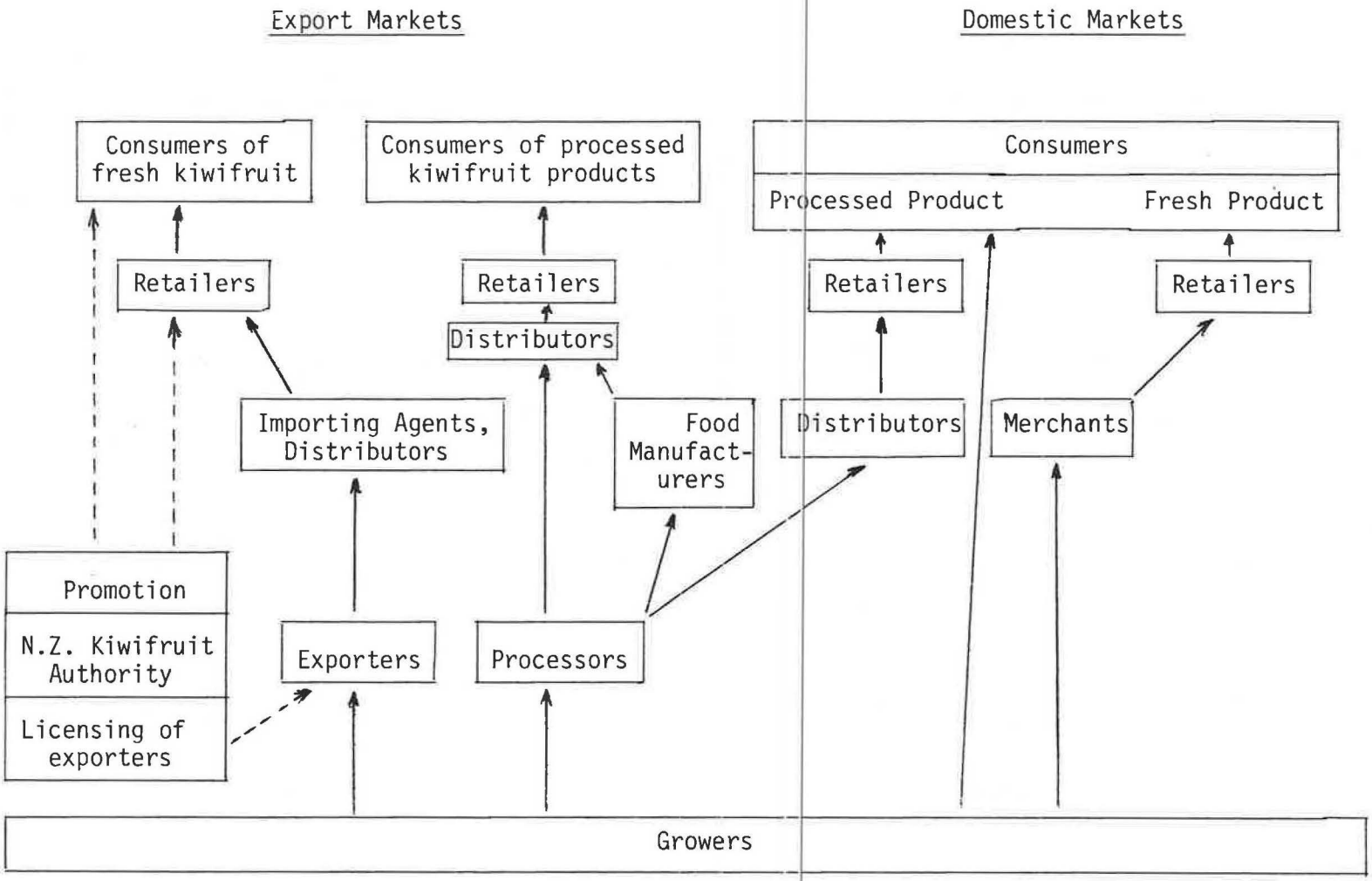


Figure 4: Product flow in the kiwifruit marketing system.



It may be possible to have the NZAPMB as the overall controlling body, who licenses out to other exporters.

3.2 WORLD PRODUCTION OF ASIAN PEARS

The major producers of Asian pears in the world are: Japan, South Korea, China and the U.S.A. (Table 10). No major changes in production or areas planted have occurred over the last ten years.

Table 10: World production and areas of Asian pears, 1980.

Country	Production (tonnes)	Area (hectares)	Per Cent of Total production
Japan	485,000	19,900	82
China	65,000	800*	10
South Korea	50,000	750*	8
U.S.A.	2,000*	150	0.01
TOTALS	602,000	21,600	100

*Estimates.

(Source: Wilton, 1980-83, FAO Yearbook)

3.2.1 Introduction

Korea and Japan export high quality Asian pears to a number of South-East Asian markets, while Mainland China exports large volumes of lower quality fruit. For instance, China sent 43,650 tonnes to Hong Kong in 1978 at an average price of HK $1,294/t. In the same year, Japan

sent 622 t at an average price of HK $6,917/t, while New Zealand sent 93 t of European pears at an average price of HK $2,636/t[1].

In comparison, New Zealand sent 5,228 t of apples to Hong Kong in 1978 at an average price of HK $2,898/t. Therefore, on the Hong Kong market, Asian pears ranged in price from roughly half to over double the price of our apples depending on quality (Wilton, 1980).

3.2.2 Japan

In 1980, Japan produced 82% of the world production of Asian pears, of which 80% was consumed in Japan.

The area of Asian pears in Japan has only steadily increased from 17,000 ha in 1970 to 19,900 ha in 1980. During this period production has fluctuated from year to year, with a low of 425,000 t in 1971 and a high of 519,000 t in 1955 (Fig. 5).

Japan exports only a small proportion of its crop, 5,500 t in 1979, increasing to 9,800 t in 1981, exporting to other Asian countries. This increase in export volume was accompanied by an increase in the F.O.B. Japanese price for a kilogram from an average of 216 yens[2] in 1979 to 286 yens in 1981, indicating a good demand for the product.

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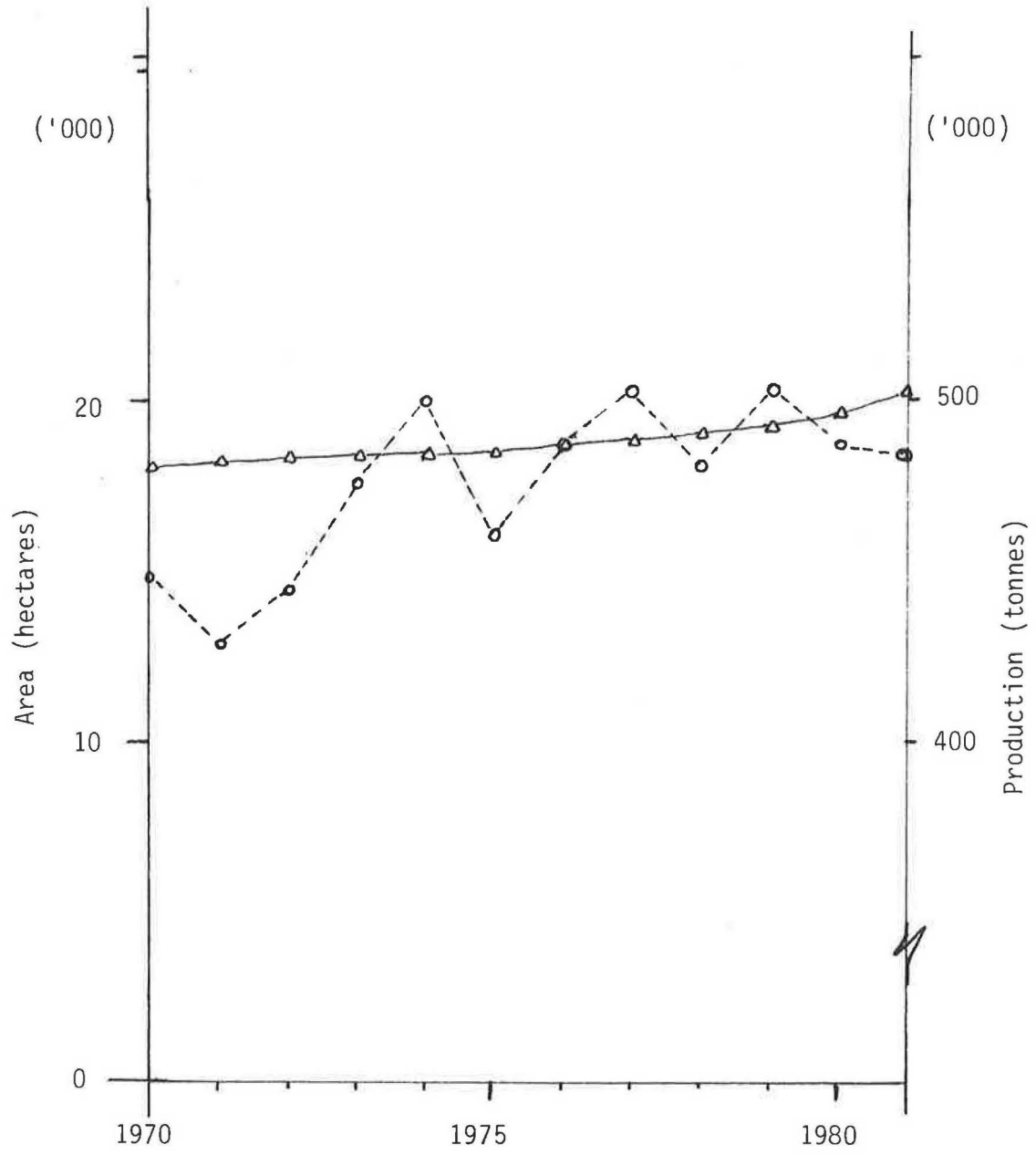
[1]The present currency exchange rate is $HK 5.00 to NZ$ 1.00.

[2]At a currency exchange rate of 155 yens to one NZ dollar, this price represents NZ$ 1.85 per kg.

Figure 5: Trends in area and production for Asian pears in Japan.



Index: area

production

(Source: Kitagawa, 1982b)

In 1979, Japan exported Asian pears to: Hong Kong, Taiwan, Singapore, U.S.A. and Guam. By 1981, with increased volumes, these existing markets were expanded and new markets were developed, including: Kuwait, Malaysia, Sabah, Indonesia, South Korea, Thailand, the Philippines and Mediterranean/Caribbean (Tables 11, 12, 13).

The Japanese fruit competes with local production in markets of Taiwan and South Korea, and competes with very large quantities of inferior produce from Mainland China.

The Japanese fruit which commands top price on these South-East Asian markets is of the same high quality as that produced for their own domestic market. It is carefully packaged, large, blemish-free fruit of the main Japanese varieties.

Japanese top quality fruit of the variety Nijisseiki exported to Singapore in 1980 sold for:

Size (per 5 kg tray)	Weight (approx.)	Price (NZ$/fruit)
13 count	0.38 kg	1.25
20 count	0.25 kg	0.90
23 count	0.21 kg	0.75

(Wilton, 1980)

The highest prices are paid for the larger sized fruit.

At the same time, New Zealand apples were selling on the market for NZ$ 0.30 each, but were smaller in size, yet the price per kilogram of fruit was similar.

Table 11: Exports of Asian pears from Japan.

Country	1979 kg	1980 kg	1981 kg
Kuwait	-	-	6,000
Taiwan	1,869,345	3,828,030	362,655
Hong Kong	3,406,650	4,501,215	6,157,005
Singapore	126,750	496,385	1,314,340
U.S.A.	87,886	160,501	268,181
Guam	16,131	42,110	62,329
Malaya	-	6,210	263,330
Sabah	-	45,000	7,500
Indonesia	-	55,500	643,350
S. Korea	-	-	442,500
Thailand			293,215
Philippines			13,500
M.M. Car.			1,050
Total	5,506,742	9,134,951	9,834,955
% Index 1979 base	100	166	179

(Source: Butler, D. 1982. N.Z.A.P.M.B. Exports and Imports of Nashi from Japan.)

Table 12: Value F.O.B. of Nashi Exported from Japan (1000 yens).

Country	1979 kg	1980 kg	1981 kg
Kuwait	-		1,998
Taiwan	504,847	1,017,952	108,776
Hong Kong	868,627	1,220,192	1,650,859
Singapore	31,012	151,925	426,991
U.S.A.	27,129	51,861	94,476
Guam	5,199	12,695	21,047
Malaya	-	2,113	86,477
Sabah	-	14,352	2,964
Indonesia	-	17,140	221,789
S. Korea	-		101,074
Thailand	-		95,408
Philippines	-		4,688
M.M. Car.	-		243
Total	1,436,814	2,488,230	2,816,790
% Index 1979 base	100	173	196

(Source: Butler, D. 1982. N.Z.A.P.M.B.
Exports and Imports of Nashi from Japan.)

Table 13: 1981 - Average value FOB of Nashi exported from Japan.

	¥ per kg
Kuwait	333
Taiwan	300
Hong Kong	268
Singapore	325
USA	352
Guam	338
Malaya	328
Sabah	395
Indonesia	345
South Korea	228
Thailand	325
Philippines	347
Mediterranean/ Caribbean	231
AVERAGE VALUE	286
(= $NZ 1.85)	

(Source: Butler, D. 1982. N.Z.A.P.M.B. Exports and Imports of Nashi from Japan.)

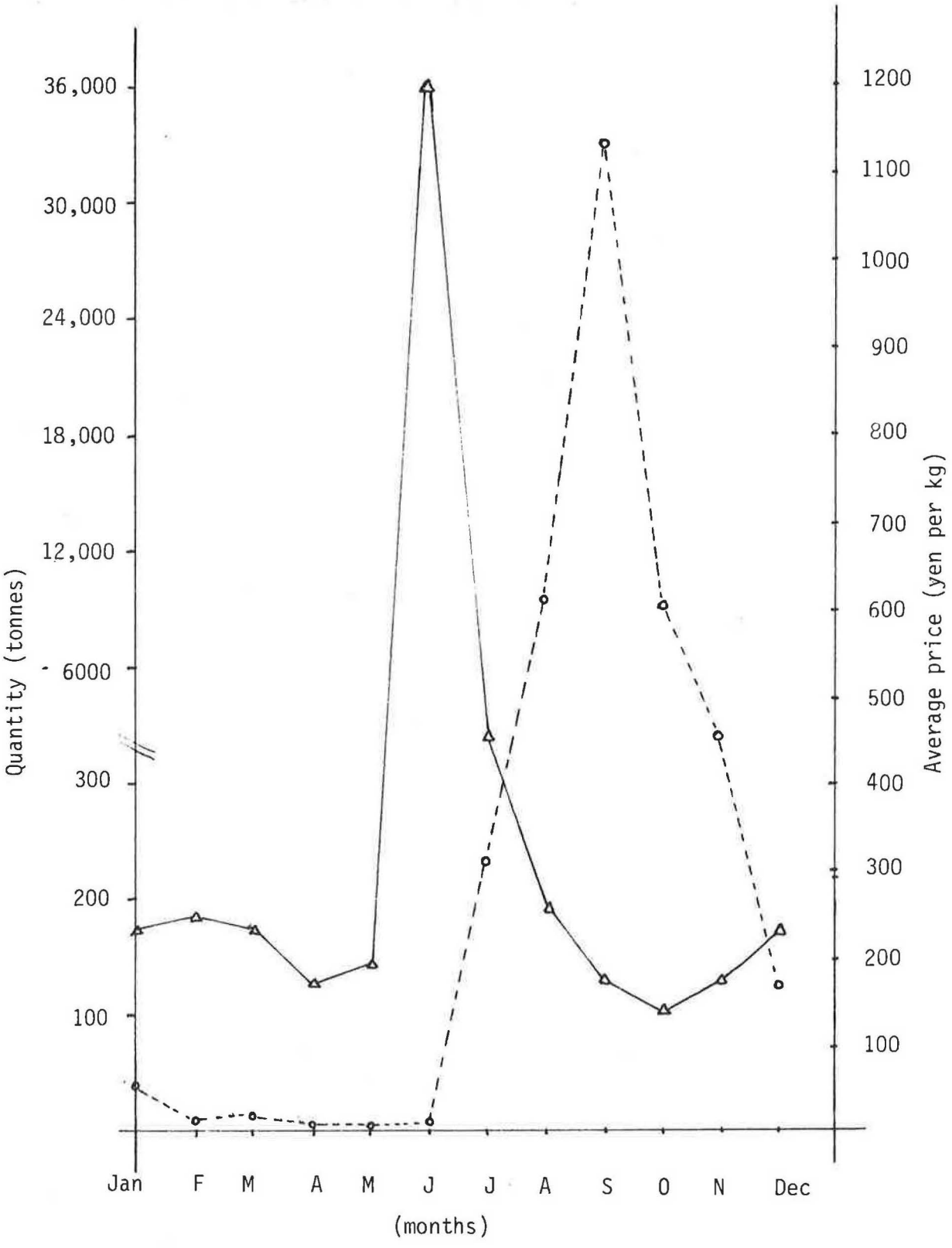
For comparison, Korean fruit of a larger size and a full russet variety with more flavour than Nijisseiki, but a coarser texture, sold for NZ$ 0.60 each, due to their inferior quality in comparison with Japanese fruit.

In Japan, for the limited supplies prior to the August to October period, considerable price premiums exist. In 1979, prices in the main market period, August to October, were in the range of 150-200 yen per kg, compared with average June and July prices of 771 and 433 yen per kg respectively. In 1980, prices ranged from 140-265 yen per kg for August to October, compared with June and July prices of 1,219 and 434 yen per kg respectively (Fig. 6). This large increase in the June 1980 price (almost double the 1979 price for the same period) was due to only 1 tonne being available while in a normal year 2-4 tonnes are on the market during this period.

Over the period 1977-1980, there has been a steady decrease in the quantity of Japanese pears on the Tokyo market, from 62,000 t in 1977 to 52,200 t in 1980. During the same period the price paid for these fruit has gradually increased from 160 yen per kg in 1977 to 194 yen per kg in 1980 (Fig. 7) (Fresh Produce Distribution Yearbook, 1981).

The peak supply period on the Tokyo market is from August to October, with 33,000 t on the market in September 1980, coinciding with the period when the lowest prices are received (Kitagawa, 1982b).

Figure 6: Japanese pear quantities and prices on a monthly basis for 1980 on the Tokyo wholesale market.

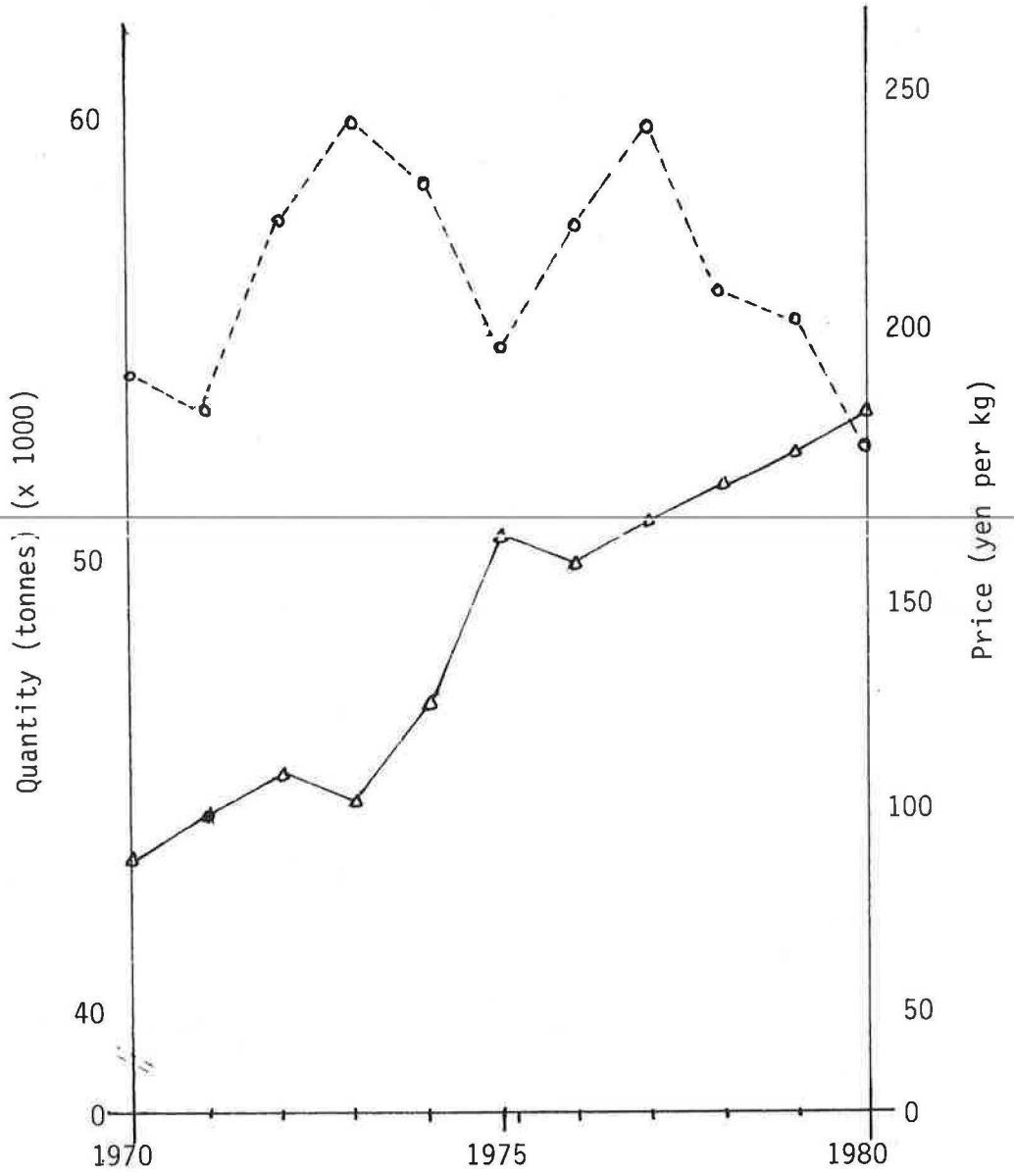


Index: △——△ av. price

o- - -o quantity

(Source: Seikabutsu Pyutsu Nenpo, Fresh Produce Distribution Yearbook, Tokyo Seikabutsu Information Centre.)

Figure 7: Trends in weighted average price and quantity of Japanese pears on the Tokyo wholesale market.



Index: △——△ price

o----o quantity

(Source: Kitagawa, 1982b)

The Fresh Produce Distribution Yearbook 1981 shows that Asian pears are available throughout the year on the Tokyo market, yet NZAPMB figures on the Japanese Nashi market show that Asian pears are only available August to December (Table 14), meaning they have ignored the low quantities available in the other 7 months.

Consumption patterns for Nashi and apples for the period 1976 to 1980 show that consumption of apples is almost double that for Nashi (Table 15).

Over the same period, the average price per kg has increased for both Nashi and apples, with the average price for Nashi lower than apples, at 263 yen per kg compared to 314 yen per kg (Table 16).

The main consumers of Nashi and apples are shown in Table 17, with kg per household at different age groups. These clearly show that younger generations, less than 24 years, consume only 25-30% of the amount consumed by the older households, 35 years and above, largely due to the change to a Westernised lifestyle and eating habits by the younger generation.

3.2.3 China

Mainland China exports most of its Asian pears to Hong Kong and Singapore.

The Chinese fruit tends to be a bulky commodity with little attempt at careful packaging. The varieties have poorer eating quality and pyriform shapes (e.g. the YaLi variety) rather than the more apple-shaped Japanese varieties. As a result, the price may be 20-50% lower than the Japanese fruit (Wilton, 1980).

Table 14: Distribution of purchases -1980, Nashi and apples on the Japanese wholesale market.

	Nashi %	Apples %
January	X	7
February	X	9
March	X	9
April	X	6
May	X	5
June	X	3
July	X	2
August	14	2
September	57	8
October	26	14
November	2	16
December	1	19
Total	100	100

(Source: N.Z.A.P.M.B., 1982)

Table 15: Consumption of Nashi and apples on the Japanese wholesale market.

Year	Nashi tonnes	Per capita kg	Apples tonnes	Per capita kg
1976	356,066	3.17	694,837	6.19
1977	369,932	3.27	666,978	5.89
1978	352,073	3.08	686,716	6.00
1979	353,502	3.06	597,064	5.17
1980	329,644	2.83	690,819	5.94

(Source: N.Z.A.P.M.B., 1982)

Table 16: Average price per kilo for Nashi and apples on the Japanese wholesale market.

Year	Nashi (av. for year) yen	Apples yen
1976	240	266
1977	213	287
1978	273	285
1979	279	355
1980	308	376
Average price	263 = (NZ$ 1.70)	314 = (NZ$ 2.00)

(Source: N.Z.A.P.M.B., 1982)

Table 17 : Main consumers of Nashi and apples from the Japanese wholesale market.

	Age of Head of H/hold								
	-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60+
Kg per h/hold									
- Nashi	2.6	4.8	7.4	9.0	10.5	10.5	10.9	9.7	9.4
- Apples	6.8	12.4	17.3	20.1	20.6	21.1	19.3	20.6	19.8

(Source: N.Z.A.P.M.B., 1982)

3.3 PROSPECTIVE MARKETS

3.3.1 Domestic Market

Wilton (1981) suggests New Zealanders who have travelled through South-East Asia generally express a liking for Asian pears. Until production begins here, the overall New Zealand consumer reaction to the rather bland taste will not be known. With early varieties ripening in New Zealand in January, the refreshing nature of the fruit to the palate in hot weather should help its introduction.

The NZAPMB imported small consignments of fruit from California during 1981 and 1982 to test local market reaction. The following points were made in their 1982 market report:

* 540 trays, counts 20-35, arrived late November 1982.
* Distributed to 16 major cities in New Zealand.
* Initial prices in Auckland were $23.00 per tray but peaked at $29.55 in Nelson.
* Average price was $18.39 per tray compared with $12.00 in 1981.
* Average retail price per fruit was $1.12.
* D'Anjou pears at $0.40 each provided the consumer with a more realistic and desirable alternative.
* Consumer demand was very limited in most areas.
* Heaviest demand was in large city areas, with country areas encountering little or no interest.
* Retailers commented that the price was far too expensive and larger quantities would need to be related to Winter Cole or

Winter Nelis pear prices, equivalent to a wholesale price of approximately $5.00 per tray (5 kg/tray) (i.e., $1.00 per kg).

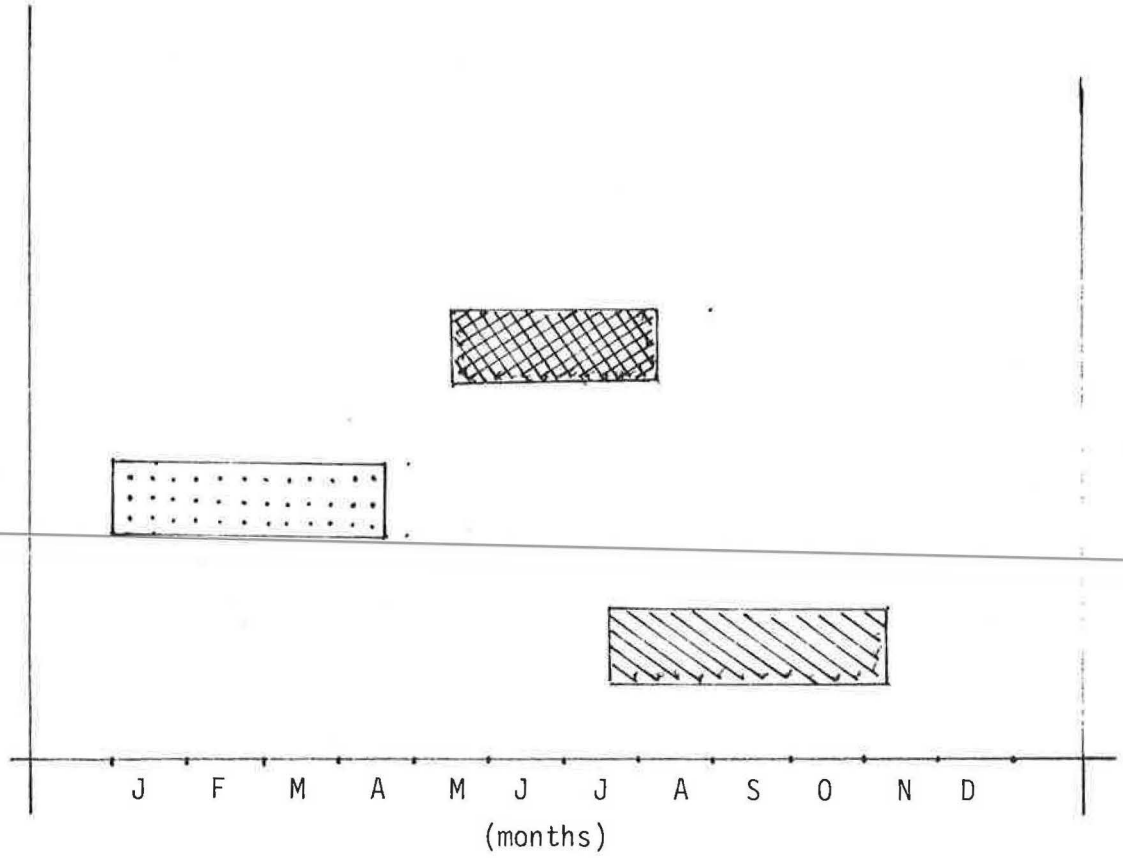
* Asian pears have sold mainly on the novelty value, but misgivings expressed by all trade sectors indicate that on a large-scale, even the fruit's attribute does not merit its inclusion in the luxury market.

3.3.2 Export Markets

Although untested for Southern Hemisphere production, there appears to be good opportunities to sell this fruit on a number of export markets, supplying fruit in their off-season. Asian pears are widely known throughout South-East Asia and are generally preferred to the European pear. In Japan, Asian pear consumption tends to be confined to the warmer season (25-30^{o}C days), with little demand in their cold, bleak winter. This may point to limited demand for fruit in the Northern Hemisphere winter, therefore New Zealand production should concentrate on late season varieties that can fill the spring to early summer market slot (June-August) (White, 1982; Fig. 8).

3.3.2.1 Japan and South Korea: Marketing of New Zealand Asian pears in both Japan and Korea remains an academic question until their plant health authorities can be satisfied the fruit is free from codling moth. Fumigation may offer a chance of entry eventually, but significant quantities will have to be available to force changes in the quarantine regulations.

Figure 8: World production periods of Asian pears and New Zealand's market opportunities.



Index:

Northern Hemisphere production period.

New Zealand expected production period (Southern Hemisphere)

Gap in Northern Hemisphere markets (opportunities for New Zealand fruit)

(Source: Fresh Produce Distribution Yearbook, 1982; White, 1982.)

During 1981, Japan absorbed 25% of New Zealand's total horticultural exports and has emerged as our single-most important market.

There is potential for increased volumes of New Zealand products to Japan if we research and develop the market correctly.

The Japanese are prepared to pay high prices for fruit, if the product meets their standards of quality, shape, visual attractiveness, maturity, flavour and presentation (Kitson, 1982).

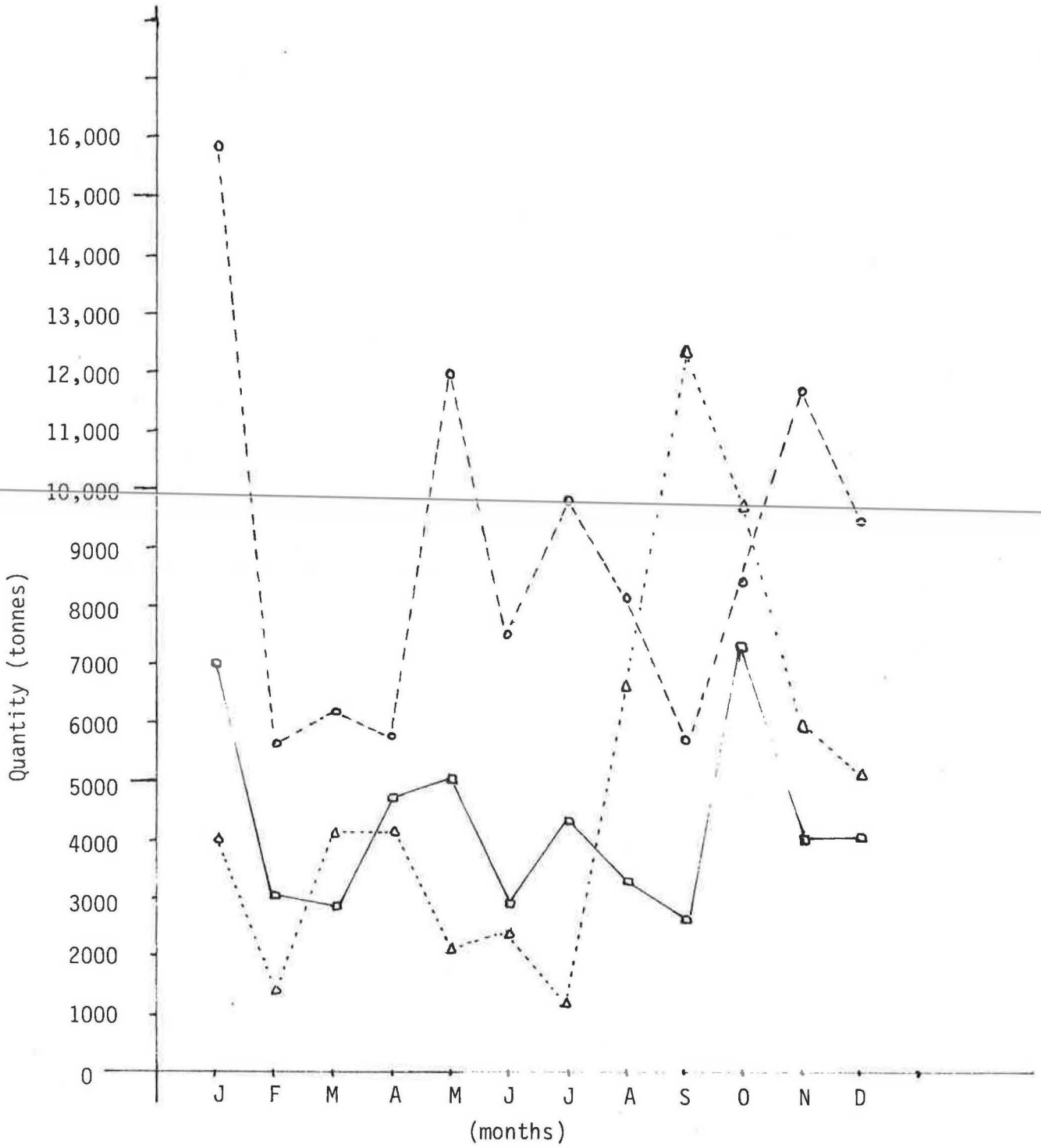
The Japanese fruitgrowers are a very strong political force and will naturally oppose importation of competitive products. In 1978, Japan produced 78% of its fruit requirements, so a small percentage short-fall in production would represent a large volume for New Zealand.

Japanese inspection procedures for imported produce are extremely strict as indicated in Appendix 10.

3.3.2.2 Hong Kong: Hong Kong provides potential to be a major market for New Zealand Asian pears.

Imports of fresh fruit in 1979 totalled 350,000 t. Pears (Asian and European) were the second largest item, accounting for 17% (58,847 t) of fresh fruit imports. Figure 9 shows Hong Kong's imports of its three major fruits for 1979. China, 47,000 t, the largest supplier, and South Korea, 190 t, together contributed 80% of pear imports. Pear imports peak during August-October (28,662 t), which coincides with the Chinese production of Asian pears. Most of the European pears are

Figure 9: Hong Kong - Monthly imports, 1979, for the three major fruits.



(Source: Hong Kong Trade Statistics, 1979).

Index: o----o oranges

Δ·····Δ pears

▣——▣ apples

imported from Australia (11%).

Domestic consumption of pears in Hong Kong, 51,300 t in 1979, consisted 87% of imports (Table 18), the remaining (7,547 t) 13% were re-exported, mostly Singapore (Table 19). Hong Kong's distribution system is very simple, with short channels for distribution from exporter to consumer (Fig.10).

Two fruit markets handle imported fruits into Hong Kong:

1) Western Market - on the Hong Kong Island.

2) Yamati Fruit Market - on Kowloon (Dunphy, 1981).

Indications from these markets about other New Zealand produce are that our plums and nectarines are too small, ideal plums should be sweet and 7-10 cm in diameter and nectarines should be large. A clear indication that larger-sized Asian pears will be preferred.

3.3.2.3 Singapore: Singapore offers potential as a major market, and with correct marketing expertise could prove more demanding than Hong Kong.

Imports of pears (Asian and European) were the third largest item, accounting for 10% (31,199 t) of fresh fruit imports in 1979 (Fig. 11). Imports increased 9,000 t between 1978 and 1979 (28%).

Like Hong Kong, Singapore imports pears over the whole year. The Asian pears supplied by China (16,106 t), Japan (97 t) and Korea (935 t) accounted for 55% of imports, while European pears composed the remaining 45%, with 42% of these imported from Australia (13,445 t; Table 20).

Table 18: Hong Kong pear imports for 1978 and 1979.

Country	1979		1978	
	tonnes	HK $1,000	tonnes	HK $1,000
U.S.A.	329.3	1,355.8	247.3	829.2
Austria	-	-	9.8	28.4
Chile	191.4	625.4	234.1	722.6
Taiwan	125.9	109.2	23.8	24.5
Korea South	190.9	696.7	422.2	1,215.3
Thailand	-	-	9.8	42.9
Japan	-	-	621.8	4,301.3
China	47,116.2	66,497.0	43,650.6	56,488.8
Singapore	131.1	507.9	40.0	150.0
South Africa	310.8	1,216.5	236.9	773.8
Australia	6,759.4	24,475.4	6,103.0	17,862.9
New Zealand	145.3	474.9	93.3	245.9
TOTAL	58,847.3	117,958.5	51,692.7	82,685.5

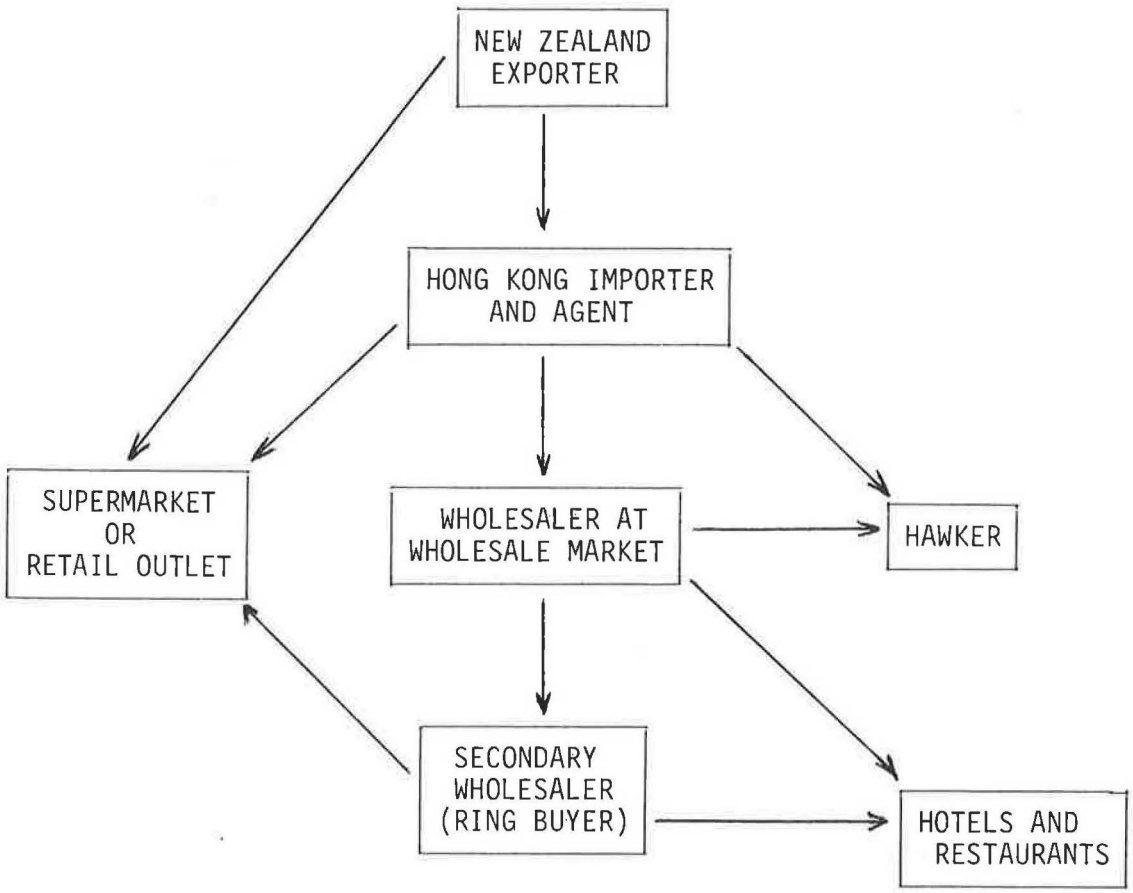
(Source: Dunphy, 1981)

Table 19: Hong Kong pear re-exports for 1978 and 1979.

Country	1979		1978	
	tonnes	HK $1,000	tonnes	HK $1,000
Canada	385.0	701.5	214.2	327.0
U.K.	8.0	15.9	13.9	27.3
Taiwan	69.3	144.1	69.3	145.1
Indonesia	662.2	1,069.5	580.7	826.9
Philippines	49.1	102.4	3.0	3.8
Thailand	-	-	5.3	7.3
Sabah	0.2	0.6	-	-
Sarawak	-	-	3.3	5.9
Singapore	6,372.3	9,453.7	7,179.2	9,084.5
TOTAL	7,547.1	11,487.8	8,068.8	10,427.8

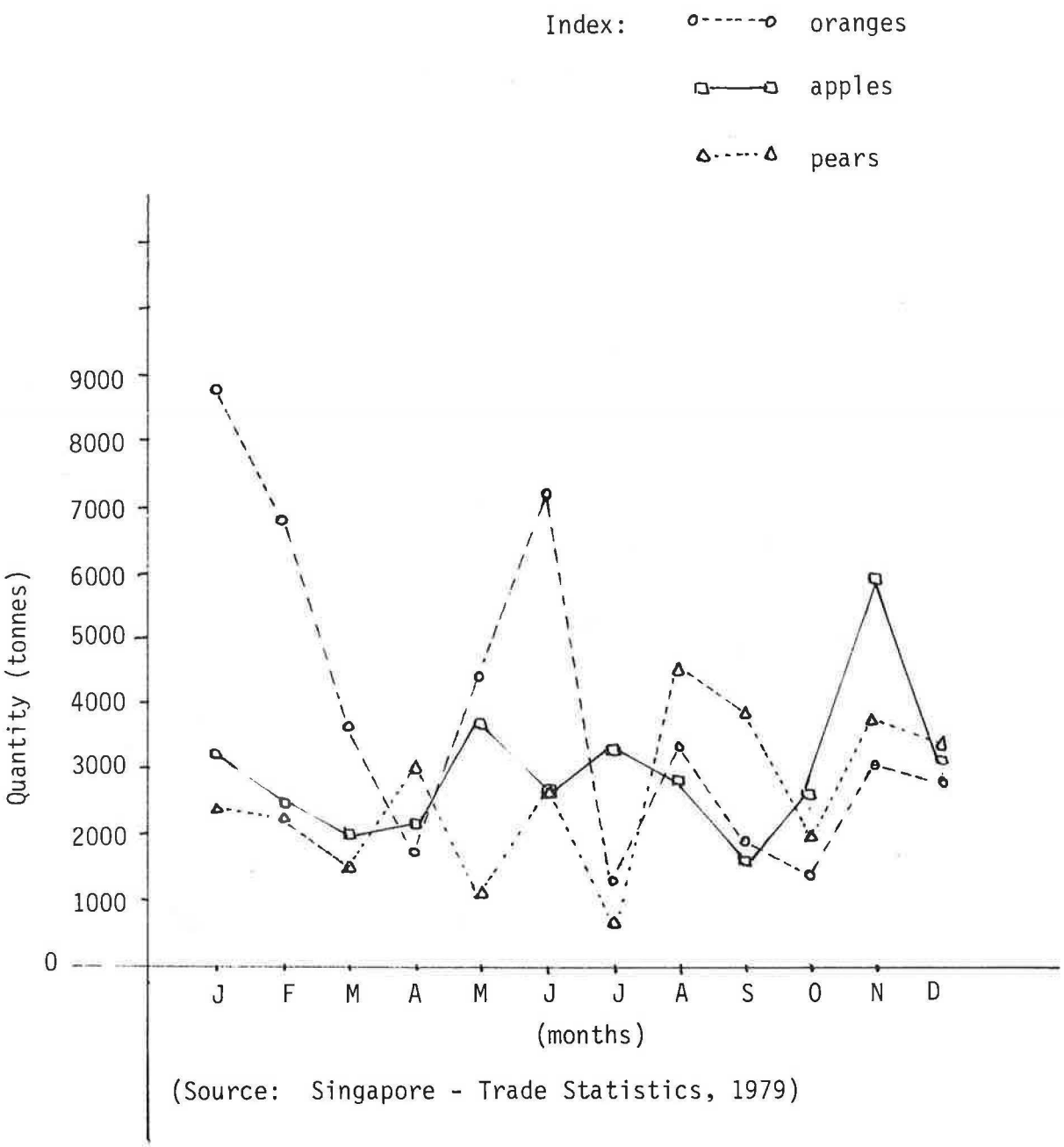
(Source: Dunphy, 1981)

Figure 10: Hong Kong markets.



(Source: Dunphy, 1981)

Figure 11: Singapore - Monthly imports, 1979, for the three major fruits.



(Source: Singapore - Trade Statistics, 1979)

Singapore consumes 74% of its imported pears, the remaining 26% were re-exported (8,165 t) in 1979, with 82% going to Malaysia (Dunphy, 1981; Table 21).

(a) Asia as a Market

* Asia is developing and becoming more Westernised.
* Hong Kong and Singapore's population are of Chinese origin.
* Both countries have rising standards of living.
* Both have unrestricted trade.
* Both have limited resources for local production of fruit and vegetables.
* Imports of fruit appear to be determined by availability in the country of supply rather than seasonal demand from the market.
* Hong Kong produces only 14 per cent of its food requirements, the other 86% are imported. It only produces 0.8 per cent of its fruit requirements while Singapore produces less than 3 per cent of its fruit consumption requirements.
* Both Hong Kong and Singapore are highly competitive as fruit and vegetables from many different countries are displayed side by side.
* New Zealand's produce in general fits into a high price bracket on the market, which is concerned with: quality, availability and price, in that order.

Table 20: Singapore's pear imports, 1978 and 1979.

Commodity	1979 Q	1979 $ $	1978 Q	1978 $ $
Pears				
Australia	13,445	13,941,918	7,659	11,217,442
China	16,106	13,326,955	12,998	9,873,697
France	62	118,854	-	200
Hong Kong	12	6,048	-	-
Japan	97	298,064	-	1,521
Korea	935	1,432,282	1,761	2,095,756
Taiwan	27	22,275	-	-
U.S.A.	515	987,795	538	986,793
TOTAL	31,199	30,125,191	22,957	24,175,409

(Source: Dunphy, 1981)

Table 21: Singapore's pear re-exports - 1978 and 1979.

	1979 tonnes	1979 S$	1978 tonnes	1978 S$
Australia	1	600	-	600
Brunei	507	797,780	403	585,508
Christmas Island	6	7,060	5	5,240
Hong Kong	131	207,947	43	87,500
Malaysia	6,752	5,531,120	4,472	3,767,791
Sabah	405	541,922	185	278,167
Sarawak	295	432,811	197	268,838
Sri Lanka	-	1,073	-	-
Thailand	1	1,776	52	51,864
United Kingdom	62	77,332	52	67,000
Vietnam	2	3,103	-	-
O.C. Africa	4	9,670	2	3,610
Burma	-	-	-	66
TOTAL	8,165	7,612,194	5,411	5,116,184

(Source: Dunphy, 1981)

(b) Market Segments - identified as being suitable for New Zealand produce are:

1) The hotel and restaurant trade.

2) The supermarket trade catering specifically for the upper market segment.

3) Hawkers (street sellers) - produce acquired from the the wholesalers for the local population.

* New Zealand sales efforts will need to be aimed at the trade sector.

* Grading and quality are the two most important factors in making a sale.

* The concept of images can be cemented through the use of brands. In Hong Kong and Singapore, there is such a wide range of produce available at retail level from an equally wide range of sources that the use of brands, packaging and promotion as sales tools becomes important. Purchasing decisions are made on image and prestige of each brand.

* Leading brands are often the most expensive - hence application of a pricing strategy will be highly important.

(c) Market Research

Major points marketers need to consider:

1) Quality (grading).

2) Availability.

3) Small consignment lots, markets lack space for storage and have a high turnover (fresh produce).

4) Agency rights - promote as an exclusive line.

5) Product specifications - consumer benefits
- very health conscious.

* Consumption patterns, tastes and expenditure habits need to be well understood. Tastes are changing and becoming more Westernised - more rich and less refined foods.
* 45 per cent of householders' income is spent on food; freshness is the major factor influencing purchases, and purchases are made daily.
* In Chinese culture, colour and brand name can assume a very significant role. Colour must enhance the product, and is associated by the Chinese with the following:

  Red - good luck
  Gold - wealth and prosperity
  Yellow - power and authority
  Green - restful
  Pink - romantic
  Black, white, blue and grey - mourning or sorrow.

  Colour is also associated with festive occasions.

3.3.2.4 Taiwan, Philippines, Malaysia, Indonesia and Thailand: It is thought that these countries may be potential markets for New Zealand fruit.

In 1975, Malaysia imported Asian pears from China (2,100 t), Japan (29 t), Korea (532 t) (Anon., 1975).

The differences in quantities imported from Japan and China may indicate that China's lower quality fruit is preferred.

3.3.2.5 U.S.A.: Small quantities of Asian pears are now being grown in the Western States, California, Oregon and Washington. California has a large Japanese and Chinese population in Los Angeles and San Francisco, which is accustomed to eating Asian pears. NZAPMB reports suggest prices range from US$ 4-12 per tray (5 kg) depending on fruit size (Wilton, 1981).

Larger sizes in California are small by Japanese standards and would be equivalent to counts 90, 100, 110 as used for European pears.

These Western States clearly have opportunities for New Zealand Asian pears and may provide a demand for smaller-sized fruit which are less popular in South-East Asia.

3.3.2.6 Others: Affluent markets in Europe, especially Germany, which is already well acquainted with New Zealand produce, may offer potential.

Undeveloped countries with large expatriate Japanese and Chinese populations, such as Papua New Guinea and Brazil, show potential.

3.4 POST-HARVEST

3.4.1 Fruit Quality

The Japanese have set very high quality standards for this crop. The preferred size of fruit is about 350 gms, but wide variations from 50-1,500 gms occur. Fruit needs to be a uniform shape and blemish-free (Plate 1).

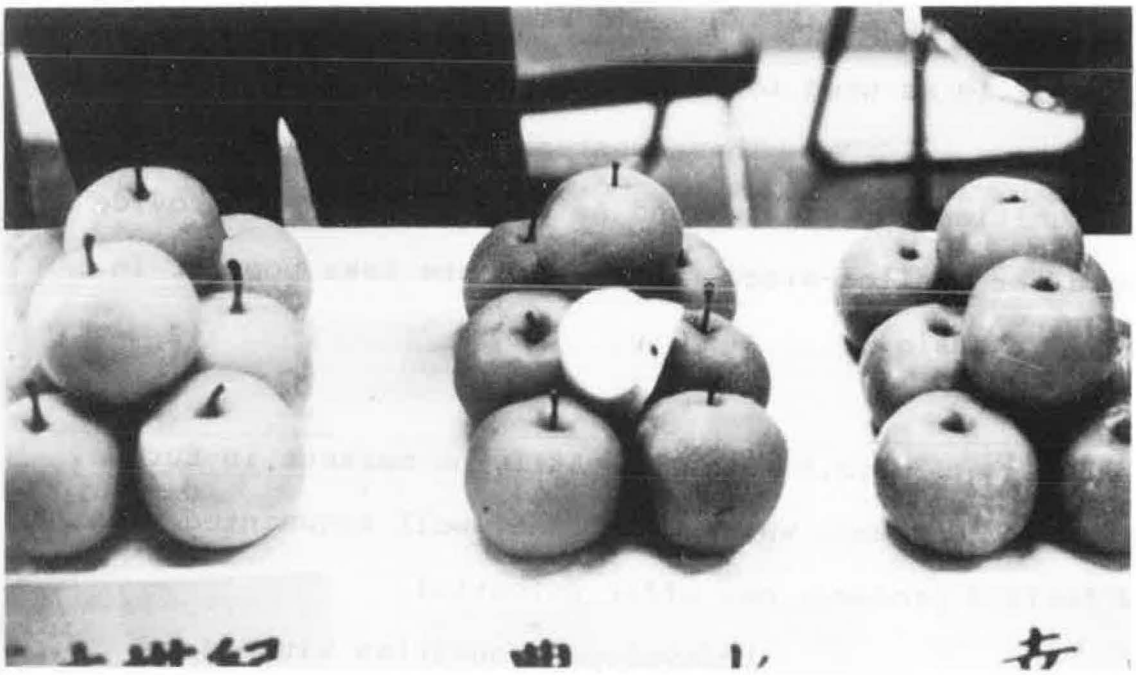


Plate 1 Japanese fruit at harvest.
Left to right: varieties - Nijisseiki - Hosui - Kosui.

Unlike the European pear, Asian pears are ripened on the tree. Their texture is very crisp and juicy, with a rather bland flavour.

An ideal fruit could be described as follows:

* 8-10 cm in diameter, round, regular.
* Golden yellow or pale silvery green, smooth and glossy (not waxy or oily).
* Free from russet, blemish and handling damage.
* Calyx should be very small or deciduous.
* Flesh free from grittiness, cracking texture and with a sweet delicate cucumber or rose water flavour.
* Fruit free from diseases, pear scab (*Venturia nashicola*) or blackspot (*Alternaria kikuchiana*).
* Freedom from lenticel spot and surface scale.
* Freedom from internal defects - browning of the core zone, water core (worse in some cultivars) and tart flesh near the core.

(McKenzie, 1980).

The Japanese high quality fruit is a result of very intensive management of small plantings (average size less than 0.5 ha). This high quality product contrasts markedly with poor quality nondescript fruit of the same varieties grown in Washington and California, where the trees are managed on the same basis as European pears. To penetrate existing Asian markets and to establish a local and export market where this crop is unknown, fruit approaching the quality of the Japanese will need to be grown and strict quality regulations will need to be enforced. In

New Zealand, a suitable standard of quality should be possible under our conditions with less management requirements than in Japan. Our climate, pest and disease situation and pollination conditions should eliminate some of the more labour-intensive operations necessary in Japan. The most important orchard practice will be at fruit thinning to select for only the correctly-shaped and blemish-free fruit (White, 1981).

3.4.2 Maturity

The Japanese fruit is generally harvested eating-ripe and sold within 7 to 10 days of harvest.

Colour charts and soluble solids are used to determine harvest dates. Generally fruit is not harvested until soluble solids reach 12% although some will achieve greater than 15%. For long-term storage, fruit would need to be harvested much earlier (Plate 2).

The fruit setting on spurs usually ripens a few days earlier than axillary fruit. The ease with which the stem can be separated from the spur by an upward twist is also used as an index of maturity. Internal breakdown of fruit often shows if the fruit is left on the trees too long (White, 1982).

Accurate assessment of maturity in New Zealand will be essential to ensure fruit being trans-shipped to export markets arrives in good condition.

A ground colour ratio curve, based on a pattern of green to yellow colour changes in the fruit, can be used to evaluate the maturation rate of individual fruits, and

thus harvesting dates. This method has been successful for determining the optimum harvest dates of Hosui, where fruit of a suitable yellow colour had no water core or pithiness. The colour index is a better maturity criterion than fruit size, days after full bloom or the calendar date.

3.4.3 Packaging

The Japanese fruit is hand-harvested into bags and transported to a co-op packing shed where it is hand-sorted and then placed individually onto an electronic grader. The fruit is then encased in a styrofoam sleeve and placed in a 15-kg two-layer carton. The tiers of fruit are packed on polystyrene trays (White, 1982).

Care is needed at harvest not to damage the peduncle which can blacken and become unsightly. The skin of the fruit is also very susceptible to rubbing, which shows as black marks on the skin after a few days, particularly with clear-skinned varieties. Bruising and stem puncturing tends to be a greater problem with larger sized fruit.

Another packing system, is to place fruits individually into polystyrene net bags of a plastic foam-type material, giving greater protection, and then into single-layered packs (Plate 3).

In the U.S.A., Asian pears are packed into a single-layered tray pack (Plates 4 and 5).

This very tender fruit will require more expensive packaging and handling methods than New Zealand is

Plate 2 U.S.A. fruit showing a wide range of maturity. Maturity colour charts (centre) can assist packers to select even lines.

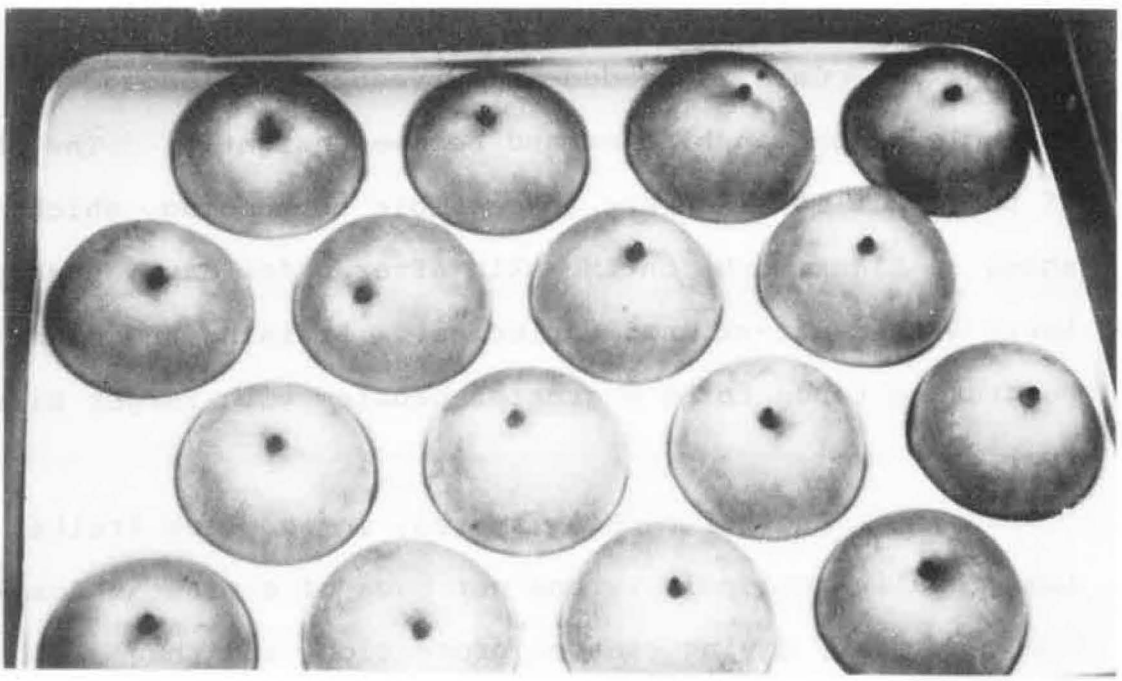


Plate 3 Single layered tray with Japanese fruit.

- large size, only 16 (400 gm) fruit per tray.
- foam pocketed tray with each fruit completely separated.

Plate 4 Single layered trays of USA fruit fully wrapped and enclosed, in a plastic liner.

Plate 5 Poor quality USA fruit.

- jumbled arrangement of fruit.
- excessive grader/handling marks.
- 'Blackend' of stems.

accustomed to giving pipfruit. Picking with gloves and placing into trays in the field may be necessary!

The New Zealand industry will need to consider carefully the packaging requirements, both with regard to market expectations and offering adequate protection for transportation.

Packaging Suggestions:

* Single-layered tray pack (4.0 kg).
* Strongly built to resist damage and protect the fruit (corrugated cardboard, tested to withstand 125 kg/2.5 cm^2 pressure).
* Polystyrene trays - pockets for each fruit/size range.
* Plastic bag around fruit/tray within the package.
* Larger fruits preferred. These may require extra protection with polystyrene nets or wax paper. Suggested size equivalents based on numbers of fruit per tray would be: 12, 16, 20, 24, 28 (i.e. giving an average of 20 fruit per tray for a 4 kg tray). Estimated equivalent weights (gms) of fruit with these size ranges would be 330, 250, 200 170, 140 grams respectively.

3.4.4 Storage

The Japanese have little interest or knowledge on the storage of Asian pears, because of the close proximity of the growing regions to the major markets.

It is claimed that Hosui and Kosui have relatively short storage life of only 1-2 weeks (Wilton, 1980). But some form of storage technology must be available because Asian pears are supplied to the Tokyo market

throughout the whole year.

In California, Asian pears are claimed to have a relatively long shelf life, maintaining their harvest quality for 10-14 days at room temperature. If held in cool storage at 0°C after harvest, most varieties keep 4-5 months. A few varieties, such as Chojuro, Okusankichi and Shinseiki, maintain acceptable quality for 6-7 months (Griggs and Iwakiri, 1977b).

Lombard (1983) found Nijisseiki fruit still in good condition after seven months at 0°C.

Maintaining the temperature close to 0°C is necessary to prevent freezing, because of their low soluble solid content. Fruit tends to break down internally once its storage life is reached, but does not show scald damage. The Ya-Li variety should be picked 2-3 weeks earlier to allow for late storage, otherwise it suffers from breakdown (Lombard, 1983).

New Zealand will need to assess each variety for storage characteristics as soon as possible.

White (1982) reported on the work of Dr Akiyashi Yamane, Director of Tottori Food Research Institute, who is one of the few people who has seriously looked at long-term storage of Asian pears (mainly with Nijisseiki and Sansui varieties).

3.4.4.1 Air Storage: Depending on maturity at harvest, Nijisseiki can be stored at 0°C for 1-3 months. Longer-stored fruit must be picked at an earlier stage of maturity. The Sansui variety is not suited to air storage (White, 1982).

3.4.4.2 Controlled Atmosphere (C.A.) Storage: Nijisseiki can be stored for up to 9 months in C.A. without losing quality. The Sansui variety cannot be stored very long, but C.A. does prolong storage life of this variety. Core flush is a problem with C.A. stored pears, especially Sansui which is sensitive to low O_2 levels. Atmospheres which are optimum are as follows:

	CO_2 %	O_2 %
Apples	3	3
Early maturity Nijisseiki (130 days after F.B.)	4	5
Later maturity Nijisseiki (150 days after F.B.)	5	8

(White, 1982).

3.3.4.3 Controlled Freezing Point Storage (C.F.): White (1982) reports that this is a new technique being developed in Japan by Dr Yamane. The freezing point of fruit is lowered by feeding a solution of sorbitol, sugar or urea into the fruit.

The solution is taken up through the freshly-cut stem of the fruit. Fructose appears to be the best sugar to use. Uptake of the solution takes about 1 week, after which the fruit is cooled. It is important to reduce temperature very slowly in the final stage, at $1^{o}C$ per day, until $-2^{o}C$ is reached. Shinsui can be stored for 10 months using this method without losing fruit quality.

3.4.5 Processing

There is no evidence in the literature that Asian pear-producing countries have developed processing products, although there seems no reason why juices, nectars, dried fruit, canned products and jams could not be developed for lower quality fruit.

4.0 FINANCIAL

4.1 INTRODUCTION

The analysis outlines the development costs for an Asian pear orchard starting from bare land and developing over a period of 10 years.

Costs and prices used are those current in November 1983. It is designed for the general case with information to help potential and existing orchardists rationalise their decisions for the development of a block of Asian pears. Indications are that initial developments of Asian pears will be by orchardists who have experience with other pip-fruit. Two financial assessment methods are used:

(i) Section 4.3 (Table 22) is a Cash Flow for 10 years on a 1-hectare block fully planted in Asian pears. Only direct capital, development and production costs related to the area are included. It is assumed than an existing orchardist is intending to expand into a 1-ha block of Asian pears; hence, land, machinery and buildings are already available on the property for this development. The effect of taxation is excluded. For an existing orchardist, the maximum allowance of $10,000 on development costs will not apply.

(ii) Section 4.4 (Table 24) is a Development Budget for 10 years on a 6-ha (5 ha planted) Asian pear orchard. It includes all costs associated with the development, such as purchasing land, house, machinery and plant.

It excludes the effect of taxation, borrowing and interest payments. Therefore these should be superimposed in order to be totally realistic for an individual property situation. Developing a new orchard will mean that the owner

is subject to the $10,000 maximum allowance claimable for development expenditure against other income.

4.2 CASH FLOW

The aim of this analysis is to illustrate the costs that are associated directly with the production of a 1-ha block of Asian pears. (Gross margin type of analysis looking at profitability of the crop.) Therefore, in order to undertake such an exercise, it is necessary to have available the necessary land and machinery for the development and maintenance of the crop and buildings.

The costings for the cash flow are shown in detail (Appendix 11) for the major management operations during the 10 years the analysis runs. These include: initial development costs, pruning/training, thinning, pest and disease control, mowing, fertiliser, irrigation, weed control and shelter maintenance.

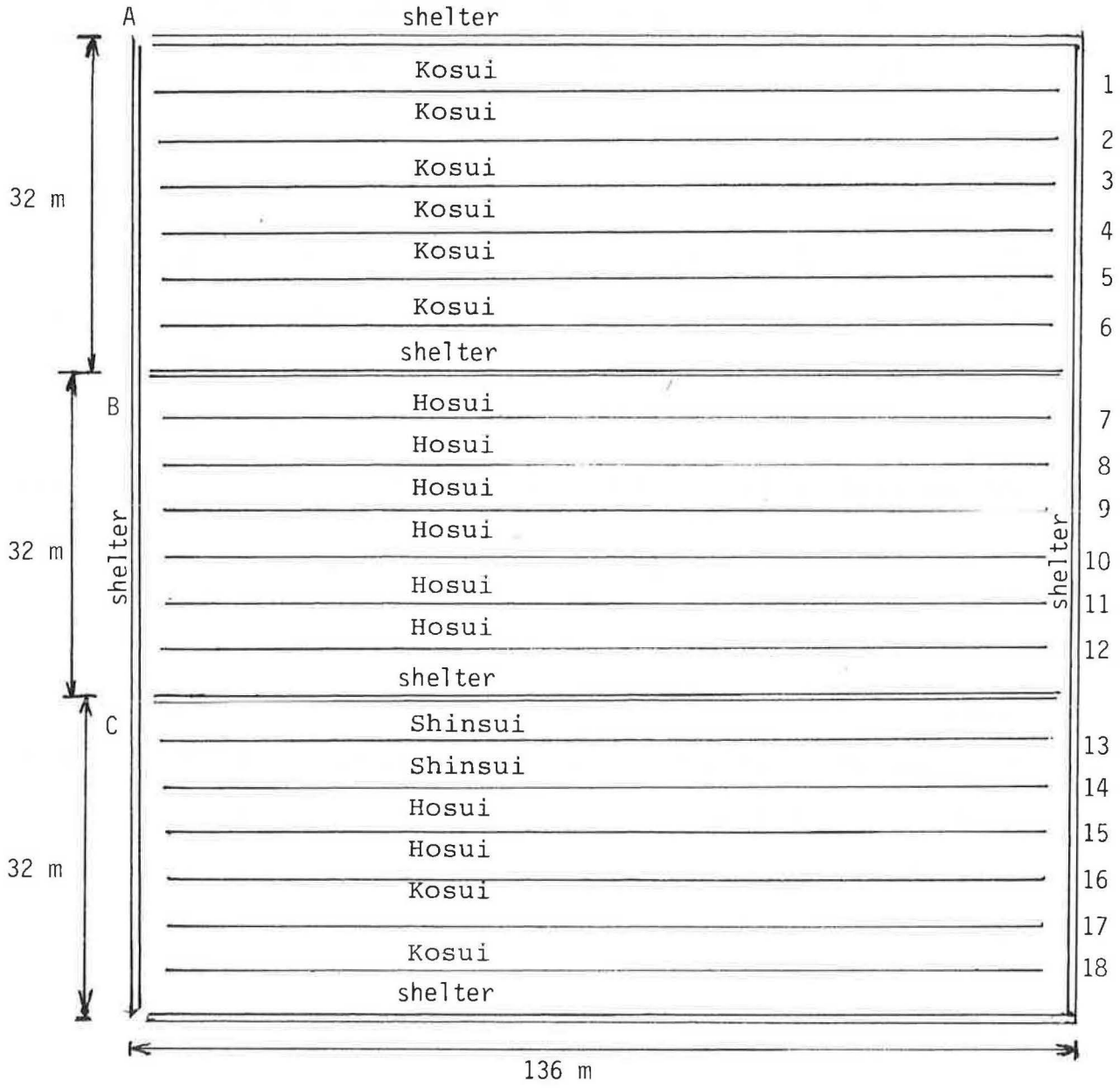
Production figures based on fruit/tree, and trays/ha are listed in Appendix 12, along with prices returned to the grower for export and local grade fruit.

4.2.1 Orchard Design

This is a guideline for the possible layout of a 1-ha block of Asian pears. (There are, of course, many variables and shapes in real orchard situations that will determine the dimensions of the blocks.)

The block is subdivided into three by two intermediary shelter belts (Fig. 12). The important feature is the layout of trees for cross-pollination purposes.

Figure 12: Design of a 1-hectare orchard of Asian pears.



3 Blocks, 6 rows wide

Spacing: 3.4 m within row, 36 trees/row.

36 x 6 rows = 216 trees/block (0.33 ha).

3 x 216 = 648 trees/ha.

Rows are 4.5 m apart, blocks 32 m wide.
Rows are 122 m long, allowing 7 m at either end for headlines.

Shelter:	2 intermediates (123 m x 2) (6 m headline at each end)	246 m
	2 boundaries (131 m x 2) (5 m entrance alley)	262 m
	2 ends (north and south) (96 m x 2)	192 m
	total shelter	700 m

Planting Scheme

Trees are planted as 1 year old whips on seedling *Pyrus pyrofilia* rootstock.

Varieties	Characteristics
Shinsui 60 trees (9%)	Early season - mid-January Full russet brown, small to medium size Flesh sweet, juicy, moderately gritty, excellent quality Kosui or Shinseiki as a cross pollinator
Kosui 252 trees (38%)	Mid-season - late January-early February Golden russet Medium size Fruit sweet, juicy, excellent quality Hosui, Shinsui or Shinseiki as cross pollinators
Hosui 264 trees (40%)	Mid-season - mid-February Full golden russet brown Medium to large size Fruit high flavour, sweet, tender, crisp and juicy Kosui or Shinseiki as cross pollinators
Shinseiki 72 trees (11%)	Fruit yellow, thin skin, medium size, firm flesh, sweet, medium eating quality Used as a pollinator variety in all blocks, every third tree in rows; 2, 5, 8, 11, 14 and 17.

The varieties Shinsui, Kosui and Hosui comprise the majority of new plantings in Japan. All are russet types, recently released from the Japanese breeding programme, showing favourable fruit characteristics.

The clear-skinned Nijisseiki variety was not included because it is more susceptible to skin damage and requires fruit bagging in Japan.

The variety Shinseiki is used as a pollinator as it is more compatible with most varieties of Asian pears. It is planted in rows: 2, 5, 8, 11, 14 and 17 as every third tree within the row.

4.2.2 Cash Flow Assumptions

4.2.2.1 Planting Assumptions:

1) Plant trees 3.4 x 4.5 m (650 trees/ha), total 1 hectare planted.

2) Land is available, cultivated 1984, plant trees and shelter, sow grass strips between rows autumn 1985.

3) Plant 1 year old whips, $13.50 each (No freight cost included).

4) Trickle irrigation installed 1984, a combined below-tree mist sprinkler/overhead system is to be utilised. Sprinklers can be telescoped to provide an overhead system for frost control. The advantage of the below-tree mist mode of operation is that it uses less water than the overhead sprinkler mode. Assumed cost $3,000/ha, a 10% proportion of a 10-ha block, includes pump and well cost, but if a dam is required, cost would be significantly higher. Irrigation for shelter, 1984, 1,400 m at $0.50/m,

$700. The frost protection extensions cost $2,500 and are installed in 1986. It is assumed that frosts are likely during blossom, therefore justifying the need for frost protection.

5) The 1 ha is subdivided into 3 blocks (0.33 ha each) by intermediate shelter belts, adopting intensive shelter as per kiwifruit developments. Artificial shelter would be an alternative, but its high cost makes it less desirable.

6) Drainage costs of $1,600/ha are included in 1984.

7) Posts and 2 wires at $1,300/ha are included 1985, as supports for the trees.

8) All labour cost are at $5.00 per hour.

9) All machinery costs are at $10.00 per hour for operations such as: weed control, pest and disease control, mowing, and fertiliser spreading. (If contracting is undertaken, these costs would be higher.)

10) Lime is applied every third year at 2.5 t/ha, beginning 1984. The first three years, orchard mix fertiliser is applied to individual trees by hand, along with urea. 1987 onwards, no urea is applied, and orchard mix is broadcast.

11) Thinning is the most labour-intensive operation, cost includes a twice-over thinning operation. No allowance is made for chemical thinning as it is not practised commercially.

12) Pruning/training costs are estimated per tree and on a hectare basis. These times will be altered by spacings and trellis systems.

13) An allowance for bird protection is included. It may be possible to apply chemicals (Mesurol) prior to harvest to deter birds (tolerances for marketable fruit and whether birds are deterred by chemicals on Asian pears is not known).

14) Cross-pollination with bees at $65.00 per hive is included. Two hives for 1987, and 1988 onwards three hives are used.

4.2.2.2 Yield - Assumptions:

1) The number of fruit per tree is calculated, with no marketable fruit until the third year (1987), and maximum yields reached in the eighth year (1992) onwards.

2) Total number of fruit per ha (fruit/tree x 650 trees/ha).

3) Assumed a single-layered tray will hold 4.0 kg of fruit. Count sizes are 12, 16, 20, 24, 28 with average sized fruit at count 20.

4) 50% yields - export quality fruit.
25% yields - local quality fruit.
25% yields - reject.

5) Price: export $2.00/kg (based on Hong Kong and Singapore) less $0.60/kg for marketing, returning $1.40/kg to the grower.

Price: local $1.00/kg (based on New Zealand wholesalers' impressions of fruit imported by NZAPMB from California, prices compare with European pears on the market) less $0.30/kg for marketing (freight, commission, etc.) returning $0.70/kg to the grower.

6) Harvesting cost:

Picking $0.12/kg
Packing/materials $0.28/kg
= $0.40/kg ($1.60/tray).

7) It is assumed tree growth is optimal for these yields, but hail storms, wind damage, poor pollination or other unfavourable climatic conditions will reduce quality/yields of fruit.

4.2.2.3 Alternatives:

1) Plant rootstocks rather than trees, buy in at $1.60 each. Grow on for 6-12 months, graft/bud at $4.00 each, grow on for another year before planting in the field as a 1 year old whip. Total direct cost of $5.60 (freight excluded) compared with $13.50 for a tree. But growing on for two years in a nursery area will demand time, water and shelter and other practices to ensure optimal growth, approximately $4.00 per tree for the two years. Reducing the margin to $3.90 per tree; $2,535 for 650 trees/ha. As a consequence, production will be delayed 2 years, therefore the opportunity cost of money will influence which decision a grower makes. Sites where shelter is essential, this would allow 2 years of growth on the shelter belts before the Asian pears are ready to plant in the field.

2) Sites not subject to frost, the $2,500 allowed for 1986 will not be required.

3) Depending on returns and influence of birds on the crop, a complete nylon netting cover could be installed for approximately $12,500/ha, which would result in higher quality fruit.

4) Erecting trellises (Tatura, Ebro, Pergola) have high establishment cost ($7,000 - $9,000/ha), but with denser plantings earlier yields of higher quality fruit result, proving a more profitable venture in the long-term.

4.2.3 Discussion of Cash Flow

The cash flow summarised in Table 22 for a semi-intensive block of Asian pears produces positive annual returns by 1988 (fourth year), but the accumulated cash flow is not positive until 1991 (seventh year). The internal rate of return (IRR), which is the interest rate equating the Net Present Value (NPV) to zero, is 24%. This is not the true IRR as overhead costs, land, machinery, buildings and plant are not included. The IRR calculated in this way is only useful as a yardstick to allow comparison of the profitability of other crops calculated on a similar basis. Figure 13 illustrates the relationship of NPV and various interest rates (discount factors). At a low interest rate, NPV is high, but with higher interest rates a rapid decrease in NPV occurs.

Using an interest rate of 0% (Fig. 14), the breakeven price of Asian pears is $0.71/kg at a constant estimated yield at maturity of 39,000 kg/ha/yr. This is $0.45/kg lower than the estimated average

Table 22: Asian Pear Cash Flow, 10 years, 1 hectare, semi-intensive (B)

Years	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Yield											
Asian Pears export	-	-	-	1300	3250	7800	16250	22750	26000	26000	26000
Asian Pears local	-	-	-	650	1625	3900	8125	11375	13000	13000	13000
Gross Revenue	-	-	-	2275	5687	13650	28437	39812	45500	45500	45500
Harvesting Costs											
Asian Pears export	-	-	-	520	1300	3120	6500	9100	10400	10400	10400
Asian Pears local	-	-	-	260	650	1560	3250	4550	5200	5200	5200
Total Harvesting	-	-	-	780	1950	4680	9750	13650	15600	15600	15600
Net Revenue	-	-	-	1495	3737	8970	18687	26162	29900	29900	29900
Capital Costs											
Trees	9775	-	135	-	-	-	-	-	-	-	-
Development	2090	1455	-	-	-	-	-	-	-	-	-
Irrigation	3700	-	2500	-	-	-	-	-	-	-	-
Total Capital Cost	15565	1455	2635	-	-	-	-	-	-	-	-
Production Costs											
Fertilizer	355	295	315	325	310	310	360	310	310	360	310
Pest & Diseases	80	275	435	680	830	1025	1170	1300	1475	1475	1475
Herbicides	85	120	120	120	120	120	120	120	120	120	120
Pruning/Training	-	210	315	380	485	595	730	810	945	945	945
Irrigation	100	100	100	130	140	150	160	170	180	180	180
Mowing	-	30	75	90	105	120	130	135	135	135	135
Thinning	-	-	-	320	415	595	730	945	1350	1350	1350
Pollination	-	-	-	130	200	200	200	200	200	200	200
Shelter	-	-	-	110	175	180	200	200	200	200	200
Bird Protection	-	-	-	150	200	250	300	300	300	300	300
Miscellaneous	100	100	100	150	150	150	150	150	150	150	150
Total Production Cost	720	1130	1460	2585	3130	3695	4250	4640	5365	5415	5365
Total Costs	16285	2585	4095	2585	3130	3695	4250	4640	5365	5415	5365
Annual Cash Flow	-16285	-2585	-4095	-1090	607	5275	14437	21522	24535	24485	24535
Accumulated Cash Flow	-16285	-18870	-22965	-24055	-23447	-18172	-3735	17787	42322	66807	91342

Price of Asian Pears Export $1.40/unit.
Price of Asian Pears Local $0.70/unit
At a discount rate of 0.00% the NPV is $91342
IRR is 23.9796%

Figure 13: Net Present Value ($) with interest rates varied.

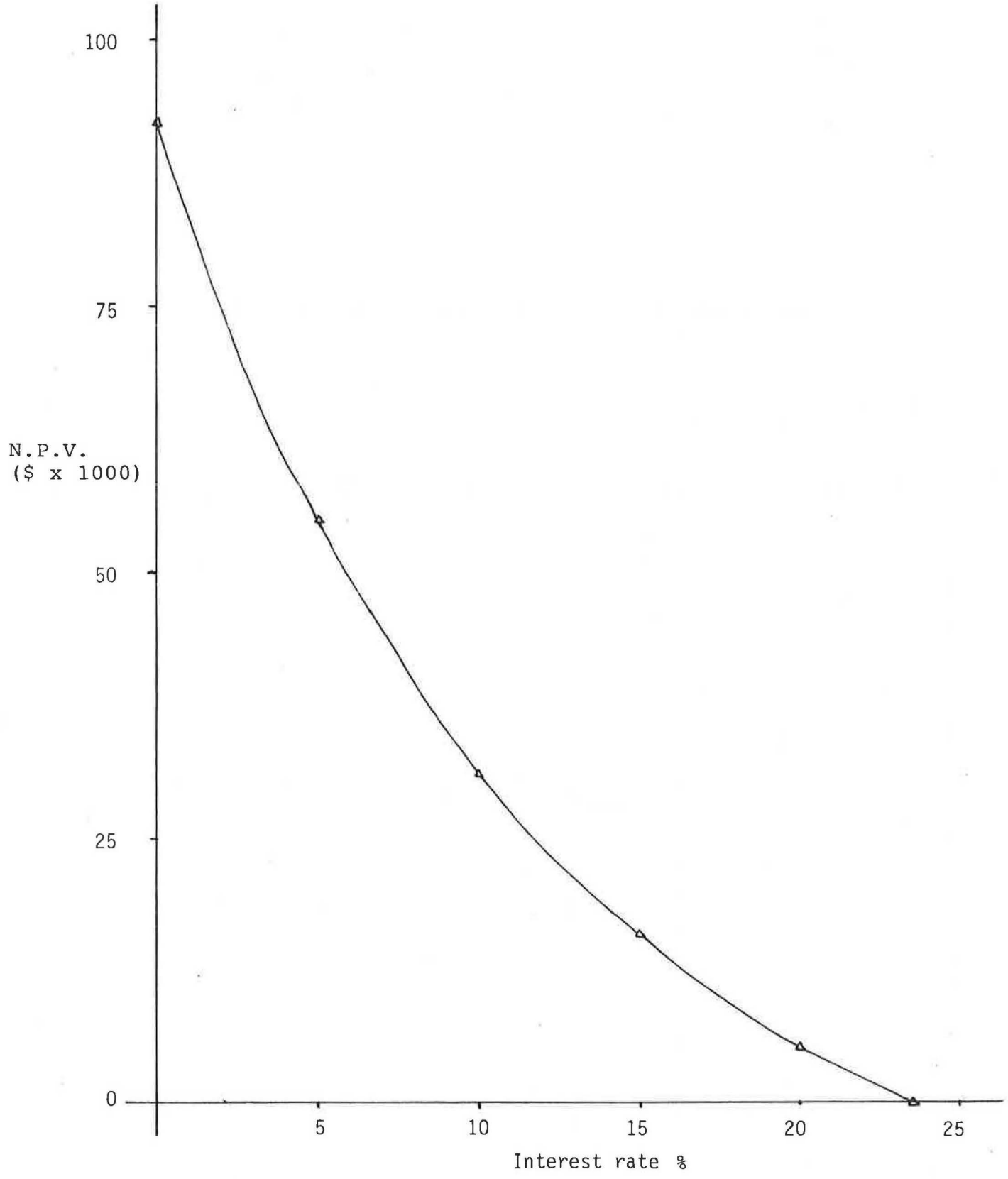
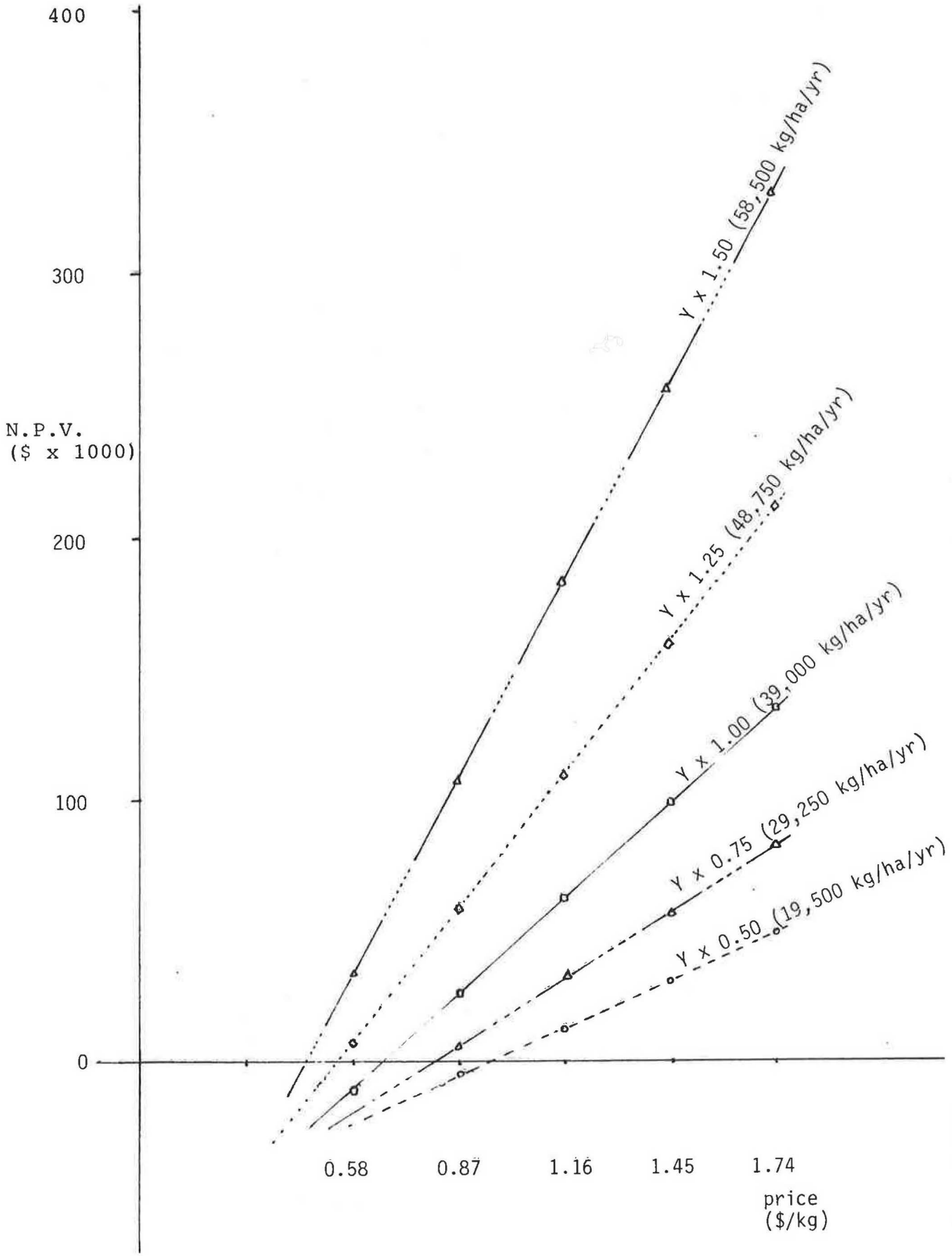


Figure 14: Net Present Value ($/ha) for Asian pears over a ten year period at 0% interest with yield and price factorised to calculate the breakeven price.



price of $1.16/kg. (50% export at $1.40/kg and 25% local at $0.70/kg).

Fluctuations in yields have been tested (Fig. 14). Increasing yields by 50% (58,500 kg/ha/yr) will mean a breakeven price of only $0.58/kg is required. If yields decreased by 50% (19,500 kg/ha/yr) a breakeven price of $0.98/kg is required.

Figure 15 illustrates the breakeven yield at 0% interest rate. If the estimated price is constant ($1.16/kg), the breakeven annual yield is 16,250 kg/ha (i.e., 22,750 kg/ha less than the estimated average yield of mature trees at 39,000 kg/ha). However, fluctuations of market prices may occur. If the price is 50% higher ($1.74/kg) then a breakeven yield of only 9,000 kg/ha/yr is required. This is 23% of the estimated average yield and emphasises the extent to which yield could drop in a high price, poor production year. If price dropped to 50% ($0.58/kg), then a breakeven yield of 63,375 kg/ha/yr (62% higher than the estimated average yield) is required.

These calculations emphasise that changes in yield demand a lower change in price to breakeven than the effect that prices have on yields. Price is the major variable factor influencing the cash flow calculations emphasising the importance of quality and market targeting.

Figure 16 illustrates the breakeven price at various interest rates. At 0%, a breakeven price of $0.71/kg occurs, while at higher interest rates (20%), a significantly higher price of $1.02/kg is required (in order to cover repayments of borrowed money).

Figure 15: Net Present Value ($/ha) for Asian pears over a ten year period at 0% interest with price and yield factorised to calculated the breakeven yield.

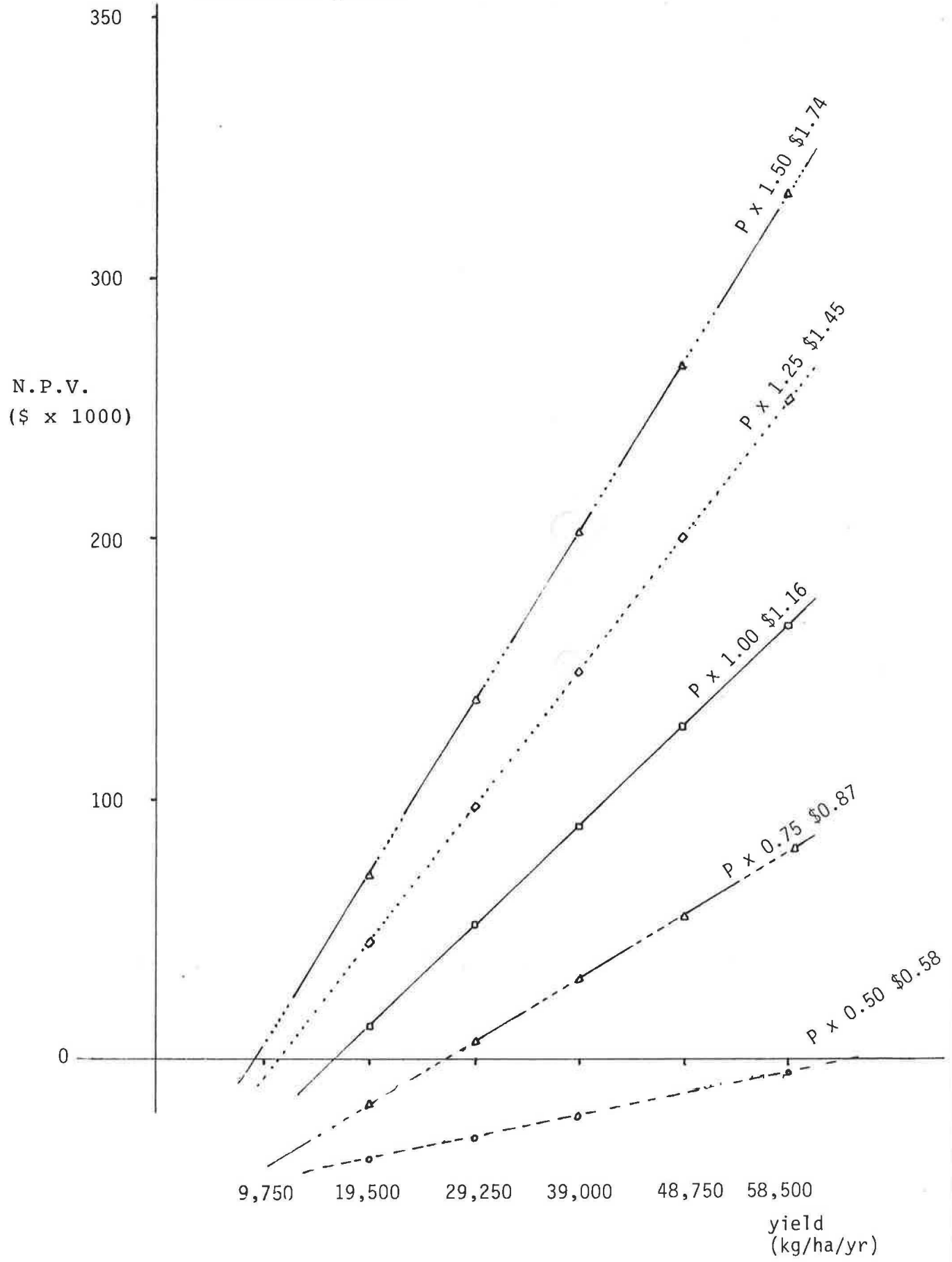
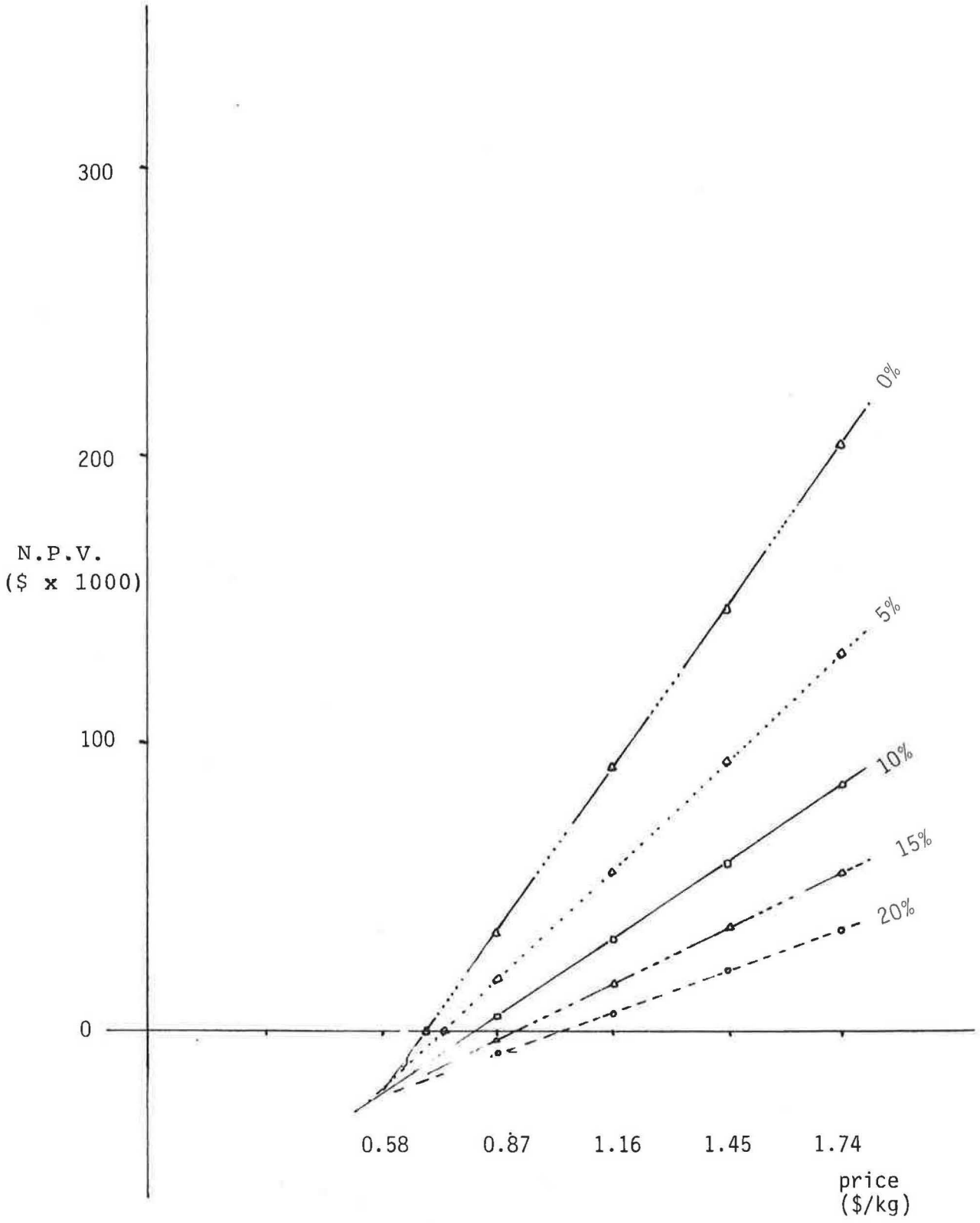


Figure 16: Net Present Value ($/ha) for Asian pears over a ten year period with interest rates and price factorised to calculate break-even prices (mature yield constant at 39,000 kg/ha/yr).



The breakeven yields vary significantly for differing interest rates, as shown in Fig. 17. At 0%, 16,250 kg/ha/yr is the breakeven yield, while at 20%, 32,250 kg/ha/yr is required, both are still below the estimated average yield of 39,000 kg/ha/yr.

For both the breakeven price and yield, the interest rate can increase before the estimated average price or yield is attained, but with the inclusion of land, machinery, buildings and plant the higher interest rates would not be feasible.

4.3 DEVELOPMENT BUDGET

The orchard model above is assumed to be non-self-contained, relying on machinery and plant currently on the property for this development as a diversification into a 1 hectare block of Asian pears.

But when such items are included in the cash flow, they will significantly influence the financial position. Table 23 lists the items required for an orchard development of 6 hectares, with 5 hectares planted.

Figure 17: Net Present Value (S/ha) for Asian pears over a ten year period with interest rates and price factorised to calculate breakeven yields (standard price of $1.16/kg).

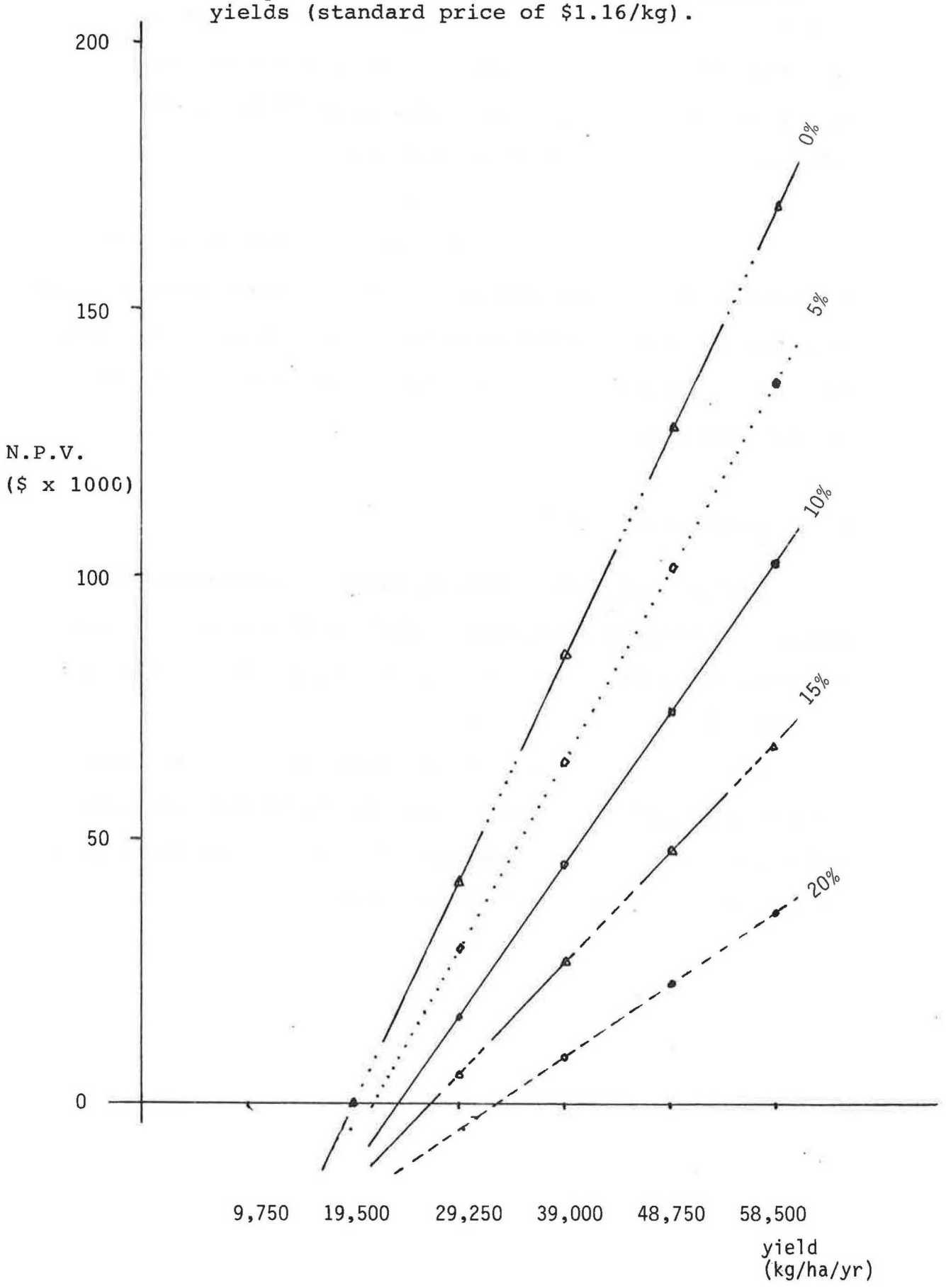


Table 23: Capital costs.

Item	Cost	Year Purchased
Implement shed	11,000	1984
New tractor	17,000	1986
Second-hand tractor	7,000	1984
Air-blast sprayer	8,800	1985
Mower	3,500	1986
Weed sprayer	1,300	1984
Fertiliser spreader	1,300	1984
3 pt linkage forklift	3,000	1986
Bins/trailers	9,000	(1500/yr) 1986-91
Miscellaneous tools and equipment	1,500	(500/yr) 1984-86
" " " " "	8,000	(1000/yr) 1987-94
Packing shed (18 x 9 m)	27,000	1986
Grader/equipment	30,000	1986
Truck	20,000	1987
TOTAL CAPITAL COST = $29,680/ha)	$148,400/5 ha	

Note: No cost for house is included. The capital costs for irrigation in the 1-ha cash flow are excluded.

Total production costs:

Development of a 5-ha orchard includes the production cost from the 1-ha cash flow (1 ha x 5) along with overhead/ running costs, giving a total of $403,600 for the 10 years.

4.3.1 Development Budget - Assumptions

1) Production costs, harvesting costs and yields are as in the 1-ha cash flow (i.e., 1 ha x 5) but include overheads (expenses and administration), permanent wages, repairs and maintenance, vehicle expenses

Table 24: Development Budget for Asian Pears, 10 years, 6 hectares, semi-intensive

Years	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Yield											
Asian Pears Export	-	-	-	6500	16250	39000	81250	113750	130000	130000	130000
Asian Pears Local	-	-	-	3250	8125	19500	40625	56875	65000	65000	65000
Gross Revenue	-	-	-	11375	28437	68250	142188	199063	227500	227500	227500
Harvesting Costs											
Asian Pears Export	-	-	-	2600	6500	15600	32500	45500	52000	52000	52000
Asian Pears Local	-	-	-	1300	3250	7800	16250	22750	26000	26000	26000
Total Harvesting	-	-	-	3900	9750	23400	48750	68250	78000	78000	78000
Net Revenue	-	-	-	7475	18687	44850	93437	130813	149500	149500	149500
Capital Costs											
Establishment	100200	20100	91700	27500	2500	2500	2500	2500	2500	1000	1000
Land	150000	80000	-	-	-	-	-	-	-	-	-
Property Sales	-	-	-	-	-	-	-	-	-	-	-400000
Total Capital Cost	250200	100100	91700	27500	2500	2500	2500	2500	2500	1000	-399000
Production Costs											
Orchard Costs	3600	12800	17400	25600	40900	44400	47600	49900	53800	53800	53800
Total Production Cost	3600	12800	17400	25600	40900	44400	47600	49900	53800	53800	53800
Total Costs	253800	112900	109100	53100	43400	46900	50100	52400	56300	54800	-345200
Annual Cash Flow	-253800	-112900	-109100	-45625	-24712	-2050	43337	78412	93200	94700	494700
Accumulated Cash Flow	-253800	-366700	-475800	-521425	-546138	-548188	-504850	-426438	-333238	-238538	256163

Price of Asian Pears Export $1.40/unit
Price of Asian Pears Local $0.70/unit
At a discount rate of 0.00% the NPV is $256163
IRR is 4.85638%

Table 24: Development Budget for Asian Pears, 10 years, 6 hectares, semi-intensive

Years	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Yield											
Asian Pears Export	-	-	-	6500	16250	39000	81250	113750	130000	130000	130000
Asian Pears Local	-	-	-	3250	8125	19500	40625	56875	65000	65000	65000
Gross Revenue	-	-	-	11375	28437	68250	142188	199063	227500	227500	227500
Harvesting Costs											
Asian Pears Export	-	-	-	2600	6500	15600	32500	45500	52000	52000	52000
Asian Pears Local	-	-	-	1300	3250	7800	16250	22750	26000	26000	26000
Total Harvesting	-	-	-	3900	9750	23400	48750	68250	78000	78000	78000
Net Revenue	-	-	-	7475	18687	44850	93437	130813	149500	149500	149500
Capital Costs											
Establishment	100200	20100	91700	27500	2500	2500	2500	2500	2500	1000	1000
Land	150000	80000	-	-	-	-	-	-	-	-	-
Property Sales	-	-	-	-	-	-	-	-	-	-	-400000
Total Capital Cost	250200	100100	91700	27500	2500	2500	2500	2500	2500	1000	-399000
Production Costs											
Orchard Costs	3600	12800	17400	25600	40900	44400	47600	49900	53800	53800	53800
Total Production Cost	3600	12800	17400	25600	40900	44400	47600	49900	53800	53800	53800
Total Costs	253800	112900	109100	53100	43400	46900	50100	52400	56300	54800	-345200
Annual Cash Flow	-253800	-112900	-109100	-45625	-24712	-2050	43337	78412	93200	94700	494700
Accumulated Cash Flow	-253800	-366700	-475800	-521425	-546138	-548188	-504850	-426438	-333238	-238538	256163

Price of Asian Pears Export $1.40/unit
Price of Asian Pears Local $0.70/unit
At a discount rate of 0.00% the NPV is $256163
IRR is 4.85638%

in the other figures used, it is questionable whether or not to apply inflation to land and building values. The trees will increase in value as they grow and should be near maximum value at the end of 10 years. Machinery and plant will have to be depreciated. A total terminal value after 10 years of $400,000 has been used in the calculations. This is likely to be conservative and should be altered according to the prospective orchardist's perception of inflation in values over time in the particular district being considered.

8) No provision is made for taxation savings or payments. Savings in taxation (by offsetting losses against other income) could substantially reduce cash input needed in the development years and increase the real internal rate of return.

9) No allowance has been made for borrowing in the initial years or investment of profits in later years as this depends on individual circumstances.

10) The two-tier levy currently in operation by the NZAPMB is excluded from the development budget.

4.3.2 Discussion on the Development Budget

The development budget summarised in Table 24 indicates a positive annual cash flow by 1990 (6th year), but the accumulated cash flow does not become positive until 1994 (10th year). The IRR is 5%, considerably lower than the 24%, estimated for the simple cash flow, due to the

inclusion of land, buildings, machinery and plant costs in the development budget. This 5% is the true rate of return, but is subject to change with the inclusion of taxation mortgage repayments, inflation and other items listed in Section 4.3.1.

Breakeven calculations can be made for the development budget figures in the same way as illustrated for the 1 ha cash flow estimates by parametising yield, price and interest rate figures. For example, at an interest rate of 10% a weighted average price of $1.49/kg is needed to breakeven. An alternative interpretation is that there is a 10% internal rate of return at an average price of $1.49/kg. As with the cash flow calculations, change in price is the critical factor in profitability.

At the standard estimated price of $1.16/kg and 10% interest rate, an annual yield at maturity of 57,525 kg/ha is required to breakeven.

5.0 RECOMMENDATIONS

(i) Priorities for Asian pears in New Zealand:

* Select varieties offering the most potential based on fruit characteristics, potential markets and the marketing season.
* Develop techniques to store these varieties for a minimum of two months to allow export to Northern Hemisphere markets.
* Develop suitable handling and packing techniques.
* Breed varieties tailored to New Zealand climatic conditions, management practices and market requirements.

(ii) Objectives of breeding should include:

* Late flowering to avoid frost.
* Later maturity season (hence less time in storage before marketed in the Northern Hemisphere).
* Good storage and handling qualities.
* Good quality flesh.
* Larger sized fruit.

(iii) A suggested monitoring system:

The DSIR has established a New Crop Scheme (discussed in Section 2.6.2) for evaluation of fruit in research and commercial trial blocks of 5 varieties on properties throughout New Zealand. Their aim is to gather fruit and assess its value for breeding purposes. With these trials already under way in New Zealand, this provides an ideal opportunity

to begin collecting data on Asian pears. This could include assessment of rootstocks, varieties, tree growth, flowering and fruit development in relation to growers' management practices.

A monitoring system to create a data base of information for knowledge, analysis and applications at a later date will be very useful (similar to that currently in operation in kiwifruit and blackcurrants). Growers are now realising the importance of such systems.

Monitoring helps to strengthen knowledge and understanding of the crop. Such systems need to be producer-orientated and to have a strong producer/consultant interface. Thiele (1983a, b) provides details on the monitoring approach.

6.0 CONCLUSION

It is clear that there are gaps in the Northern Hemisphere market supply of Asian pears which New Zealand could fill. The period June to August suits Southern Hemisphere production. Research work needs to be conducted on varieties and storage to ensure high quality produce.

Although the New Zealand industry is in its infancy, the DSIR, MAF and marketing organisations are already co-operating to see that New Zealand producers obtain high quality propagating material to fulfil export market demand. Varieties such as Hosui, Kosui, Shinsui and Nijisseiki seem to hold the most promise.

A firm local market will be important to back up the export industry. Preliminary consumer surveys using imported fruit have been inconclusive and further work on the local scene is required both with fresh and processed products.

It is likely that Asian pears will grow in New Zealand under similar conditions to those of the common pear, but more precise husbandry procedures will be needed to produce the quality demanded by Asian markets. There remains to be overcome the quarantine restrictions (due to codling moth) strictly enforced by Japan and Korea. As yet there is no sign of these regulations being relaxed.

A comparison of Japanese and New Zealand climatic conditions illustrates that Asian pears will grow favourably in pipfruit growing districts throughout New Zealand.

Although this paper documents what appears to be a bright future for an Asian pear industry in New Zealand

based on fresh export, careful co-ordination and co-operation is essential, with a degree of restraint to ensure sound and gradual development.

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APPENDIX 1: Characteristics of Japanese misunashi pear cultivars (from Seike, 1973).

Ripening season/ cultivars	Period Bloom to harvest (days)	Skin color (1)	Fruit size (2)	Sugar content (3)	Flesh firmness (4)	Acidity (5)	Eating quality (6)	Keeping quality (7)	Remarks
Early:									
Hayatama	100-110	RB	S-M	L-M	F	M	M	P-M	The earliest Japanese pear. Susceptible to black spot.
Choju	105-115	PRB	M	M	M	L	G	P	New early cultivar. Resistant to black spot.
Kimizuka-wase	105-115	RB	M	M	M	L	G	P	Shows biennial bearing and core breakdown.
Yakumo	110-120	YG	S	M	S-M	M	G	G	Tree size is small. Resistant to black spot.
Tama	115-125	PRB	M	M-H	M	L	G	M	New early cultivar. Resistant to black spot.
Shinsui	115-125	RB	S-M	H	S	H	E	M	A promising new cultivar. Susceptible to black spot.
Hakko	115-125	YG	L	M	S	M	G	P-M	An attractive early cultivar. Resistant to black spot.
Kosui	120-130	PRB	M	H	S	L	E	M	A promising new cultivar. Resistant to black spot.
Shinseiki	120-130	YG	M	M	F	H	M	M	Resistant to black spot.

APPENDIX 1 (contd.) : Characteristics of Japanese misunashi pear cultivars (from Seike, 1973).

Ripening season/ cultivars	Period Bloom to harvest (days)	Skin color (1)	Fruit size (2)	Sugar content (3)	Flesh firm-ness (4)	Acidity (5)	Eating quality (6)	Keeping quality (7)	Remarks
Midseason:									
Chojuro	135-150	RB	M	H	F	M-L	M	M	Resistant to black spot.
Kikusui	135-145	YG	M	H	S	H	E	P	Resistant to black spot.
Hosui	135-145	RB	M-L	H	S	H	E	G	A promising new cultivar. Resistant to black spot.
Nijisseiki	140-155	YG	M	M	S	H	G	G	The leading cultivar. Susceptible to black spot.
Late:									
Niitake	155-170	RB	VL	M-H	M	M	G	G	The earliest blooming cultivar with infertile pollen. Resistant to black spot.
Shinko	155-170	RB	M-L	M-H	M	H	M-G	G	Resistant to black spot.
Imamuraaki	180-195	RB	VL	M-H	M	H	M-G	VG	Resistant to black spot.
Okusankichi	195-210	RB	VL	S-M	M	VH	M-H	VG	Traditional long keeper

Symbols:
1. R=russet, B=brown; Y=yellowish; G=green; P=partially.
2. S=small (200 g); M=medium (250-300 g); L=large (400-450 g); VL=very large (>450 g).
3. L=low (10% soluble solids); M=medium (10-11.5%); H=high (>12.5%)
4. S=soft (4.0 lbs); M=medium (4.5-5.0 lbs); F=firm (> 5.0 lbs).
5. L=low; M=medium; H=high; VH=very high.
6,7. P=poor; M=medium; G=good; VG=very good; E=excellent

(Source: Kanato, K.; Kajiura, I., 1982. The Ideal Japanese Pear, pp 138-155. In: Childers, N.F.; van der Swet, T. (editors), The Pear.

APPENDIX 2: VARIETY CHARACTERISTICS - (averages for three to five years at Davis, California).

	Tree	Dates	Season if held at 32°F (0°C)	Fruit characteristic at harvest: Size	Shape	Stem	Skin	Flesh	Quality
SHINSEIKI Early-maturing Origin:Japan (1945); seedling of Nijisseiki x Chojuro.	Medium size and vigor, spreading, medium dense, productive	First bloom: 3/18. Full bloom: 3/23. Harvest: 7/25 to 8/15	Harvest through January	Lgth: 57 mm Diam: 67 mm Wgt: 153 g	Uniform, globular to oblate in longitudinal section, circular in transverse section.	Length 19 mm; relatively straight; light green; pubescent with raised, tan to brown, oval or oblong lenticels.	Yellow;taste bland; medium tough & thick; surface fairly smooth, semiglossy; lenticels light brown, conspicuous, small to medium, slightly raised, hexagonal or roundish.	White;sweet, mild; soluble solids 12.7%; aroma faint; texture firm, crisp, juicy; more pulpy & coarse with more stone cells than Twentieth Century	Good to to excellent
KIKUSUI Mid-season variety. Origin: Japan (1927); seedling of Taihaku x Nijisseiki.	Medium size and vigor, spreading, slightly drooping, dense, very productive	First bloom: 3/21; Full bloom: 3/27. Harvest: 8/10 to 8/19	Harvest through January	Lgth: 58 mm Diam: 73 mm Wgt: 185 g	Uniform, oblate and lopsided in longitudinal section, angular in transverse section.	Length 31 mm; slightly curved; broader at cavity; light green; slightly pubescent with raised, light tan, elliptical lenticels.	Yellowish green, usually faintly mottled with green; slightly bitter; relatively tough & thick; surface dull, smooth except for lenticels; lenticels conspicuous, medium sized, slightly raised, hexagonal or roundish, tan.	White; sweet, mild trace of tartness; soluble solids 14.4%; faint aroma peculiar to variety; texture firm, tender, crisp, juicy; somewhat more pulpy and coarse with more stone cells than Twentieth Century.	Good to very good.
NIJISSEIKI (TWENTIETH CENTURY) Mid-season variety. Origin: Japan (1898); chance seedling.	Medium size and vigor, medium upright-spreading, dense, productive.	First bloom: 3/18. Full bloom: 3/25. Harvest: 8/10 to 8/20	Harvest through December	Lgth: 55 mm Diam: 66 mm Wgt: 146 g	Fairly uniform; round to oblate, often lopsided, in longitudinal section; circular in transverse section.	Length 25 mm; slightly curved; light green; pubescent with raised, tan, oval lenticels.	Greenish yellow, mottled with green; taste bland; relatively thin & tender; surface smooth, dull to semiglossy; lenticels inconspicuous, small to medium size, slightly raised, round or hexagonal, light tan.	White; sweet, mild, refreshing, slight tartness; core slightly acidic; soluble solids 12.3%; aroma slight; texture firm, tender, crisp, very juicy, somewhat coarse & pulpy (compared with Bartlett fruits), with a few stone cells.	Good to excellent
CHOJURO Mid-season russet-skinned. Origin: Japan (1895); chance seedling.	Medium size, vigorous, spreading, slightly drooping, dense, very productive	First bloom: 3/17. Full bloom: 3/24. Harvest: 8/9 to 8/19	Harvest through January	Lgth: 54 mm Diam: 66 mm Wgt: 150 g	Oblate and lopsided in longitudinal section, circular or slightly angular in transverse section.	Length 28 mm; slightly curved; brown with greenish tint on exposed side, green on shaded side; lenticels very small, raised, light tan, elliptical.	Greenish brown to brown; taste faintly astringent; relatively tough, medium thick; surface completely russeted, usually dull; lenticels conspicuous, medium size, slightly raised, roundish or hexagonal, light tan.	White, mildly sweet, somewhat bland, core somewhat sour; soluble solids 13.4%; distinctive, characteristic aroma; texture firm, crisp, somewhat coarse and pulpy, some stone cells; less tender & juicy than the green-skin types.	Good
OKUSANKICHI (BANSANKICHI) Large, late-season, russet-skinned. Origin: Japan (an old variety) open-pollinated seedling of Wasesankichi	Fairly large very vigorous, upright, spreading, dense, productive.	First bloom: 3/21. Full bloom: 3/27. Harvest: 9/20 to 10/15.	Harvest through February	Lgth: 86 mm Diam: 93 mm Wgt 390 g	Turbinate or globular in longitudinal section, circular to somewhat angular in transverse section.	Length 35 mm; relatively straight; green; lenticels raised, tan, circular to elliptical.	Greenish tan to tan; taste somewhat bitter; tough, relatively thick; surface russeted, dull; lenticels conspicuous, large, raised, round or hexagonal, light tan.	Dull white; slightly tart, refreshing; soluble solids 12.0%; aroma faint or lacking; texture firm, crisp, juicy, relatively few stone cells; more coarse & pulpy than Twentieth Century.	Poor to fair.

APPENDIX 2 (contd): VARIETY CHARACTERISTICS - (averages for three to five years at Davis, California).

	Tree	Dates	Season if held at 32°F (0°C)	Fruit characteristic at harvest: Size	Shape	Stem	Skin	Flesh	Quality
YA LI Late-season variety. Origin: China; old variety.	Large, vigorous, upright, somewhat spreading, dense, productive	First bloom: 3/10. Full bloom: 3/17. Harvest: 9/8 to 9/23	Harvest through December	Lgth: 82 mm Diam: 70 mm Wgt: 198 g	Fairly uniform; turbinate to globular-acute-pyriform in longitudinal section, often lop-sided, neck obscure in some specimens; circular in transverse section.	Length 47 mm; curved; broader at cavity; fleshy, often lipped; light brown, some with greenish tint; lenticels small, elliptical, slightly raised, sparsely scattered, tan.	Light greenish-yellow; taste bland; moderately tough, medium thick, surface smooth, dull to semi-glossy, slightly waxy; lenticels conspicuous, small to medium, slightly raised, numerous, pentagonal or hexagonal, tan; usually free of russet.	White; mildly sweet, trace of tartness; soluble solids 11.7%, fragrant aroma; texture tender, crisp, juicy, slightly pulpy and coarse, relatively few stone cells	Good to excellent.
TSU LI Late-season variety. Origin: China; old renowned variety.	Large, vigorous, upright, dense, moderately productive.	First bloom: 3/10. Full bloom: 3/18. Harvest: 9/10 to 9/23.	Harvest through January	Lgth: 88 mm Diam: 75 mm Wgt: 242 g	Variable; ovate-pyriform in longitudinal section, neck obscure in some specimens; circular to angular in transverse section	Length 40 mm; broadened near cavity, may be lipped; slightly curved, often obliquely set; brown or brown with a greenish tint; lenticels raised, medium-sized, elliptical, tan.	Light green to yellowish green; taste slightly bitter; relatively tough and thick; surface semi-glossy, but lenticels make it look rough and dull; lenticels numerous, small to very large, raised, roundish or polygonal, tan.	White with faint tint of yellow; sweet, trace of tartness, refreshingly mild; soluble solids 13.1%; aroma distinct and characteristic of the variety; texture firm, tender, crisp, juicy, somewhat coarse and pulpy.	Good

TERMS:

ACUTE - sharply pointed but not drawn out.

CAVITY - depression in which stem is set and joined to fruit axis.

ELLIPTICAL - in the form of a flattened circle.

GLOBULAR - nearly rounded or spherical.

LENTICEL - a pore surrounded by cork.

OBLATE - flattened at the poles; axis is shorter than diameter.

OVATE - shaped like longitudinal section of hen's egg, the broader end basal.

PUBESCENT - covered with fine, short, soft hairs.

PYRIFORM - the classical pear shape.

TURBINATE - shaped like a top or inverted cone.

(Source: Griggs, W.H.; Iwakiri, B.T., 1977a. Asian Pears in California, pp 1-12. Division of Agricultural Science, University of California.)

APPENDIX 3: FRUIT CHARACTERISTICS OF ASIAN VERSUS BARTLETT PEARS. [1/]

Type of pear and variety	Fruit characteristics at harvest: Size: Weight	Size: Length	Size: Diameter	Stem: Length	Stem: Mid diameter	Shape: Longitudinal section	Shape: Transverse section	Skin: Colour	Skin: Surface	Skin: Lenticel size	Flesh: Firmness	Flesh: Soluble Solids	Quality
	(g)	(mm)	(mm)	(mm)	(mm)						(lb)[2/]	(%)	
Japanese													
Shinseiki	153	57	67	19	2.6	Globular to oblate	Circular	Yellow	Semi-glossy	Small to medium	8.3	12.7	Good to excellent
Seigyoku	213	62	76	24	2.5	Oblate	Circular	Greenish yellow	Semi-glossy	Small	7.7	12.6	Good to very good
Kikusui	185	58	73	31	2.4	Oblate & lopsided	Angular	Yellowish green	Dull	Medium	7.6	14.4	Good to very good
Nijisseiki (Twentieth Century)	146	55	66	25	2.6	Round to oblate, often lopsided	Circular	Greenish yellow	Dull to semi-glossy	Small to medium	7.0	12.3	Good to excellent
Ishiiwase	200	62	74	35	2.8	Oblate	Circular	Greenish brown	Russeted	Small to medium	7.6	12.7	Fair to good
Chojuro	150	54	66	28	2.5	Oblate and lopsided	Circular	Greenish brown to brown	Russeted	Medium	10.9	13.4	Good
Okusankichi (Bansankichi)	390	86	93	35	3.3	Turbinate or globular	Circular	Greenish tan	Russetec dull	Small to medium	7.8	12.0	Fair
Chinese													
Ya Li	198	82	70	47	2.7	Globular-acute-pyriform	Circular	Light greenish yellow	Dull to semi-glossy	Small to medium	6.8	11.7	Good to excellent
Tsu Li	242	88	75	40	3.0	Ovate-pyriform	Circular to angular	Yellowish green	Semi-glossy	Small to very large	8.0	13.1	Good to excellent
Occidental													
Bartlett	215	93	73	33	3.3	Oblong-obtuse-pyriform	Angular	Greenish yellow	Semi-glossy	Small	17.7	11.7	----------
Bartlett (after ripening)								Yellow			2.3	13.0	Good to excellent

1/ Values are averages for 3 to 5 years at Davis, California.
2/ Measured by a Magness and Taylor type pressure tester using a 5/16 inch plunger head.

(Source: Griggs, W.H.; Iwakiri, B.T., 1977a. Asian Pears in California. In: Childers, N.F.; van der Swet, T. (editors), The Pear.

APPENDIX 4: PERCENT FRUIT-SET FROM SELF AND CROSS-POLLINATION OF ASIAN VARIETIES

PERCENT FRUIT-SET FROM ASIAN VARIETIES[1]

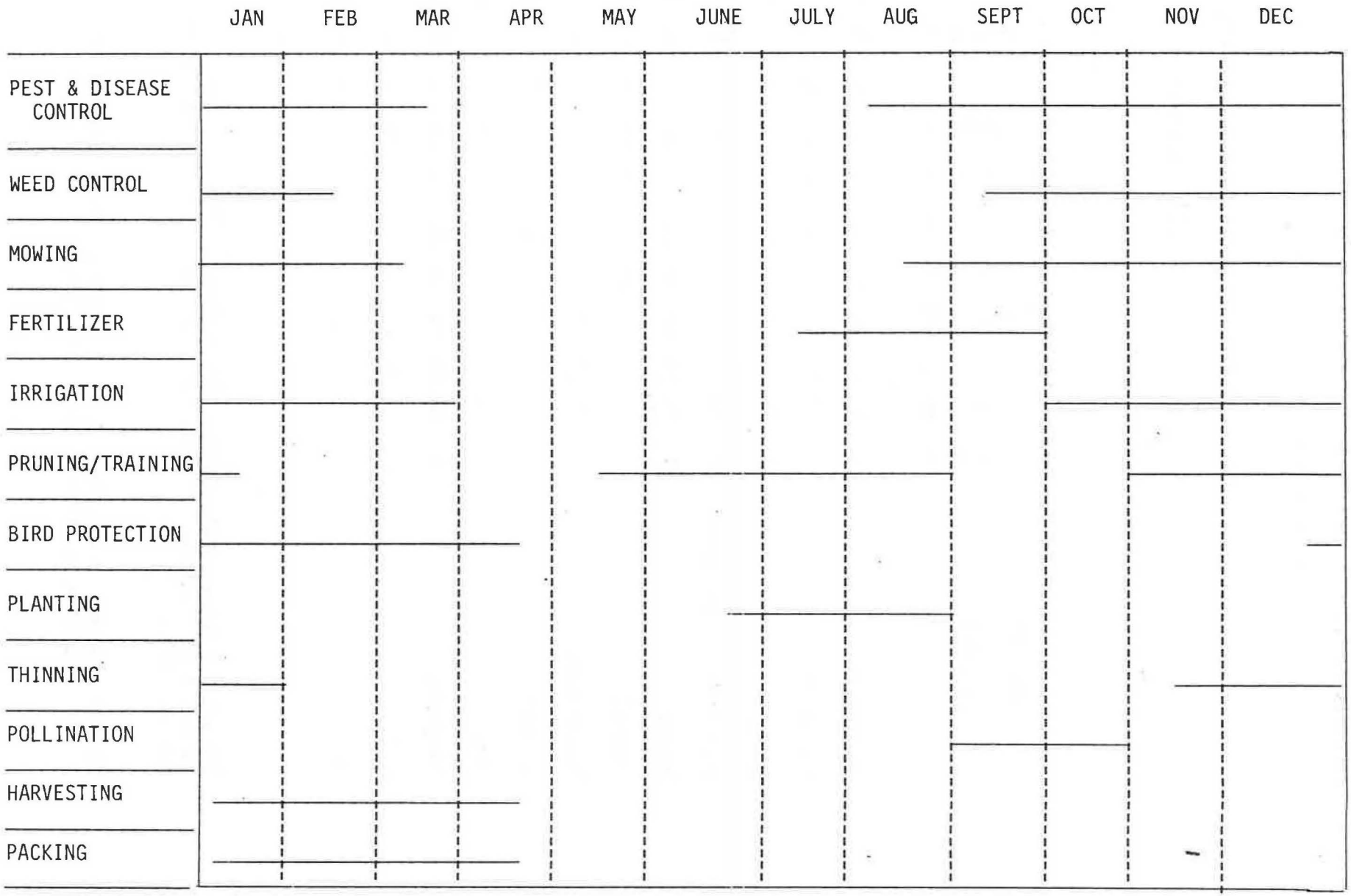
Variety pollinated	Pollen variety: Imamura Aki	Shinseiki	Chojuro	20th Century	Doitsu	Kikusui	Okusankichi	Seigyoku	Kumoi	Ishiiwase	Ya Li	Tsu Li	Bartlett
Imamura Aki	0	13	17	25	11	21	-	10	0	0	19	6	19
Shinseiki	9	11	42	40	29	39	30	12	0	8	38	39	36
Chojuro	7	20	5	20	50	20	-	5	0	-	47	25	17
Nijisseiki (20th Century)	36	47	54	0	7	3	10	8	0	4	56	57	57
Doitsu	26	45	14	22	0	22	-	22	-	-	4	38	25
Kikusui	-	53	65	20	43	6	3	41	2	21	35	41	45
Okusankichi	-	22	14	31	-	28	3	-	-	-	-	-	16
Seigyoku	-	0	16	24	38	32	8	0	0	-	26	50	46
Kumoi	-	40	33	42	27	69	-	57	3	-	32	49	8
Ishiiwase	6	43	16	25	14	41	-	27	0	0	-	23	32
Ya Li	12	24	25	60	-	34	-	9	-	-	1	16	24
Tsu Li	0	8	9	4	-	2	-	-	-	-	31	2	6

[1]Values are percentages of emasculated flowers that set fruits following self or cross pollination. Pollination tests were made during the period 1965 through 1976.

(Source: Griggs, W.H.; Iwakiri, B.T., 1977b. Asian Pear Varieties in California, University of California.)

APPENDIX 5: ASIAN PEAR

ORCHARD MANAGEMENT CALENDAR



APPENDIX 6: HOURS OF LABOUR FOR ORCHARD MANAGEMENT OF ONE HECTARE OF NIJISSEIKI PEARS IN TOTTORI PREFECTURE, JAPAN (1972).

Orchard Management		Period	Hours of labour	N.Z.*
Fertilizer application	Application	Sept. to Feb.	100	15
	Transportation	Sept. to Feb.	10	2
Training and pruning	Pruning	Winter	760	110
	Training and binding to trellis	Winter to Spring	450	0
	Training in summer	Summer	60	80
Soil management	Tillage	Winter	50	9
	Weeding	Spring to Summer	90	3
Disease and pest control	Chemical spray	Spring to Fall	60	25
Artificial pollination	Pollen collection	Early April	30	-
	Pollination	Mid-April	200	-
Fruit thinning and bagging	Fruit thinning	April to May	680	270
	Fruit bagging	May to June	1,680	-
Harvest	Harvest of fruit	Aug. to Sept.	950	400
	Transportation	Aug. to Sept.	100	20
Total			5,220	924

*Estimates for hours of each operation in New Zealand as used in the cash flow.

(Source: Uraki, M., 1982. The culture of Nijisseiki Pears in Tottori Prefecture, Japan, pp 77-83. In: Childers, F.H.; van der Swet, T. (editors, The Pear.)

APPENDIX 7: RECOMMENDED FIREBLIGHT CONTROL FOR EUROPEAN PEARS

FIREBLIGHT

Fireblight is the single biggest killer of pears. The source of infection is spread by bees to flower parts after having first fed on bacterial ooze from infected fruit.

Bacterial blast kills only flowers and spurs whereas fireblight moves down into the wood having killed the flowers and spurs (shoots) first. The disease finds easy entry through wounds, rub, breaks of severe hail damage areas. Late blossom is particularly prone to infection.

Conditions optiminal for fireblight

When temperatures exceed 16°C with relative humidity 70%+ or if plants have a wet surface.

The disease overwinters in cankers on the trees.

Remedy

Cut back 30 cm from point of noticeable infection.
Sterilise secateurs
Sterilize all cuts made

	Waiting Period	Protectant	Eradicant	Persistence	Systemic	Resistence
Bordeaux	Nil	Good	No	V. good	No	No
Copper Oxychloride (kocide)	Nil	Good	No	V. good	No	No
Agrimycin (Antibiotic) needs refrigeration storage	35 days	Good	2 days after infection	3 days to breakdown	Yes	Possible

	Uses		Russet	Bonus	Blossom/Light Damage
	Young Trees/Cropping				
Bordeaux	Dormant	Dormant	Severe	Dormant Fungicide	Severe
Copper Oxycloride (kocide)	All year	Summer	Some	Good Black Spot control	No
Agrimycin	Nil	Blossom	Slight	None	No

(Source: Jenner, K. in
Pulford, W.M., 1983. Summary of European and Asian Pear Seminar, pp 1-10, MAF, Motueka, New Zealand [mimeography].)

APPENDIX 8: RECOMMENDED SPRAY PROGRAMME FOR NIJISSEIKI PEARS IN TOTTORI, JAPAN, 1978.

Stage of Growth	Period*	Chemicals	Diseases and pests 1/
Just before bud scale fall	Late March	Cyanox + Difolatan	Black spot, Scab, Rust, Fruit moths, Leaf roller
Beginning of bloom	Mid-April	Polyoxin + Thiophanate	Black spot, Scab, Rust
After pollination	Mid-April	Difolatan	Black spot, Scab, Rust, Mites
Petal fall	Late April	Cyanox + Oxin copper + Thiophanate	Black spot, Scab, Rust, Mealybugs, Scales, Fruit moths, Aphids, Race bug, Soldier bugs
Just before first fruit bagging	Early May	Denapon + Polyoxin + Oxin copper	Black spot, Soldier bugs, Mealybugs, Scales
During first fruit bagging	Mid-May (double spray)	Denapon + Oxin copper + Thiophanate	Black spot, Soldier bugs, Mealybugs, Scales, Fruit moths
Fruit growing	Late May	Acarol + Oxin copper	Black spot, Mites, Leaf roller, Powdery mildew
" "	Early June	Denapon + Polyoxin + Oxin copper	Black spot, Leaf roller, Fruit moths, Mealybugs, Scales.
" "	Mid-June	Vamidothion + Oxin-copper-captan	Black spot, Physalospora canker, Scab, Mites, Aphids
" "	Late June	Oxin-copper-captan	Black spot, Physalospora canker, Scab
Cessation of shoot elongation	Early July	Sumithion + Polyoxin	Black spot, Mealybugs, Scales, Fruit moths
Fruit growing	Mid-July	Plictran + Oxin copper	Black spot, Mites, Powdery mildew
" "	Early August	Sumithion	Soldier bugs, Leaf roller, Fruit moths
Just before harvest	Late August	Supracide + Sanipa	Black spot, Fruit moths, Leaf roller, Race bug, Mealybugs, Scales
During Harvest	Mid-Sept.	Sanipa	Black spot, Scab, Powdery mildew
Just after harvest	Late Sept.	Denapon + Difolatan	Black spot, Scab, Fruit moths, Leaf roller, Mealybugs, Scales, Race bug
After leaf fall	Fall and Winter	Ethion petroleum oil	Pests of hibernation

1/ Black spot (Alternaria kikuchiana); Scab (Venturia mashicola); Rust (Gymnosporangium haraeanum); Physalospora canker (Physalospora piricola).

*N.Z. equivalent: Early blossom, late September; Harvest, mid-February.

(Source: Uraki, M. 1982. The culture of Nijisseiki pears in Tottori Prefecture, Japan. pp 72-82. In: Childers, N.F.; van der Swet, T. (editors), The Pear.

APPENDIX 9: PEAR PROGRAMME

Refer notes for individual problems and alternative materials

No.	Stage	Materials and Rate per 100 litres Dilute Application	
1	Green Tip	* Lorsban or *Tokuthion	
2	+ 7 days	Bordeaux mixture or Copper Oxychloride	600g:800 or 300g
3	Tight Cluster	dodine *Tokuthion or *Lorsban or parathion methyl	see label see below see label 75ml
4	Full bloom During blossom do not use materials harmful to bees	‡captan Agrimycin (for fireblight control	125g see notes)
5	Petal Fall	dodine or captan azinphos methyl	see label 125g 100g
6	+10 days	repeat 5	
7	Early November	repeat 5	
8	Mid-November	dodine or captan +parathion methyl or +Lorsban or azinphos methyl	see label 125g 75ml 75g 100g
9	Early December	repeat 8	
10	Pre-Christmas	repeat 8	
11	Early January	captan azinphos methyl	100g 100g
12	+ 14 days and repeat at 14 day intervals	Repeat 11 depending on date of harvest	
13	Leaf Fall	Bordeaux mixture 1000g:800g to assist with bacterial disease control	

* Tokuthion - use 100 ml/100L plus 2.5% oil at green tip followed by 60 ml/100L at tight cluster for mealy bug control. Complete coverage essential. On mature trees 5000L/ha spray volume is required to give complete penetration into all bark cracks and crevices.

* Lorsban - do not use less than 3L/ha of Lorsban 40 EC.

‡ Captan - substitute dodine for captan if infection periods are occurring, otherwise use captan as the basic protection material. Rough russet can be a problem if dodine used over bloom.

+ Lorsban, or parathion methyl included for mealy bug control. If mealy bug not a problem azinphos methyl can be used. Mite control measures may be required at this time also. Refer mite and mealy bug control notes.

(Source: MAF, Recommended spray programme for European pears Nelson - Marlborough, 1983-84).

APPENDIX 9 (contd.)

PEARS

BLACK SPOT

Resistance to dodine has occurred overseas and if possible use dodine over the main infection periods and use captan as the basic protectant material. For black spot in pears it is vital that spray intervals should be close.

Note: Avoid dodine on Conference and russet can occur on Winter Cole if dodine is used in cold conditions. Dodine applied over the blossom period has been suspected of affecting fruit set in pears. If possible do not apply dodine near full bloom.

FIRE BLIGHT

Use streptomycin 100 ppm plus non-ionic wetter just before full bloom. If weather is wet repeat once or twice at 3-5 day intervals on varieties susceptible to fire blight. If weather continues wet after petal fall and fire blight still active, continue to apply streptomycin. With varieties subject to late blossom such as Packhams Triumph pay particular attention to applying streptomycin while late blossom is present and weather favours fire blight infection.

Do not combine streptomycin with Bordeaux or other alkaline materials.

Streptomycin may be applied semi-concentrate, but do not concentrate wetter.

PEAR MIDGE

Apply lindane at green tip, and spray soil and trees butts as well, Diazinon and parathion when used during the season all help control.

MEALY BUG

Refer apples - Tokuthion is an effective alternative to Lorsban for the pre-bloom sprays. For thorough spray penetration keep unwanted sucker growth in check.

PEAR LEAF BLISTER MITE

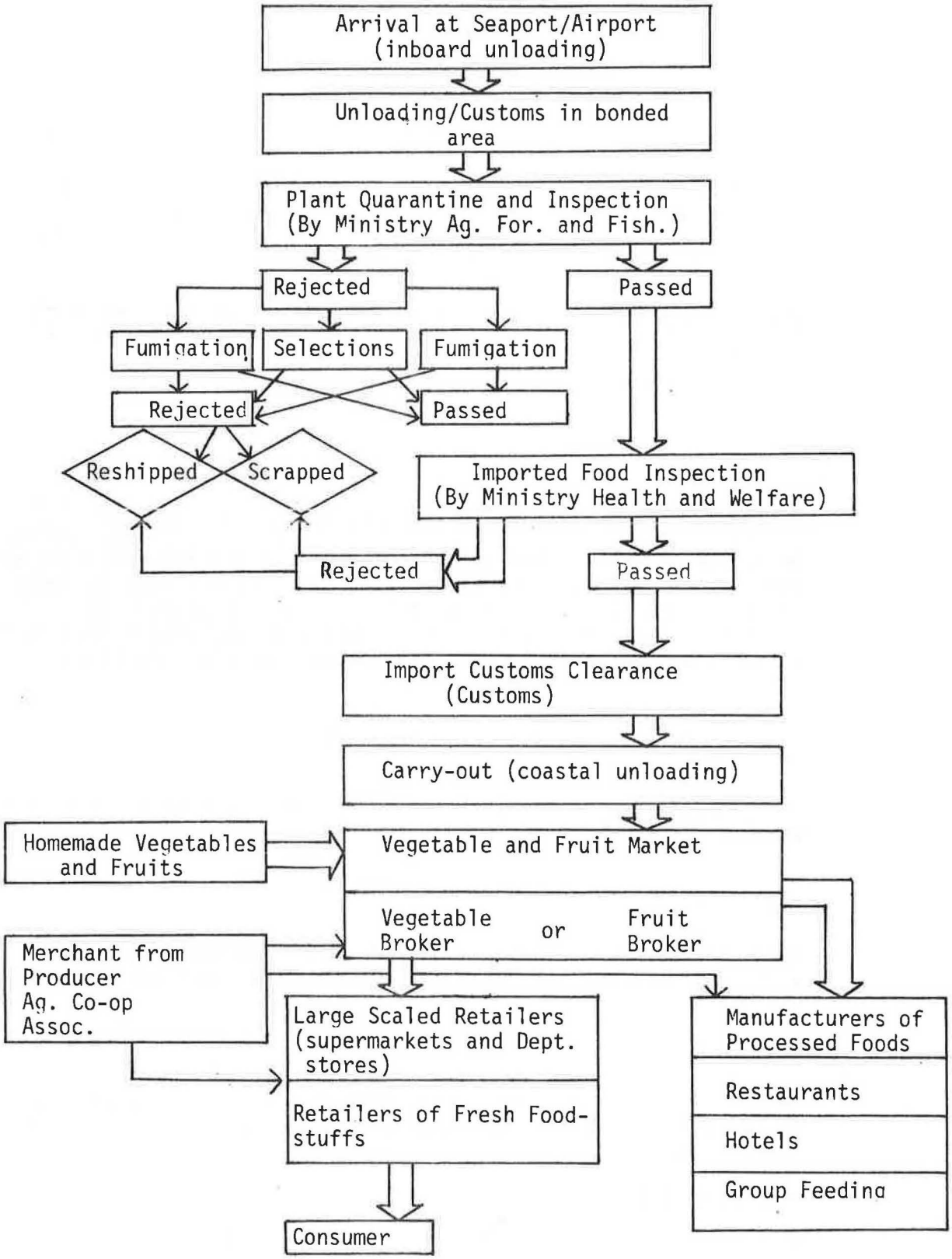
Where a problem, apply lime sulphur at bud movement.

SCALE, MITES, LEAF ROLLER AND CODLING MOTH

As for apples.

(Source: MAF, Recommended spray programme for European pears Nelson - Marlborough, 1983-84.)

APPENDIX 10: JAPANESE INSPECTION METHODS AND DISTRIBUTION CHANNELS FOR IMPORTED FRUIT AND VEGETABLES. (Ref. C.W. Kitson, N.Z. Export-Import Corp., 1981).



APPENDIX 11(a):

(a) Development Costs (1 ha block of Asian pears)

This section of costs is associated with land development, and apart from the initial cost of the trees is all tax deductible.

Items	Cost	Year
Asian pear trees (650)	8,775	1984
Shelter (1,400)	700	1984
Replacement trees	135	1986
Drainage	1,600	1984
Ground Preparation	170	1984
Marking out, 10 hrs	50	1984
Planting, 650 @ 0.35 each	230	1984
700 @ 0.06 each	40	1984
Trickle irrigation	3,700	1984
Grassing down	155	1985
Posts, wires (2)	1,300	1985
Frost protection	2,500	1986
Tree guards (plastic), ~~$0.20c~~ 0.25 each	130	1984
TOTAL DEVELOPMENT COST	$19,485/ha	

This excludes costs for roadways or an amenity area that would be required for a larger-sized block.

APPENDIX 11(a) contd.....

(b) Development Costs (1 ha block of Asian pears)

	Per ha		
Year 0			
Cultivation, plough	40.00		
subsoil	40.00		
disc	36.00		
harrow	27.00		
levelling	27.00		
		170.00	
Irrigation,			
proportion of 10 ha block (10%)	3,000.00		
+ shelter irrigation $0.50/m	700.00	3,700.00	
Trees (650/ha)			
1 yr old whips - (grafted)		8,775.00	
Shelter, mixture of trees			
1,400 @ $0.50/m		700.00	
YEAR 0 TOTAL COST			$13,345.00
Year 1			
Cultivation			
rototiller	40.00		
drill grass between rows	35.00		
seed, $2.50/kg @ 20 kg/ha	50.00		
roll	30.00		
		155.00	
YEAR 1 TOTAL COST			155.00
Year 2			
Irrigation			
frost protection		2,500.00	
Trees			
replacements - 10 trees @ $13.50 each		135.00	
YEAR 2 TOTAL COST			2,635.00
TOTAL CAPITAL COSTS (Years 0, 1, 2)			$16,135.00

APPENDIX 11(b):

Pruning/Training

6500 trees/hour)

Year	1985	'86	'87	'88	'89	'90	'91	'92	'93	'94
Winter										
trees/hr	30	25	18	15	12	10	8	6	6	6
hours/ha	21	31	36	43	54	65	81	108	108	108
Summer										
trees/hr	30	20	16	12	10	8	8	8	8	8
hours/ha	21	32	40	54	65	81	81	81	81	81
Total hrs/ha	42	63	76	97	119	146	162	189	189	189
Cost/ha ($) ($5.00/hr)	210	315	380	485	595	730	810	945	945	945

Thinning

Year	1985	'86	'87	'88	'89	'90	'91	'92	'93	'94
First time:										
trees/hr	-	-	20	15	10	8	6	4	4	4
hours/ha	-	-	32	43	65	81	108	162	162	162
Second time:										
trees/hr	-	-	20	16	12	10	8	6	6	6
hours/ha	-	-	32	40	54	65	81	108	108	108
Total hrs/ha	-	-	64	83	119	146	189	270	270	270
Cost/ha($) ($5.00/hr)	-	-	320	415	595	730	945	1350	1350	1350

APPENDIX 11(b) (cont'd....)

Pest and Disease Control

Year	1984	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94
$											
Materials	50	200	300	500	650	750	850	1000	1100	1100	1000
Labour	10	25	45	60	85	95	110	120	125	125	125
Machinery	20	50	90	120	170	180	210	230	250	250	250
TOTAL COST	80	275	435	680	830	1025	1170	1300	1475	1475	1475

Mowing

Year	1984	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94
$											
Labour	-	10	25	30	35	40	45	45	45	45	45
Machinery	-	20	50	60	70	80	90	90	90	90	90
TOTAL COST	-	30	75	90	105	120	135	135	135	135	135

Fertiliser

Year	1984	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94
Materials:											
8:4:8:14	105	160	160	220	255	255	255	255	255	255	255
Urea	140	140	140	-	-	-	-	-	-	-	-
Lime	50	-	-	50	-	-	50	-	-	50	-
Labour	30	25	25	35	25	25	35	25	25	35	25
Machinery	30	20	20	50	30	30	50	30	30	50	30
TOTAL COST	355	345	345	355	310	310	360	310	310	360	310

APPENDIX 11(b) (cont'd....)

Herbicides (material costs)

1984	Spray weeds sprouting on bare ground between trees, 2 x Preglone on 1.5 m strip at 6 ℓ per sprayed ha (1/4 ha)		40.00
1985	Preglone, 3 ℓ/ha @ $12/ℓ	36.00	
	Linuron, 2.25 kg @ $31/2 kg	39.00	75.00
1986, 1987	As per Year 1985		
1988 onwards	Preglone, 1.5 ℓ/ha @ $12.40/ℓ	18.00	
	Simazine, 2.0 kg/ha @ $16.00/kg	32.00	
	Weedazol, 1.0 ℓ/ha @ $10.00/ℓ	10.00	60.00

Shelter

Shelter is necessary for wind protection; when trees are used problems arise; trimming and root pruning is required once the trees become established.

Costs:

1987	Trimming, 2.0 hours, $30.00/hr	60.00	
	Pruning, 1.0 hour, $40.00/hr	50.00	110.00
1988	Trimming, 2.5 hours, $30.00/hr	75.00	
	Pruning, 2.0 hours, $50.00/hr	200.00	175.00
1989	Trimming, 2.7 hours, $30.00/hr	80.00	
	Pruning, 2.0 hours, $50.00/hr	100.00	180.00
1990 onwards	Trimming, 3.3 hours, $30.00/hr	100.00	
	Pruning, 2.0 hours, $50.00/hr	100.00	$200.00

APPENDIX 11(b) (cont'd....) COSTS

			Total
Fertiliser (material costs)			
1984	Orchard mix (8:4:8:14) at 0.5 kg/tree - 325 kg @ $170/t		55.00
	December, apply urea, 0.5 kg/tree, 325 kg @ $450/t		140.00
	Lime at 2.5 t/ha, $20.00/t		50.00
	Shelter, orchard mix, 1400, @ 0.200 kg/tree - 280 kg @ $170/t		50.00
1985	Orchard mix, 1.0 kg/tree, 650 kg @ $170/t	110.00	
	Urea, 0.5 kg/tree	140.00	
	Shelter	50.00	
			300
1986	Orchard mix, 1.0 kg/tree	110.00	
	Urea, 0.5 kg/tree	140.00	
	Shelter	50.00	
			300.00
1987	Orchard mix, broadcast 1.3 t/ha	220.00	
	Lime, 2.5 t/ha at $20/t	50.00	
			270.00
1988	Orchard mix, broadcast, 1.5 t/ha	255.00	
	(also 1989, 1991, 1992, 1994)		255.00
1990	Orchard mix, broadcast, 1.5t/ha	255.00	
	Lime, 2.5 t/ha	50.00	
	(also 1993)		305.00

Irrigation

Year	1984	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94
Power	30	40	50	50	50	50	50	50	50	50	50
Maintenance	70	60	50	50	50	50	50	50	50	50	50
Frost protection (operation)	-	-	-	30	40	50	60	70	80	80	80
TOTAL COST	100	100	100	130	140	150	160	170	180	180	180

APPENDIX 11(b) (cont'd ....) WEED CONTROL

Year	1984	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94
Material ($)	40	75	75	75	60	60	60	60	60	60	60
Labour ($)	15	15	15	15	15	15	15	15	15	15	15
Machinery ($)	30	30	30	30	30	30	30	30	30	30	30
Total Costs ($)	85	120	120	120	105	105	105	105	105	105	105

APPENDIX 12: PRODUCTION

An average yield has been used in this analysis. It is included as tray equivalents, and represents yields which should be attainable on a well-managed block of Asian pears.

Year	No. fruit/tree	Av. kg fruit/tree	Trays/tree	Trays/ha (4 kg/tray)
1984	-	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	20	4	-	650
1988	50	10	2.5	1,625
1989	120	24	6	3,900
1990	250	50	12.5	8,125
1991	350	70	17.5	11,375
1992	400	80	20	13,000
1993	400	80	20	13,000
1994	400	80	20	13,000

Price of Product

For this analysis, returns to the grower are calculated at $1.40/kg ($5.60/tray) export and $0.70/kg ($2.80/tray) for local market fruits (i.e., average price of $1.16/kg or $4.64/tray). An average price in each market is used with no distinction between varieties.

Year	Production (tray equivalents)	Export 50% ($5.60/tray) ($)	Local 25% ($2.80/tray) ($)	Gross income ($)
1984	-	-	-	-
1985	-	-	-	-
1986	-	-	-	-
1987	650	1,820	455	2,275
1988	1,625	4,550	1,137	5,687
1989	3,900	10,920	2,730	13,650
1990	8,125	22,750	5,687	28,437
1991	11,375	31,850	7,962	39,812
1992	13,000	36,400	9,100	45,500
1993	13,000	36,400	9,100	45,500
1994	13,000	36,400	9,100	45,500

APPENDIX 13: NPV Table in dollars for Asian Pear Cash Flow, 10 years, 1 hectare Semi-Intensive with a discount factor of 5%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-34877.10	-28791.20	-22705.40	-16619.50	-10533.60
0.75	-15513.00	254.96	16022.90	31790.80	47558.70
1.00	3851.15	29301.10	54751.10	80201.10	105651.00
1.25	23215.30	58347.30	93479.40	128611.00	163743.00
1.50	42579.40	87393.50	132208.00	177022.00	221836.00

NPV Table in dollars for Asian Pear Cash Flow, 10 years, 1 hectare Semi-Intensive with a discount factor of 10%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-31507.20	-27240.20	-22973.10	-18706.00	-14438.90
0.75	-17930.20	-6874.56	4181.04	15236.70	26292.30
1.00	-4353.10	13491.00	31335.20	49179.30	67023.50
1.25	9223.96	33856.60	58489.30	83122.00	107755.00
1.50	22801.00	54222.20	85643.40	117065.00	148486.00

NPV Table in dollars for Asian Pear Cash Flow, 10 years, 1 hectare Semi-Intensive with a discount factor of 15%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-29039.80	-25981.30	-22922.90	-19864.50	-16806.10
0.75	-19308.50	-11384.40	-3460.36	4463.70	12387.80
1.00	-9577.17	3212.54	16002.20	28791.90	41581.60
1.25	154.13	17809.50	35464.80	53120.20	70775.50
1.50	9885.42	32406.40	54927.40	77448.40	99969.40

NPV Table in dollars for Asian Pear Cash Flow, 10 years, 1 hectare Semi-Intensive with a discount factor of 20%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-27182.30	-24945.80	-22709.30	-20472.90	-18236.40
0.75	-20066.20	-14271.80	-8477.30	-2682.82	3111.65
1.00	-12950.20	-3597.74	5754.74	15107.20	24459.70
1.25	-5834.20	7076.28	19986.80	32897.30	45807.70
1.50	1281.81	17750.30	34218.80	50687.30	67155.80

NPV Table in dollars for Asian Pear Cash Flow, 10 years, 1 hectare Semi-Intensive with a discount factor of 0%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-39624.40	-30731.60	-21838.80	-12945.90	-4053.13
0.75	-11329.10	11711.40	34751.90	57792.30	80832.80
1.00	16966.30	54154.40	91342.50	128531.00	165719.00
1.25	45261.60	96597.30	147933.00	199269.00	250605.00
1.50	73556.90	139040.00	204524.00	270007.00	335491.00

APPENDIX 14: DEVELOPMENT BUDGET ($)

Year	Total Production Costs										
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Expenses/ administration		2,500	2,500	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Permanent wages		800	1,800	2,500	14,000	14,000	14,000	14,000	14,000	14,000	14,000
Repairs and maintenance		1,900	3,600	4,000	4,200	4,400	4,600	4,800	5,000	5,000	5,000
Vehicle expenses		1,000	1,200	2,200	3,000	3,500	3,700	3,900	4,000	4,000	4,000
Accountancy		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Production costs		7,200	10,100	12,700	25,200	25,900	26,300	26,700	27,000	27,000	27,000
Production costs from 1 ha cash flow x 5 = 5ha	3,600	5,600	7,300	12,900	15,700	18,475	21,300	23,200	26,800	26,800	26,800
Total cost	3,600	12,800	17,400	25,600	40,900	44,400	47,600	49,900	53,800	53,800	53,800

APPENDIX 15: NPV Table in Dollars for Asian Pears, 10 years, 6 hectares Semi-Intensive with a discount factor of 5%.

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-453877.00	-423448.00	-393019.00	-362589.00	-332160.00
0.75	-357057.00	-278217.00	-199377.00	-120538.00	-41698.30
1.00	-260236.00	-132986.00	-5736.22	121514.00	248764.00
1.25	-163416.00	12244.70	187905.00	363565.00	539226.00
1.50	-66594.90	157476.00	381546.00	605617.00	829687.00

NPV Table in Dollars for Asian Pears, 10 years, 6 hectares, Semi-Intensive with a discount factor of 10%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-474175.00	-452839.00	-431504.00	-410169.00	-388833.00
0.75	-406289.00	-351011.00	-295733.00	-240455.00	-185177.00
1.00	-338404.00	-249183.00	-159963.00	-70741.90	18478.80
1.25	-270519.00	-147355.00	-24192.00	98971.40	222135.00
1.50	-202633.00	-45527.40	111579.00	268685.00	425791.00

NPV Table in Dollars for Asian Pears, 10 years, 6 hectares, Semi-Intensive with a discount factor of 15%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-476944.00	-461652.00	-446360.00	-431068.00	-415775.00
0.75	-428287.00	-388667.00	-349047.00	-309426.00	-269806.00
1.00	-379631.00	-315682.00	-251734.00	-187785.00	-123837.00
1.25	-330974.00	-242697.00	-154421.00	-66144.00	22132.80
1.50	-282318.00	-169713.00	-57107.80	55497.10	168102.00

NPV Table in Dollars for Asian Pears, 10 years, 6 hectares, Semi-Intensive with a discount factor of 20%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-471154.00	-459972.00	-448790.00	-437607.00	-426425.00
0.75	-435574.00	-406602.00	-377630.00	-348657.00	-319685.00
1.00	-399994.00	-353232.00	-306469.00	-259707.00	-212945.00
1.25	-364414.00	-299862.00	-235309.00	-170757.00	-106204.00
1.50	-328834.00	-246492.00	-164149.00	-81806.00	535.85

NPV Table in Dollars for Asian Pears, 10 years, 6 hectares, Semi-Intensive with a discount factor of 0%

	YIELD				
Price	0.50	0.75	1.00	1.25	1.50
0.50	-398672.00	-354208.00	-309744.00	-265280.00	-220816.00
0.75	-257195.00	-141993.00	-26790.60	88411.70	203614.00
1.00	-115719.00	70221.90	256163.00	442103.00	628044.00
1.25	25757.80	282437.00	539116.00	795795.00	1052470.00
1.50	167234.00	494651.00	822069.00	1149490.00	1476900.00