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THE MACADAMIA INDUSTRY

IN NEW ZEALAND

A Thesis for the Degree of
Master of Philosophy

At Massey University
Palmerston North

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ABSTRACT

The New Zealand macadamia industry has been characterised by many small plantings, lifestyle blocks up to 1500 trees and two commercial plantations with more than 10000 trees. Completed research programmes have been few, mainly because government funding in horticulture has been channelled to the needs of the major crops such as kiwifruit. Changes in political policy affected funding for minor horticultural crops and spasmodic cuts in finance severely hindered long-term research projects. Because of its small size the macadamia industry had limited funds available from members but some research programmes have been completed including pest control, tree nutrition, basal stain and future research needs. A private consultant, Ian Gordon has carried out variety trials on a local selection. Several selections have been planted in different locations and have proven to be useful in pollination of Beaumont, the main variety planted in New Zealand.

Within the limits, set by climatic factors, the suitable growing areas are north of a line from New Plymouth to Gisborne. Both of those areas are marginal for commercial planting but sites on the sheltered north facing positions could grow satisfactory yields.

Yields per tree, generally have been below commercial requirements. Bad site selection, over sheltering, wrong variety choices for cross-pollination success, inadequate care with orchard management practices, especially with tree nutrition and pest control, and a general lack in professional planning have contributed to the present situation. There are exceptions, of course, with some orchards and processing plants equalling international standards.

Historical factors have left the local industry in a situation where growth and development have slowed. The reliance on one main variety, Beaumont, and the sale and/or closure of the three commercial enterprises in the decade of the twentieth century severely curtailed growth. This exposed the need for research projects in the search for

new varieties suitable for the cooler New Zealand climate and studies to promote better cross-pollination and final nut set results.

In addition the industry must raise quality standards to meet overseas competition. This country is not self-sufficient in the production of macadamia products and often the local product is much inferior to those imported. There is one processing plant in New Zealand which has quality standards the equal of the overseas competition and there is another one which is modern with high quality machinery but is not working to capacity due to a lack of available nut in shell (NIS). However there are a number of other processors who do not reach the required standards and their products lower the image of the nut as a high value food item. Local packaging is often below international standards and the New Zealand Macadamia Society could raise these issues with its members in an effort to improve sales and marketing results.

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Henry Bell is recognized as a new variety plant breeder in Australia of major importance. Since leaving his native Otago, some fifty years ago, Henry has run his Queensland property with great invention. His knowledge and success was important to my study and on many orchards and nurseries in New Zealand the results of his plant breeding have been crucial to the progress of the local breeding research.

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A number of pioneers in the New Zealand industry were approached and interviews recorded. These included early nurserymen, Co-op members and growers who made early plantings from the 1970's from Tauranga, Katikati and to the Bay of Islands.

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GLOSSARY

NIS	Nut in shell ie the outer husk has been removed.
% Moisture Content (M.C) NIS	<p>A mature NIS taken from a tree, is approximately 1/3 shell, 1/3 kernel 1/3 moisture. The processor pays the grower a price based on the weight of NIS at 10% M.C. Example – a grower sends 1000Kg NIS to processor. The processor makes the following calculation to find M.C.</p> $\% \text{ MC NIS} = \frac{\text{wet wt} - \text{corrected dry wt}}{\text{wet wt}} \times 100$ <p>NB corrected dry wt @ 1.5% is dry wt x 0.985</p> $\begin{aligned} \therefore \% \text{MC NIS} &= \frac{1000\text{Kg} - (850\text{Kg} \times 0.985)}{1000} \times 100 \\ &= \frac{1000 - 837}{1000} \times 100 \\ &= \frac{163}{1000} \times 100 \\ &= 16.3\% \end{aligned}$
% Kernel (Crackout)	<p>= The weight of the kernel as a percentage of the total weight of NIS</p> $= \frac{\text{Kernel weight}}{\text{Total weight of NIS}} \times 100$ <p>Example = Processor receives 1000Kg of NIS. After drying to 1.5% MC the total kernel is weighed.</p> $\begin{aligned} &= \frac{\text{kernel weight}}{\text{total weight NIS}} \times 100 \\ &= \frac{350\text{Kg}}{1000\text{Kg}} \times 100 \\ &= \frac{350}{10} \\ &= 35\% \text{ crackout} \end{aligned}$

No. 1 kernels are those which contain 72 + % of oil. A common test to find No 1 kernel is to place all kernels in the sample in tap water (ambient heat). The kernels that float are No 1.

$$\begin{aligned}
 \% \text{ No 1 kernel} &= \frac{\text{weight of floaters}}{\text{total wt. kernel}} \times 100 \\
 &= \frac{30 \text{ kg}}{35 \text{ kg}} \times 100 \\
 &= \frac{30 \times 100}{35} \\
 &= 85.7\% \text{ No 1 kernel}
 \end{aligned}$$

The term “usable kernel” may be defined as kernel which has been visually examined and been sorted as sound kernel. Sound kernel includes fully developed kernel and is free of defects such as insect damage, mould, decay, immaturity, discoloration, basal stain or rancidity and which are suitable for roasting, sale as raw kernel or use in confection sales.

$$\begin{aligned}
 \% \text{ Recovery (usable kernel)} &= \frac{\% \text{ kernel}}{100} \times \% \text{ No 1 kernel} \\
 &= \frac{35 \text{ (crackout)}}{100} \times 85.7 \\
 &= \frac{7}{20} \times 85.7 \\
 &= 29.9\% \text{ Recovery}
 \end{aligned}$$

Nut Maturity - Moisture content (at least 25%) and the percentage of No 1 kernels (contain more than 72% oil) are the best indicators of nut maturity. In Australia mature nuts drop over a period of 1-3 months. In New Zealand varieties do not drop generally and the grower picks random samples from the orchard from, late June, and checks if the inside of the husk has turned brown. If still white or cream picking is delayed until husks are brown. Then the trees are strip picked.

(int.) - *M. integrifolia*

(tet.) - *M. tetraphylla* -

The only macademia species which produce edible nuts.

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CHAPTER ONE : INTRODUCTION

1.01 The Macadamia Industry in New Zealand

New Zealand, because of its geographical situation and relatively new immigration patterns, has imported a wide variety of crop plants for local cultivation. Maori migrations brought vegetable such as the yam and kumara from the Pacific regions and from early nineteenth century new settlers introduced vegetable and fruit plants as food sources (King 2003). Missionaries, for example, planted grapes and other crops, in the Bay of Islands in the 1830's (Pickmere 1994).

A diversity of sub-tropical and exotic horticultural fruit crops was introduced into New Zealand during the twentieth century. Some have had only limited commercial success, but others, such as kiwifruit, avocados, blueberries, olives and macadamias have adapted to local conditions. These, and others, continue to produce profitable crops for domestic and export markets (Ferguson and Bollard 1990).

The New Zealand macadamia industry grew from three commercial decisions made in the late 1970's and early 1980's. New Zealand's largest planting of macadamias commenced in Okaihau in 1978. Another large enterprise developed at South Head, near Helensville, where extensive site development preceded a planting of some 10000 mixed varieties from 1981. The third venture began when a meeting in Rawene in 1982 decided to form a co-operative of interested growers based in Whangarei.

Prior to these developments individual plantings of macadamias had occurred as far south as Dunedin (Gordon 2002) and Nelson and from as early as the 1870's. Climate was a key factor in obtaining a profitable yield from trees in New Zealand and most experimental plantings were made from the Bay of Plenty northward. A number of lifestyle plantings in the 1970's formed the basis for the setting up of the New Zealand

Macadamia Nut Growers Co-operative. Government researchers and semi-tropical and exotic nurserymen indicated that the Beaumont variety was superior to all others under New Zealand conditions. This led to the situation that over 90% of all macadamia trees planted in the country until 2000 were Beaumont.

Australian and Hawaiian plantations rarely chose Beaumont as the nut from this variety had to be hand picked (it does not drop to the ground naturally when mature) which brings a heavy harvesting cost. In addition the kernel is sweeter than most Australian and Hawaiian varieties which made it unpopular with processors as the Beaumont kernel burns when roasted. This meant that the Beaumont kernel had to be separated from the other varieties – another expense. Although some New Zealand processors (Garden 2002, Ward 2002) did not find the Beaumont kernel a problem in processing and continued to grow the variety, basically Beaumont did not suit the large plantations over 5000 trees.

By 2000 the local macadamia industry had failed to make significant progress. All three commercial ventures had failed to achieve profitable yields from their orchard bases and the businesses were sold to new owners or ceased trading. Crop yields per tree were disappointing, compared to overseas results, and many growers were disillusioned. Some turned to growing alternative crops or sold off their land.

Features of the New Zealand macadamia industry by 2000 included:

- ❖ An industry that was relatively small, scattered and lacking in co-ordination by a central authority.
- ❖ The Nut Growers Co-operative ranged from a total of 114 members in 1987 to 47 by 1996.

The New Zealand Macadamia Society had reached a total of 76 members by 2005. Both the above associations attracted similar types of members – lifestyle and small scale growers with less than 1500 trees.

- ❖ In 2002 the size of the local industry, using statistics provided by the New Zealand Macadamia Society, was modest. (Table 1)

hand fertilise trees and to keep grass and weeds from smothering trees, paths and drains. Good research was available from the NZ Macadamia Growers Co-operative's regular news letters and from researchers at the Kerikeri Research Station and other agricultural agencies (Richards & Dawson 1993, Kerr News Bulletin 1986).

- ❖ The quality of processing plants ranged from excellent to unacceptable. Considering the small scale of the local industry there were too many processors – twelve (NZMS Newsletter No 39). There is an urgent need to rationalise the processing industry by reducing the number of factories and reaching the ISO production standards by those remaining. The macadamia nut is considered to be a luxury product and the local quality must reflect that image.

The following study reflects the present stage of the local macadamia industry development. It will begin with botanical classification and description of genus *Macadamia*, its discovery in Australia and its distribution. This will be followed by signs of commercial success on world markets particularly in Australia, Hawaii and South Africa. Chapter two will deal with research methods and materials. The following three chapters will follow the history of macadamias in New Zealand, the industry today and possible future directions to achieve growth.

The year 2000 appeared to be an appropriate time to commence a study of the New Zealand macadamia industry. My wife and I had recently sold our 2.2 hectare macadamia orchard because of ill-health and my mobility was severely restricted. In addition I was disturbed to hear that all records and traces of the life work of an important macadamia pioneer had been destroyed and lost forever.

Earlier, in my career as a teacher, I had gained a MA degree at Victoria University and a Dip Bus at Massey University. This academic background and ten year experience in converting a citrus orchard in Kerikeri to a macadamia plantation seemed to be sufficient preparation to start my research.

My wife and I had happily enjoyed eating macadamia nuts for many years and the chance to take early retirement and make a radical life change was too attractive to miss. We bought the citrus orchard complete with rich volcanic soil, irrigation, good aspect and shelter, a house, shed and tractor. The citrus trees were mature navel oranges, mandarins and tangelos planted in rows four metres apart.

We read local literature from government sources and private nurseries and took a trip to Queensland to learn about varieties, growing and processing in a wide range of conditions. Later we made another trip to Queensland concentrating on processing machinery and methods. Both trips were planned with the help of the secretary of the Australian Macadamia Society.

We planted 400 macadamia trees on our orchard. We chose Beaumont as the main crop and Elimbah and Renown as pollinators. We removed a citrus tree every four metres in every second row making the spacing of the macadamias four metres in the row and eight metres between the rows. Leaving most of the citrus in the ground had two advantages. The mature trees provided excellent shelter for the new macadamias and citrus could be removed as the macadamias grew. In addition, citrus provided an income before macadamias became commercial. The last citrus were removed in the tenth year.

We imported processing machinery from Australia in the third year when our trees started to produce increasing yields. In addition we bought nuts from other growers and had no problem in selling our products to supermarkets and health and gourmet food outlets. At that stage we had chocolate and carob bars made for us in Auckland containing nut pieces plus cherry and raisin. In addition we had macadamia spread made in Auckland. Our major sales were made of fresh nuts to supermarkets and health shops. We made marketing trips to Singapore, the USA and London and while our products were up to an acceptable quality standard we could not produce enough to satisfy market needs.

After two or three years of processing we required a larger and more efficient method of drying the NIS to 1.5% moisture. We purchased a container and had a dehumidifier unit fitted. The container was added to our factory and dried 6-8 tonnes of NIS in less than two weeks and maintained the nuts until they were needed for processing.

1.02 Botanical Classification and Description

The genus *Macadamia* belongs to the :

family: *Proteaceae*

sub-family: *Grevilleoideae*

tribe: *Macadamieae*

There are seven Australian species which fall into the following intrageneric groups:

- 1 *M. integrifolia*, *M. tetraphylla*, *M. ternifolia*, *M. jansanii*
- 2 *M. claudieana*
- 3 *M. whelanii*, *M. grandis*.

Note: *M. hildebrandii* is only found on Sulawesi, Indonesia, and is closely related to *M. claudieana* (George 1998).

Only the species *M. integrifolia*, and *M. tetraphylla* produce edible nuts (Peace 2001).

1.03 **Proteaceae Family**

The early history of the *Proteaceae* family in Australia shows that it emanated from a common moist forest flora approximately 100 million years ago. Pollen records indicate that the *Macadamia* species evolved in the late Cretaceous period about 60 million years ago (Dettmann and Jarzen 1998).

In New Zealand only two species of *Proteaceae* still exist. They are *Knightia excelsa* and *Toronia toru*. Pollen from many *Proteaceae* genera has been found in New Zealand including pollen from the *Macadamia* tribe (Pole 1998).

1.04 **Discovery in Australia**

“Four thousand years ago, in the Old World, many important food plants were being cultivated by man, including wheat, rice, barley, onions, tea, apples, olives and almonds. Before the time of Christ, corn, the sweet potato, cacao and kidney beans were under cultivation in the New World. The macadamia is a rarity – a “new” crop which was domesticated for the first time in 1858 in Australia. It is the only native Australian plant ever developed as a commercial food crop” (Rosengarten 1984).

The macadamia, an evergreen tree, is a native of the coastal rain forests of southeast Queensland and northern New South Wales, Australia. Some species produce nuts, which were an important source of food for the aboriginal tribes, but there is no evidence that the trees were cultivated. The aboriginal name for the nut is “Jindilli” in Queensland and further south in New South Wales it is called “Kindal Kindal”. Some aborigines in tropical Queensland ate the bitter nuts from the *M. whelanii*, perhaps after extensive leaching (Gross and Weston 1992).

A German explorer, Friedrich Leichhardt, collected the first nut specimens on 18 September 1843. According to Leichhardt’s diary the nuts were collected in the

Bunya Bunya Brush near Dulabi, Queensland. The nuts collected were *M. ternifolia* and therefore were inedible and the nuts and foliage were held in the Melbourne Herbarium for some years.

There has been some confusion, among scientists, about the location of the area where the nuts were found. Some suggest that Leichhardt climbed Mt Bauple, on 18 September 1843, which is 150 km north of the Bunya Bunya Brush and that *M. ternifolia* does not occur there. Evidence indicates that Leichhardt climbed Mt Bauple on 31 July and then carried on to an area where the specimens were collected (Gross and Weston 1992).

1.05 Taxonomic History

The taxonomic history of the macadamia species has been highlighted by reclassification changes. The first formal descriptions of macadamias came from Baron Ferdinand von Mueller in 1857. Mueller named a collection of two branches of macadamias he and Walter Hill found in the forests on the Pine River of Moreton Bay, as *M. ternifolia* in honour of his friend John Macadam, MD, who was at that time Secretary of the Philosophical Institute of Victoria. New Zealand could have had an early introduction to macadamias as Dr Macadam sailed from Australia to New Zealand in 1865. However, it was a very rough voyage and Dr Macadam broke some ribs, developed pleurisy and died at sea at the age of thirty-eight (Rosengarten 1984).

Later, in 1867, Mueller received further samples from Hill including edible fruit. Mueller described the fruit, and the tree which grew them, but he did not give a new name to the species. This was unfortunate as the original name, *M. ternifolia*, described a species which produced bitter inedible fruit. For the next hundred years Australian scientists found that it was difficult to classify the new samples accurately.

Two Australian scientists, Maiden and Betcher, proposed in 1897 that the 1867 samples were a different species because of the edible fruit and differing leaf shape. Maiden and Betcher classified the new samples as *M. integrifolia* (Gross and Weston 1992).

Current thinking accepts the taxonomy as follows with acknowledged classifying scientists shown in brackets:

- ❖ *M. integrifolia* - (Maiden and Betcher 1897) - the main commercial species in Australia and Hawaii. It is a native of southeast Queensland and the nut is edible.
- ❖ *M. tetraphylla* - (Johnson 1954) - the nut is edible but with a sweeter flavour as it contains 50% more sugar. It is a native of southeast Queensland and northern New South Wales.
- ❖ *M. ternifolia*, - (Mueller 1857) has a small inedible nut with a bitter kernel caused by *cyanogenetic glycosides*. It is a native of southeast Queensland.
- ❖ *M. jansenii* - (Gross and Weston 1992) - is similar to *ternifolia* but the nuts are a little larger and inedible. It is a native of Miriam Vale in South Queensland just north of Maryborough.
- ❖ *M. claudieana* - (Gross and Hyland) - has soft shelled nuts which are edible, not bitter - found only in the Iron Ranges, far north Queensland.
- ❖ *M. whelanii* (Batley 1901) and *M. grandis* (Gross and Hyland) - both have inedible nuts with *grandis* bearing soft-shelled fruit. These species are found in State Forest Reserve 755, in the vicinity of the Barong Logging Area, north Queensland.
- ❖ *M. hildebrandii* - (Steenis 1952) - is found on the island of Sulawesi (Celebes) Indonesia and is closely related to *claudieana*.

Note: All species produce nuts with hard shells except *grandis* and *claudieana* which have soft shelled nuts (Gross and Weston 1992).

1.06 Morphological Features

The five major morphological characteristics of the four southern species –*M. jansenii*, *M. ternifolia*, *M. integrifolia* and *M. tetraphylla* are outlined in Table 2.

Table 2: Morphological features of the four southern species

Species	Leaves per whorl	Colour of new leaves	Petiole	Leaf margin spininess	Mature leaf shape
<i>Jansenii</i>	3	green	present	none	Short to medium length : width ratio > 4 Wider near the Middle
<i>ternifolia</i>	3	bright red	present	medium	Short Length : width ratio > 4 Wider near the middle.
<i>integrifolia</i> (int.)	3	green or bronze tipped	present	none to medium	Medium Length : width ratio > 4 Wider near the middle
<i>tetraphylla</i> (tet.)	4 or 4/5	deep red	absent	high	Long Length : width ratio > 4 Wider near the middle

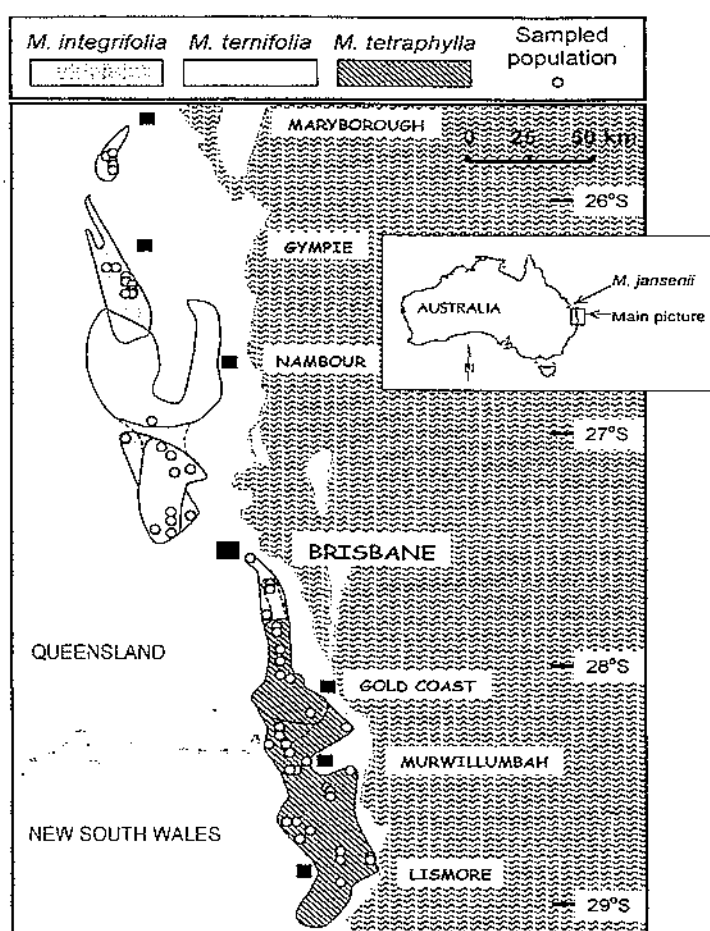
(Peace 2001).

1.07 Species Distribution

The four southern species are restricted to a narrow coastal strip of southern Queensland and northern New South Wales approximately 500 km long and usually less than 50 km wide. The northernmost species is *M. jansenii* known in only one small population

isolated by more than 180 km from the other species. Natural populations of *M. integrifolia* are found in several separate regions in southeast Queensland, from the Mt Bauple region approximately 20 km south of Maryborough to just into the Gold Coast hinterland. *M. ternifolia* occurs in the Pine Rivers district and the Blackall and Conondale Ranges, possibly one continuous region. Natural hybrids of *M. integrifolia* and *M. ternifolia* occur in populations where their ranges overlap – throughout most of the Pine Rivers district and probably also in the Imbil area. The southernmost species, *M. tetraphylla*, occurs naturally from the southern part of the Gold Coast hinterland in Queensland to south of Lismore in New South Wales. Macadamias in the Gold Coast hinterland are almost entirely natural hybrids of *M. integrifolia* and *M. tetraphylla* (Figure 1) (Peace 2001).

Figure 1: Species distributions and natural hybrid zones of the four species of the southern clade of macadamia



(Peace 2001).

The only known successful cross between *M. integrifolia* and *M. ternifolia*, is HAES791. This hybrid is able to produce edible nuts and was probably a natural cross rather than an intentional action. It is possible that *M. ternifolia* and *M. jansonii* could be used in plant breeding to give characteristics such as heat resistance but the bitter flavoured nuts of these varieties would have to be overcome to make the hybrid fruit edible (McConachie 2004).

One variety which may be useful in future macadamia breeding programmes, especially in warm northern areas of Queensland, is *M. claudieana*. It has a large fruit which is easily separated from its thin shell and the kernel is not bitter (Gross and Weston 1992).

1.08 Commercial Origins

Despite the Australian origins, the first development of macadamias as a commercial crop took place in Hawaii. In 1881 some *M. ternifolia* seed were taken to Hawaii from Australia and planted. Soon after, it was realised that there had been a mistake and that this species was undesirable for orchard cultivation. The trees were cut down to stop the spread of this unwanted species (Gross and Weston 1992). The following year William Purvis imported *M. tetraphylla* seed from the north Gympie area Queensland and planted them on the island of Hawaii. One of the original trees planted by Purvis was still producing nuts in 1983. In 1918 Mr Walter Naquim, who was the manager of a sugar company on the island, planted 18,000 macadamia seedlings sourced from the original Purvis trees. This large planting was a part of a reforestation project and the yield grew steadily. The wife of the sugar company manager experimented with the nuts in a number of ways to extend the income from the orchard. Mrs Naquim produced the first marketable added-value macadamia products, chocolate-coated macadamias (Rosengarten, 1984).

The first commercial macadamia orchard in Australia was established about 1888, when Charles Staff planted 250 *M. tetraphylla* seedlings near Lismore, New South Wales (Rosengarten, 1984). Developments in Australia followed more slowly until the

1960's—1970's when prospects for large scale planting and profitable local and export markets appeared.

1.09 Macadamia Production Figures

Macadamias make up barely 1% of the total world tree nut production (Table 3). This is partly due to the relatively recent appearance on nut production tables. Production costs for macadamias are higher than most other nuts because of the need for harvesting (using mechanical means), de-husking, drying, processing and packaging kernel.

Table 3: World nut production

<u>Nuts</u>	<u>Kernel tonnes</u>
Macadamia	25,000
Pecans	110,000
Pistachios	200,000
Cashews	250,000
Hazelnuts	330,000
Walnuts	370,000
Almonds	650,000
Total	1935,000

(Hargreaves 2004)

New Zealand production was too small (35,438kg) to be included in world macadamia production figures of nut-in-shell and kernel for 2003. Seven countries are listed (Table 4). Hawaii was the leading nut producer until the late 1990's but the sale of Hawaiian macadamia plantations for real estate and the increased planting in Australia meant that they produced the greatest volume in 2003.

Table 4: World macadamia production – NIS and kernel (2003)

Country/Region	NIS Tonnes	Kernel Tonnes
South Africa	12,500	3,400
Kenya	8,800	1,000
Malawi	4,000	1,000
Zimbabwe	900	120
Central America	17,000	3,100
Hawaii	22,000	5,500
Australia	30,000	9,100
Total	95,200	23,220

(Hargreaves 2004)

Note Factors that determine the weight of usable kernel include:

- ❖ The weight of moisture lost when drying down from 10% (the international standard for processors buying from growers) to 1.5% (the international standard when nuts are processed).
- ❖ The weight of kernel which cannot be used because of blemish which makes the kernel of no commercial value.

Australian production steadily increased from 1987 to 2004 due to new plantings, availability of new varieties and better on-farm management. Prices to growers varied from a high \$3.95 (1988) to a low \$1.60 (1991). These fluctuations (Table 5) reflect local supply quantity and quality variations and international economic conditions and these swings are common in the world food market places.

Table 5: Australian NIS production and prices

YEAR	NIS PRODUCTION	NIS PRICES - \$/KG @ 10pc MC
1987	4,400	3.10
1988	5,200	3.95
1989	6,800	3.65
1990	12,000	2.50
1991	10,000	1.60
1992	13,000	2.03
1993	14,500	2.75
1994	19,700	2.80
1995	17,500	3.00
1996	20,500	3.05
1997	25,400	2.70
1998	26,500	2.45
1999	33,000	2.25
2000	29,500	2.12
2001	34,800	2.45
2002	30,200	2.75
2003	29,700	3.20
2004 forecast	37,000	3.10

(Hargreaves 2004)

Macadamia Production Figures

Hawaii was the first place to build a commercial macadamia industry. The figures (Table 6) are for Dry Nut In Shell (10% moisture) and they show the steady increase until year 2000. Available figures for the Hawaiian industry commenced in 1947. There was a steady increase in yields to reach a peak in 1995 – 2000. The sale of macadamia plantations and difficult weather conditions have combined to reduce production figures in the years since 2000.

Table 6: Actual & projected production (based on per tree yields) for Hawaii

YEAR	Projected Total Prod'n DIS tons	Actual Total Prod'n DIS tons
1947		286
1948		308
1949		318
1950		308
1951		342
1952	34	386
1953	81	438
1954	202	440
1955	424	422
1956	602	410
1957	838	466
1958	1141	603
1959	1485	831
1960	1844	953
1961	2263	1165
1962	2665	1701
1963	2967	2351
1964	3224	2723
1965	3484	3465
1966	3720	3866
1967	3941	3953
1968	4185	3613
1969	4311	4734
1970	4487	4558
1971	4692	5995
1972	4939	6554
1973	5325	5947
1974	5837	5499
1975	6463	7425
1976	7069	8260
1977	7693	8614
1978	8365	8927
1979	9103	9517
1980	9884	12093
1981	10567	15146
1982	11416	15132
1983	11885	16656
1984	12274	16520
1985	12617	17101
1986	13031	19051
1987	13482	19958
1988	14073	19369
1989	14854	20369
1990	15484	22907
1991	16461	22680
1992	17456	22453
1993	18794	21773
1994	20314	22000
1995	21572	23814
1996	23059	23134
1997	24324	25628
1998	25517	26309
1999	26491	26082
2000	27348	25628
2001	28070	22680
2002	28311	25300
2003	28509	23500

(Lee 2004)

Production Figures for South Africa, Australia and Hawaii

Australia, Hawaii (USA) and South Africa are the three major macadamia producing countries in the world. Data for areas planted and production in 2003 for these countries indicate that yields were 1.25, 1.58 and 3.14 tonnes per hectare for South Africa, Australia and Hawaii respectively. These figures suggest that either planting densities were more intensive planting in Hawaii with 22,000 tonnes produced from 7,000 hectares or that the trees in Hawaii carry heavier crops than trees in the other sites.

Table 7: Planted area (2003) and production NIS (2003) in South Africa, Australia and Hawaii.

Country	Planted Area (2003)	Production (2003)
South Africa	10,000 ha	12,500 tonnes
Australia	19,000 ha	30,000 tonnes
Hawaii	7,000 ha	22,000 tonnes

(Lee 2004)

CHAPTER 1 : REFERENCES

- Dettman, Mary E. and Jarzen, David M. 1998. The Early History of the Proteaceae in Australia : The Pollen Record. Australian Systemic Botany. 11: 401 – 438.
- Ferguson, A.R. and Bollard, E.G. 1990. Kiwifruit Science And Management, Edited by I.J. Warrington and G.C. Weston for the New Zealand Society for Horticultural Science. Ray Richards publisher: p 166.
- Garden, Robert. 2002. Audio tape No 2, 24/5/02
- George, Alec S. 1998. Australian Systemic Botany, 30 Oct: 11: 275 – 266
- Gordon, Ian. 2002, 2003. Audio tapes No 10, 29/9/02 and No 19. 11/2/03.
- Gross, C.L. and Weston, P.H. 1992. A review of Macadamia F. Mueller. A paper presented at the National Herbarium of NSW, Royal Botanic Gardens, Sydney. 28 Aug: (First nine pages held)
- Hargreaves, Graeme. 2004. Growth of the macadamia industry. Australian Nutgrower. Sept: 26 – 29.
- Hayes, Vanessa. 2002. Audio tape No 16, 29 Oct
- Kerr, Vince. 1986. The need for research on growing macadamias In New Zealand. News Bulletin, May.
- King, Michael. 2003. The Penguin History of New Zealand. Penguin Books: p 63

Lee, Philip. 2004. More projections and comparisons of growth in tree plantings and production. In a Nutshell, Southern Macadamia Growers' Association, Jan: 5 – 22.

McConachie, Ian. 2004. Email of 14 Jun

New Zealand Macadamia Society (NZMS) 2004. Newsletter No 39, July: 9

Peace, C. 2001. Delimitation of species ranges and natural hybrid zones for *Macadamia tetraphylla*, *M. ternifolia* and *M. jansonii* using DNA markers. (Draft) Thesis held by Commonwealth Scientific Industry Research Organisation for PhD (University of Queensland).

Pickmere, Nancy Preece 1994. Kerikeri Heritage of Dreams, Northland Historical Publications Society Inc., Russell, New Zealand. Chapter Two, p 4.

Pole, Mike. 1998. The Proteaceae Record in New Zealand. Australian Systemic Botany, 30 Oct: Chap.1 : 343 – 372

Richardson, A., Dawson, T. 1993. Enhancing abscission of mature macadamia nuts with ethephon. NZ Journal of Crop and Horticultural Science, Vol. 21: 325 – 329

Rosengarten, F. 1984 The Book of Edible Nuts. Walker Publishing Company Inc. pp 117 – 125

Ward, Debbie and Phil. 2002. Audio tape No 17, 30 Nov

CHAPTER TWO : METHODS AND MATERIALS

2.01 Methods

It is very difficult to visit every macadamia orchard in the country. There is no national or regional register of orchards or processing plants. Using Macadamia Society listings as a starting point a selection of properties was made for probable visit. Included were orchards from the Far North to New Plymouth in the west to Gisborne in the east and if there was a processing plant on a property this became an extra reason to visit. Calls were made on pioneers, consultants, nurserymen and specialists employed by HortResearch. Two Australian consultants with specialist roles within New Zealand were visited in Queensland. If possible a tape recorded interview took place in the orchard nursery, or processing plant but sometimes this was not possible. Notes were sometimes taken from phone messages at work or home when the recorder was not available. In several cases emails were sent and answers received and in one situation a grower (the Searles) provided a full report on a serious problem which ravaged their orchard. Some growers or pioneers declined to participate in the study.

2.02 Ethics Information Sheet

An Ethics Information Sheet (Appendix 1) and Consent Form (Appendix 2) were sent to those to be interviewed. The letter identified me and the reasons for the proposed meeting and asked for permission to participate in the research project.

2.03 List To Be Interviewed

The list of those who were sent the information sheet include:

Beer, Ernie, 5 First Avenue, Tauranga - Retired Grower.

- Bell, Henry, Hidden Valley Plantations, Beerwah, Queensland, Australia - Grower, Processor, Plant Breeder.
- Boyes-Barnes, Mrs Fay, Cannon Drive, Kerikeri
- Canning, Mrs Anne, Waipapa West Road, Kerikeri - Grower.
- Chamberlain, Clive, P O Box 4121, Kamo, Whangarei - Organic Grower, Processor.
- Charteris, Christine & Bill, Surrey Hill Road, Oakura, New Plymouth - Growers, Processors.
- Clarke, Mrs Marjorie, 18 Kemp Road, Kerikeri - Organic Grower.
- Collins, Mike, Inlet Road, Kerikeri - Grower.
- Courtice, Roger, Piha, Auckland - Partner in Macadamia Plantations. (Did not participate in the study).
- Dawes, Stuart, 7 Kerrymaria Place, Takapuna - DSIR Scientist.
- Edwards, Rick, HortResearch, Mt Albert, 120 Mt Albert Road, Mt Albert, Auckland - Librarian.
- Endt, Dick, 108 Parker Road, Oratia, Auckland - Nurseryman.
- Ferguson, Lindo & Laetitia, Butler Point, Hihi Road, Mangonui - Growers.
- Garden, Rob, Macnut Farms Ltd, 914 South Head Road, RD 1 Helensville - Grower, Processor.
- Gordon, Ian, 168 Scenic Drive, Titirangi, Auckland - Consultant, Grower, Plant Breeder.
- Graham, John, 52 Riverview Road, Kerikeri - Grower.
- Graveson, Mrs N, 4 The Close, Retirement Village, Kerikeri
- Hayes, Vanessa, P O Box 238, Gisborne - Grower, Plant Breeder.
- Henderson, Bruce, Thompsons Road, Kaitia - Grower, Processor.
- Kerr, Vince & Diane, P O Box 4267, Kamo, Whangarei - Nurseryman, Consultant.
- Lin James, Jamesmay International Ltd, 1340c Glenbrook Road, Waiuku, Auckland - Grower, Processor.
- Lykho, Dr Anatoly, Macadamia Plantations, Okaihau - Grower.
- Mackie, Jim, Taheke Road, Kaikohe - Grower.
- Martin, Phil, HortResearch Station, No 1 RD, Te Puke - Scientist. (Did not participate in the study).
- McClelland, Glenmohr Road, Waipu - Grower.

- 4 What has been the yield (NIS) in last two or three years?
- 5 What machinery do you have eg. dehusker, cracker and so on?
- 6 What pests affect your orchard? Eg Vegetable Bug, rats – other? Is the damage serious? What do you do to eradicate the pests?
- 7 Do you process your own crop? Buy in more?
- 8 Do you add value?
- 9 Are your markets local (in your area) or in a large centre?
- 10 Do you have leaf and/or soil tests done regularly?
- 11 Do you follow the recommendations arising from these tests?
- 12 In the future do you see problems with hand picking?
- 13 How do you improve your yield for quality and quantity?
- 14 Future direction and other views of the industry?

When replies came back agreeing to host an interview, phone contact was made and visit dates and times confirmed. Most visits included an interview inside followed by a tour of the trees and dehusking and drying facilities. Sometimes a second visit was made to clear up any mistakes or for further clarification. All tapes were replayed and written notes made of the relevant information. Descriptions of most visits are printed in Chapter Four.

Visits were made to two important Australian macadamia experts. Both Ian McConachie and Henry Bell have made important contributions to the Australian industry and to research and development in New Zealand orchards. Henry Bell is well known for research on new varieties and a number of his selections have been planted in New Zealand. Ian McConachie has been a consultant to several local growers and frequently visits this country. Profiles of both appear in Chapter Three.

2.05 Data Sources

Data sources included:

- 1 Information obtained from field visits to growers, processors, consultants and scientists.

- 2 Information obtained from pioneers in the industry.
- 3 Published work in journals, scientific papers and government and industry related features. Key publications on research included:

New Zealand – The Orchardist, the Tree Cropper, HortResearch published papers, Growing Today, New Zealand Macadamia Society Newsletter. New Zealand Macadamia Nut Growers Co-operative Company Limited News Bulletin, NZ Journal of Crop and Horticultural Science.

Australia – Australian Macadamia Society News Bulletin, Australian Systemic Botany, Queensland Journal of Agricultural and Animal Science, Australian Journal of Botany, Journal of Horticultural Science.

USA – Californian Macadamia Society Yearbook, Journal of the American Society of Horticultural Science.

CHAPTER THREE : THE HISTORY OF MACADAMIAS IN NEW ZEALAND

3.01 Early Plantings



It is not known where or when the first macadamia tree was planted in New Zealand. Trees or seed were planted in New Zealand in the late nineteenth century (Boyes-Barnes 1987). A large *M. integrifolia* tree still stands in Mr Jim Smaile's property at 37 Pupuke Road, Takapuna, overlooking Lake Pupuke. The tree was planted by Sir Frederick Whitaker in about 1875. Whitaker is listed in the Dictionary of New Zealand Biography as a lawyer, entrepreneur, politician and premier (Dictionary of NZ Biography, Volume 1).

Plate 1: The oldest known macadamia tree planted in New Zealand (planted about 1875) growing in Takapuna, Auckland

(Photo: B. Coleman)

Jim Smaile has a note stating that the tree was a *M. ternifolia*. However this is incorrect as, *M. ternifolia* has bitter inedible fruit and Mr Smaile gathers a good harvest each year and enjoys the sweet kernels regularly. The tree is listed in the volume Great Trees of New Zealand as the oldest macadamia tree in the country (Plate 1) (Burstall and Sale 1984). Without doubt unrecorded plantings of macadamias were made in warm sites from the Bay of Plenty northwards from the 1920's (McConachie 1986).

3.02 The New Zealand Industry 1932–1950

The first known substantive planting of macadamia seeds in New Zealand occurred in Kerikeri in 1932 (Pickmere 1994). Mr Syd Jolly, the District Manager of the New Zealand Tung Oil Company based in Kaikohe, planted seeds brought from Australia on his own land and gave seeds and seedlings to folk living in the Kerikeri district to make shelter belts on the local citrus orchards. Some of those first trees were still growing, until 2003, but a new owner of the land cut down the macadamias.

Jolly, a man of independent means, had purchased a considerable parcel of land near to the Kerikeri town centre and when the Tung Company collapsed in 1938, he concentrated on civic affairs and work on his properties. He experimented with growing gum trees to make hard wood poles and with citrus, but neither venture proved profitable. The legacy Mr Jolly left was a large number of macadamia trees growing as specimen trees on private Kerikeri properties and the use of macadamias as shelterbelts on the local orchards.

In 1948, the New Zealand Department of Agriculture introduced seed from six different strains of macadamias from Australia. The New South Wales and Queensland Departments of Agriculture selected the strains and collected the seeds (Schroeder and Fletcher 1965). As the land for the nursery in Kerikeri was not ready for planting, Mr Percy Everett, from the Department of Agriculture, arranged for Mr T. W. Graveson to plant the seed in his orchard in Darwin Road, Kerikeri.

Graveson, who had recently moved to Kerikeri from Auckland, had a flair for research and took a keen interest in sub-tropical plants. At one time he had tried his hand at growing tea and coffee successfully. He was a well-known citrus grower who had experimented with grafting on various stocks to obtain best returns considering labour costs, resistance to drought and immunity from disease (Hale 1955).

For two years Graveson took care of the new strains from Australia. The agreement with Everett was that no money should be paid but Jock Graveson would keep two seedlings from each of the six strains. There was no record of the names of the six strains as, apparently, Mr Graveson chalked the names on the shed wall! After two or three years the government nursery was ready and the macadamia seedlings were planted with other experimental crops. Although the nursery was closed after a few years the introduction of new strains made more choices available for local growers (Mrs Nell Graveson, 2002).

3.03 1950's–1980

The only macadamia variety in New Zealand with a Maori name was first observed in Whangarei. The history of the Rangataua line of macadamias starts with a heavy yielding tree in Whangarei. There is no known written history about this tree but a Mr Willie Levesque, in Tauranga, planted two trees in the early 1950's using seeds from the Whangarei tree. One of these trees was a prolific bearer with thin-shelled nuts which could be cracked easily with a common nutcracker (Lens 1988).

Mr Hans Lens planted some of these nuts in 1966 in his citrus and kiwifruit orchard in the Bay of Plenty and one tree was in a sheltered and shady spot. The tree was forgotten. Its first crop appeared in 1979 and Lens believed that the tree had a good commercial future because of the thin shelled nut and its early bearing habit; the yield increased steadily as the tree matured and the tree was suited to the soils and climate of the Bay of Plenty.

Rangataua was patented by Mr Russell Gammon from Omokoroa Nurseries, number PV 3231 – AB. The year of the patent is not available. Gammon was the sole propagator but

the species has not proved to be popular in the main macadamia areas in New Zealand. HortResearch in Kerikeri planted it in its trial block but it was not successful and was removed to make way for new varieties. Mr Ted Dawson of HortResearch noted that Rangataua had a low yield, had a very thin shell and was prone to Green Vegetable Bug damage (58%) compared to varieties which had approximately 3% damage. On the positive side this variety had a high crackout (47.8%) but a low percentage of No 1 kernel of (49.4%) (Dawson 2003).

The Ministry of Agriculture and Fisheries (MAF) commenced long-term trials at the research station at Mount Albert in 1958. Early plantings were mainly Kerikeri seedlings but by 1958 seedlings from two Queensland selections, Sewell N3 and N7 had been planted. Although growing in a windy dry environment, there were good crops of thin-shelled nuts but no figures of the yield are available (Dawes 2002).

From the mid-1950's it was the practice for groups of MAF officials and scientists from the Department of Scientific and Industrial Research (DSIR), to make annual visits to Kerikeri. A major reason for the visits was to inspect the development of the citrus industry in the region and to evaluate the trials of other crops including macadamias. Included in the visiting group was Mr Bill Fletcher, a Horticultural Adviser Officer, who had been involved with early trials with macadamias at Mount Albert (Fletcher 1976).

Mr Brian Piper was an adviser in citriculture and on a visit to Kerikeri in 1957-58, he picked up a number of macadamia nuts and put them in his pockets. Shortly after this Mr Piper left government service and bought some land to start a citrus orchard and nursery at Te Puna, near Tauranga. He planted the nuts to form two shelterbelts. Nuts from these shelterbelts were selected and planted at the Te Puke Research Station. To identify these nuts the Te Puna shelter belts were labelled PA and PB and the trees were numbered one, two and so on. The P denoted the orchard – Pipers. Over thirty years later the Piper selection, PA39, became a popular choice in macadamia orchards in New Zealand as it produced good yields of thin shelled nuts which dropped, and the selection became a good pollinator for *Beaumont* (NZMS Newsletter April 2002; Piper 2002).

By the early 1960's many properties in Kerikeri had seedling trees, the descendants from the Jolly and Graveson plantings. A Mr Robert Walker, a wealthy Scottish immigrant, arrived in Kerikeri in about 1935 and took an active interest in the developing horticulture industry in the area. He returned to Scotland in 1939 to fight in the Second World War but in 1946 he came back to Kerikeri and bought a few acres on Kerikeri Road. Mr Walker planted citrus and approximately 100 macadamia seedlings and by the early 1960's they were producing good yields; These seeds almost certainly came from Mr L Anderson, Hall Road. Mr Walker was a keen grower and worker but took no payment or profit from the sale of nuts or citrus. He did, however, take careful records of NIS and he took nuts to the local chemist, who had the best scales, to be weighed. Unfortunately all these records have been lost. Mr Walker worked on neighbouring orchards and Mr John Graham owned one of these. Mr Graham undertook to market the nuts on the Walker property and the largest nuts were sold to Duncan and Davies in New Plymouth, to Don Boyes-Barnes who was establishing a macadamia nursery in Kerikeri, and to orchards for shelter belts. In a good year they took \$10,000. The small nuts were for eating. The Walker property was used by MAF as a show place for visitors and for those who were interested in growing macadamias (Graham 2003).

In the late 1960's Mr Dick Endt a nurseryman at Oratia, Auckland, met Professor R. A. Hamilton from the USA and heard about the macadamia industry in Hawaii. This sparked an interest and on a visit to Kerikeri he observed the seedling trees growing on the Anderson property in Hall Road, Kerikeri. He took samples of two varieties back to Auckland and used these as his first attempts at grafting macadamias. In 1974 he visited Hawaii and California to observe methods of growing and processing in these two areas. Back home in Oratia Mr Endt planted approximately twenty varieties which he imported from Hawaii, California, Australia and southern Africa but after extensive trials he settled on *Beaumont* and *Elimbah* as the most promising. These became his main selections for sale until the 1990's when he decided to concentrate on other exotic and semi-tropical species and to drop macadamias from his catalogue (Endt 2002).

A friendly rival of Mr Endt, Mr Jim Pringle had a citrus nursery at Te Puna, Tauranga. Mr Pringle became interested in growing and selling macadamia plants and visited South Africa to look at the industry there. When he returned to New Zealand he brought back some scion wood from hybrid varieties and these formed the basis of his macadamia nursery although other varieties were grown later. The establishment of this nursery predates the trials at Te Puke, 1972 and there was close co-operation between Mr Pringle and Mr Dawes' team at the research station (Pringle 2002).

Mr Stuart Dawes, a scientist in the Plant Diseases Division, DSIR, Auckland, was the project manager for the macadamia selection trials at the Te Puke Research Orchard. According to the laying down report, 26 macadamias were planted on 28 and 29 October 1971. Varieties included Maroochy (N7) and Sewell (N3) from the Mt Albert Station and two unnamed *M. integrifolia* varieties growing down in a gully at Te Puke. In December, just two months later, a number of trees were dead and replaced by more N7 and N3 trees. In addition a number of Piper selections were planted as shelter belts between orchard blocks. On 14/12/72 three more varieties, Nutty Glen, Hinde (H2) and Keauhou (246) were planted using cuttings grown by Mr W. A. Fletcher, MAF. (Notes held by Te Puke Station 1973)

In 1972 Mr D J W Auckland, a member of the Californian Macadamia Society, wrote an article, including photographs, which was published in the Society's Bulletin (Auckland 1972). His opinion was that macadamias could have a future as an orchard crop in suitable sites in New Zealand. There was a description of Mr Auckland's orchard which was situated west of Auckland in the foothills of the Waitakere ranges. He had twenty acres planted in sub-tropical crops including tamarillos, kiwifruit, citrus, feijoas and a few macadamia trees. These trees were N3 and N7 seedlings and some were quite tall. He propagated more macadamias in his glasshouse that were planted in rows in the orchard.

Mrs Marjorie Clark and her husband Gerry were one of the very early organic orchard growers in New Zealand, and they bought Homelands Orchard in Kerikeri in 1958. There were a variety of fruit trees planted including several macadamias.

In 1974, Mrs Clark visited Britain and stayed at a religious community in Scotland. On her return home she “heard” a specific message – “Don’t eat any more nuts: Grow them.” The harvest of fallen nuts encouraged the idea that more macadamia trees would increase the income from the orchard. At this time Don Boyes-Barnes visited the orchard, stayed for a few days, liked the lifestyle and encouraged Mr and Mrs Clark to buy more trees. Fifty macadamia trees were bought from Dick Endt and a partnership between the Clarks and Boyes-Barnes was formed. The total of macadamia trees planted among the citrus at Homelands increased to 291 by 1982 consisting of seventeen varieties.

The Clarks had decided to become organic growers in 1961 and they became the second registered organic growers in New Zealand. Don Boyes-Barnes did not agree with the organic principles but, in spite of the different values and methods, the partnership lasted until the death of Boyes-Barnes in 1999. Boyes-Barnes and Gerry Clark shared an interest in solo off-shore sailing and Gerry spent much of his time in building and testing a new boat. In 1982 Gerry Clark set sail and was away for almost four years sailing the southern oceans. Homelands orchard was planted on sloping land, facing east and overlooking the Kerikeri Inlet. Apart from the 291 macadamias there were approximately 700 citrus trees including mandarins, grapefruit, tangelo and navel oranges. The property required much manual and heavy orchard management to maintain the organic philosophy and to produce saleable fruit. There are some orchard records from the mid-1970’s until 1982. Perhaps, with her husband absent and the physical demands increasing as yields improved, Mrs Clark left the partnership details and sale and production records to others to record.

For some years the pest Green Vegetable Bug (GVB) (*Nezara viridula*) caused serious damage to the macadamia kernel in the Homeland orchard. Some times the damage reached over 50%. Mrs Clark invested in a parasitic wasp, purchased from Palmerston North, and along with other predators such as the Australian Paper Wasp and praying mantis, brought damage down to acceptable levels.

Mrs Clark joined in a friendly partnership in 1992 with Mr and Mrs Wakelam and rented a small room in a local pack house. They set up a processing plant to process and package the joint yield to sell locally (Clark 2002).

One of the more interesting macadamia orchards is situated at Whanarua Bay in the eastern Bay of Plenty. Mr Tim Simcock, an orchardist in Opotiki, experimented by planting, in 1969, some mixed macadamia seed from the Te Puke research station. He was pleased with the yield from these trees and he purchased a property at Whanarua Bay which had been planned to be a motor camp and several holiday sections.

Simcock believed that macadamias were a viable horticultural crop because of the low maintenance required to run the orchard and for the high prices received for the yield. The property of 2.5 ha. was planted in the late 1970's with a range of varieties including:

Piper selections of DSIR – PA39, PB3, PB33

Hawaiian Selections – 246, 333, Mauka

South African Selections – Nelmac 1 and 2

Australian Selections – Own Choice, Beaumont, Renown, Nutty Glen, Maroochy.

In total there were approximately 370 trees planted on a spacing of 4 x 5 metres (Simcock 2004).

Mr Simcock sold the property in 1988 to two Australian ladies, Beverly Davy and Robin Moule, who wanted a change of lifestyle from their Melbourne businesses. Simcock moved to Tauranga and currently has a row of shade houses growing a variety of orchids.

The Australians sought advice from the DSIR and brought in Ian Gordon as consultant. Yield improved from 1.5 tonnes in 1989 to 4.2 tonnes in 1993. That equated to approximately 12kg per tree which was much higher than most growers achieved according to a 2002 survey of members conducted by the Macadamia Society (NZMS Newsletter, April 2002). Blocks of Beaumont trees produced on average between

18kg – 28kg per tree per block depending on the site, position and pollinators. Own Choice, Nelmac2 and Renown were the heaviest croppers and one seven year old PA39 gave 33kg but there were few trees of this selection in the orchard.

Some varieties proved to be not worth keeping, the Hawaiians were an example, and were replaced by others such as the Gordon Titirangi selections GT1, GT201 and GT207. GT1 proved to be a good pollinator for Beaumont and produced an acceptable yield of small nuts of very good quality. Other replacement trees included more Beaumont and PA39 and during the 1990's several of the Bell 'A' series from Australia were planted as a part of a trial carried out in different parts of the northern region of the North Island by Horticultural Research. The trial was an attempt to find a suitable dropping variety to replace Beaumont as a main crop for large commercial holdings.

In addition to the growing of macadamia trees the owners became involved in processing the crop. They produced a range of added-value macadamia goods, such as roasted and chocolate-coated nuts, that were marketed around the Bay of Plenty/Waikato successfully. The home orchard shop caught the travellers on the Coast Highway. The TV programmes 'Country Calendar' twice features this orchard (Gordon 2002).

Mr Don Boyes-Barnes, was an architect in Wellington, and was looking for a new challenge. On a visit to Mr Gerry Clark in Kerikeri, he saw some macadamia seedlings on the property. Boyes-Barnes liked the lifestyle and joined in a joint venture with Mrs Marjorie Clark in 1975. He bought land in Kerikeri and established a nursery, "The Macadamia Centre" (Gordon 2002).

In September 1979 Boyes-Barnes and a friend, Mr Mike Collins, travelled to Hawaii and made an intensive study of the different sizes, conditions and varieties in the plantations on several islands. They also visited a research station and a processing plant. Initially they visited an agricultural engineer, Tung Liang, at the University of Hawaii at Honolulu. They hired a car, and with Tung Liang, they went to Hilo (east coast), and took a clockwise direction trip around the southern part of the island, to Kona, on the West

Coast. There was a research station at Hilo, where they saw the original numbered trees, which eventually were given names and propagated as varieties. For example the Haes variety was named after the 'Hilo Agricultural Experimental Station'.

They visited some of the big commercial plantations as well as some that were on the market as an investment or lifestyle properties. Film star Julie Andrews owned one. Tung Liang's interest had initially been in the harvesting side, but he had become an all round industry expert. Brewers, a sugar company had interest in diversifying into macadamias, and their Moana Loa plantation and processing plant was visited. They considered that as the light levels were so poor under the plantation trees at Moana Loa, they could plant trees close in NZ. They were wrong about that as some of the early orchards which were planted following recommendation from Boyes-Barnes had their trees too close to be successful.

Collins initially worked with Boyes-Barnes in his nursery thinking that it might be a suitable change in direction, as citrus was being severely challenged by kiwifruit and the severe regimentation of that industry did not interest him at all (Collins 2003).

3.04 1980–2000

In 1980 and 1982 Mr Collins planted 371 macadamia trees between the citrus trees in two orchard blocks. The planting included seven varieties from three different nurseries and within a year many trees were dead or were in poor condition. The nurseries that supplied the trees were The Macadamia Centre (204 trees), Tharfield (102 trees) and Duncan and Davies (65 trees).

Table 8: Mike Collins first macadamia orchard

	Variety	Total No.	Dead or in Poor Condition	
			No.	Percentage
Australian Hybrids	Beaumont	141	30	21.9%
	Own Choice	34	0	0
South African Hybrids	Nelmac 1	18	5	27.6%
	Nelmac 2	43	12	27.9%
Hawaiian <i>Integrifolia</i>	Keau	54	18	33.3%
	Ika Ika	56	23	41.1%
	Keahou	25	9	36.0%
		371	115	

(Collins 1981)

It is unclear why so many trees failed. Own Choice was planted in the same block and in rows 4, 6 and 8 close to the middle of a block of 13 rows. Beaumont was in alternate rows in one block of 16 rows, and were rows 2, 10 and 12 in the other block of 13 rows. Own Choice was planted near the middle of the block, not near shade. Beaumont were spread throughout the blocks and experienced all possible possible conditions in the orchard.

Nelmac 1 and 11 were both in the same block with Nelmac 1 in rows 1 and 3, near the shelter belts and Nelmac 11 were in rows 9, 11 and 13 near the shelter belts at the other end of the blocks. All the tree failure for Nelmac 11 happened in rows 11 (5) and 13 (7).

The three varieties of Hawaiian *M. integrifolia* were in the same block and were planted alternately with Beaumont. Keahou was in row 16 in one block, next to the shelter, and in row 5 in the other block. Eight of the Keahou failures were in row 16 in the first block. Ika Ika was planted in rows 8, 10, 12, and 14 and had the worst failure rate of 41.1%, or 23 trees, with the failures in row 8 (4), 10 (6), 12 (9) and 14 (4).

Mr Collins believed that a lack of shelter in some areas of the orchard and some shady areas were the main causes of failure. The three Hawaiian selections seemed to be more affected by the cooler orchard conditions than the Australian and South African hybrids.

In 1982 Mr Collins with the co-operation of Mr Dawes of DSIR, planted a mixed trial block using funds provided by a DSIR grant for new industry development. Beaumont was planted in each fourth row to provide comparisons with other varieties. Ten rows of seven Piper selections were included in the trial and other varieties planted were Keau 660, Nelmac 1, Kau 344, Sewell and Mauka 741. Unfortunately, the funding and interest from DSIR quickly discontinued and Mr Collins became busy with a saw milling venture. It was regrettable that no yield data was kept recording variety performance. This block had wider spacing than the early plantings – 6m x 7m compared to 3m x 6m. Throughout the orchard Beaumont was the superior variety and the *M. integrifolia* selections from Hawaii were not economically viable (Collins 2003).

3.05 Big Plans

On January 29, 1980, the Northern News printed an article about a new industry starting near Lake Omapere and close to Okaihau. A syndicate of 22 people formed Macadamia Products Ltd to grow macadamia seedlings and other horticultural products including 1000 pepinos and 2000 yellow tamarillos. Other fruits planted included cherimoya, casanas, persimmons and babacos.

Macadamias were to be the main planting on the 400 acre farm with between 35000 to 40000 trees envisaged. The venture included growing the trees, mechanically harvesting the crop, processing and packing the kernel. The manager, and the only active member of the syndicate, was Mr Murray Mason, a former horticultural researcher in the DSIR. It was anticipated that the macadamia trees would produce 40 kilos of nuts per tree in the twelfth year and by the fifth year enough nuts would be produced to commence processing.

Although no varieties were named in the article it was obvious that the plan was to plant non-dropping varieties as harvesting was to be done by shaking trees by a machine. After de-husking nuts were to be dried in hot air silos and then cracked. Depending on market demands the kernel would be roasted, salted and packed in tear-top cans or packaged raw

in vacuum sealed plastic bags. At the prices current in 1980 it was hoped that the scheme would have an annual turnover of \$13 million for the nuts and an additional sum for the fruit grown which would be sent to a Bay of Plenty cannery and exported to Germany.

The farm would have 120 acres committed to macadamia and the rest of the farm to include over 6 km of shelter belts, processing plant, tunnel and glass houses to raise seedlings, and land for growing the fruit mentioned above. It was hoped that up to 40 people would be employed when the scheme was fully operational (Northern News 1980).

Since the outline of the scheme in January 1980 there has been no mention of the success or failure of the plan in any media source. Enquiries to ex Co-operative members and other major macadamia producers have not produced any details regarding the setting up or fate of the scheme.

3.06 Commercial Ventures

It was ironic that at the time a large macadamia scheme was receiving local press headlines there were three commercial ventures being formed. Two of these remain operational, with different owners and philosophies. One was wound up in 1999 and each enterprise is described in the following pages.

3.07 Macadamia Plantations of New Zealand

In the late 1970's, Mr David Paykel and partner Mr Roger Courtice, purchased 230 acres of farmland on Horeke Road, Okaihau. On this site New Zealand Macadamia Plantations was established with macadamias to be planted on 150 acres and the rest of the land to be used for other crops, such as avocados and persimmons and for a shade house, plant nursery and operating sheds. Although the area is quite close to the Bay of Islands the site chosen was inland, elevated and exposed to all main winds with colder temperatures (particularly in winter and early spring) than the main macadamia plantings around Kerikeri.

The first trees were planted on 28 January 1978 (Henry 2002). The owners decided to concentrate on Hawaiian varieties so that harvesting could be carried out mechanically. This choice was unusual in New Zealand as all other major growers selected Australian varieties and hand picking was the harvesting method. All trees were grown in the nursery and Maroochy (N7) was used for the rootstock.

Planting the orchard took several years until the maximum number of trees reached 14000. There were over 10000 Hawaiian trees and the rest were mainly Beaumont, Own Choice, Renown, PA39 and GT1. Trees were planted at 3.5m between trees and 7.5m between rows and blocks were in 100m x 100m squares. There was no permanent irrigation system.

The original orchard book shows the following named Hawaiian varieties and the number of trees for each:

Table 9: Hawaiian varieties planted at Macadamia Plantations of New Zealand

246	Keauhou	4332 trees
508	Takea	1982 trees
344	Kau	2173 trees
741	Mauka	1068 trees
333	Ikaika	303 trees
800	Mackay	187 trees
462	Jordon	273 trees
660	Keaau	206 trees

(Henry 2002)

From the beginning trees were slow to produce nuts and yield per tree was very disappointing. It became obvious that the climate did not suit the Hawaiian varieties and even Beaumont and Own Choice were not producing commercial crops. By the mid 1990's the partnership between Paykel and Courtice became precarious and the property was sold to Mr Case Bakker in 1993-94.

Mr Bakker decided that he would sub-divide the orchard into lifestyle blocks. The new owners could clear the land and use it however for anything they wished, or keep the

macadamias and sell the crop to a processor. However, in 2000 Mr Bakker sold the property to Dr Antoly Lykho.

From a maximum of 14,000 trees the orchard now has approximately 12,000 with losses caused by weather (e.g. Cyclone Bola), tree failure, fencing and general orchard practice (Henry 2002, Veldhuizen 2003).

3.08 History of The New Zealand Macadamia Nut Growers' Co-operative Ltd

During the 1970's and early 1980's there was increasing interest in macadamias as a possible lifestyle planting to give extra cash to supplement the country living costs especially in people in retirement. Several nurseries in the Far North, Auckland and the Bay of Plenty promoted the exotic species as easy to grow and maintain with little pruning, or fertiliser application needed and picking was easy. In addition the publication of articles following trials carried out by DSIR, together with MAF information pamphlets, added to the interest and informal visits to existing orchards became popular. Most plantings were from north of Auckland and weekend venues attracted developing attendance

Meetings were held in Northland in the late 1970's and early 1980's with both interested growers and people who were merely curious. These were field days with no fixed structure or business agendas.

A more organised gathering, a discussion day, was held in the Hokianga on 13 March 1982, attended by approximately 300. It was decided that a further meeting should be held to discuss the formation of a formal society. Thus, in the Hokianga County Hall, Rawene on 17 April 1982 an association named "The New Zealand Macadamia Nut Growers" was formed with approximately 100 foundation members. A committee was elected with a Chairman, Secretary, Treasurer and ten members (Mac News No 1a).

Agenda items included talks on the Co-operative Structure by Bevan Fitzsimon of the Community Enterprise Lion Trust and Marketing by Dick Wauchop of Apteryx International Marketing Ltd. The meeting concluded with an address by the local Member of Parliament, Neil Austin (Mac News No 1b).

The meeting began at 10.30am and finished at 3.30pm and the committee then held its inaugural meeting. Its business included:

- (i) A research project on “nut set” was approved at a cost of \$4000 with the sum to be raised by a research levy on growers and pledges from other members. Not enough members of the Co-operative agreed to pay a compulsory research levy and to pledge further funds to complete the research in the time set by the researcher. Many members believed that it was too early in the Co-operative’s life to set levies and pledges on growers who had no income off their new orchard plantings. The committee was forced to cancel the project for that year.
- (ii) Information services for members would include field days, seminars, newsletters (Mac News and Mac Links), which include condensed papers from research articles.
- (iii) Legal structures were discussed including trusts, companies, co-operatives and foundations.
- (iv) A Field Day was to be held on 22 May 1982 with visits to orchards in Kaikohe, Okaihau and Kerikeri.

Items missing in the notes from the first meeting include:

- (i) Attendance figures;
- (ii) Subscriptions and levies figures;
- (iii) Dates and venues for future meetings.

During the next twelve months the committee made enquiries and took the necessary steps to form a Co-operative with ten directors. It was understood by the majority of the Board that a co-operative was more of a marketer than a processor (Macadamia News 1983).

- (i) The payment of reasonable travelling and other expenses was to be determined at the AGM.
- (ii) All directors must hold a foundation share.
- (iii) All directors must retire each year but may be re-elected at the AGM.

The supply of produce (NIS) was under the control of the directors who may refuse or accept the nuts without giving any reasons. The produce was to be marketed as the directors thought fit and from the gross returns they could deduct:

- (i) costs of processing and marketing.
- (ii) costs of running the company plant in the future including wages and administration charges, and
- (iii) a reserve fund contribution.

The balance was to be paid out to members in two payments based on the weight of the NIS supplied and the number of supply shares held. It was noted that the directors had the powers to fix grades to the NIS and to assign levels of payment to the various grades (Macadamia Growers November 1983b).

During 1984 membership of the co-operative rose steadily and by August there were 114 members. Trees were maturing and the 1985 crop available was 2.9 tonnes. It was hoped that the Co-operative would be able to market the dried NIS in containers bearing its own label. Unfortunately, drying schedules being calculated by Massey University had not been completed and the marketing was delayed until the following year.

The terms offered to growers for the 1986 crop were:

Basic Price

All grafted varieties	=	\$3.50 pk NIS @ 10% of moisture
Other, including seedlings	=	\$2.50 pk NIS @ 10% of moisture
Payment would be made as follows	=	50% after evaluation
		50% on completion of sale.

A Special General Meeting was called for 3 May 1986 to launch the co-operative as a commercial venture. The company was incorporated under the Co-operative Companies Act 1956 with a nominal capital of \$160,000. Under the proposed structure new shareholders could, for a modest fee, receive regular newsletters and attend meetings and field days for one year. At that stage the new members would be offered four classes of membership.

Option 1 *Pay now*

Founders' Share	=	\$20	
Commercial Share	=	\$1000	<u>Total = \$1020</u>

Option 2 *Payable 1/4/87 Payable 1/4/88*

Founders' Share	=	\$20		
Commercial Share	=	\$600	\$650	<u>Total = \$1270</u>

Option 3 *Payable 1/4/87 Payable 1/4/88 Payable 1/4/89*

Founders' Share	=	\$20			
Commercial Share	=	\$400	\$550	\$550	<u>Total = \$1520</u>

Option 4

Hobby membership – those who had less than 100 trees would pay an annual subscription of \$50 + G.S.T.

The passing of the resolution, at the Special General Meeting to create a new class of commercial share was a major change of direction in the philosophy of the co-operative. From its inception members of the organisation had set marketing of crops as the limit of the co-operative's trading activity. It was believed that processing, adding value and marketing were beyond the original aims set by the founding members. Membership numbers dropped from 114 in August 1984 to 73 in May 1986 and by that date only 59 had paid for the commercial share. The decision to change the co-operative to a

commercial venture may be seen as the first reason for organisation's eventual failure to trade 16 years later in 1999.

At the end of April 1986, five directors of the co-operative met representatives from MAF at the Kerikeri Horticultural Research Station. Leading the discussion Dr Everett explained the Government's new policy in which funds for research had been heavily reduced. This meant that Grower Groups would be required to pay for MAF research and in the case of the Macadamia Co-operative this would cost \$20,000 for the project involving the two blocks of trial trees at the Research Station.

This was a heavy blow for the struggling co-operative which would need to re-evaluate its research methods and priorities (News Bulletin May 1986).

In May 1987 sale of the 1986 crop was reported with a total weight of 671 kg NIS graded for quality. Over 82% of the nuts purchased on behalf of the growers were the popular varieties of Beaumont and Own Choice. Prices paid out to members were at the following rates:

\$4.90 for 100% No 1 grade kernel

\$4.50 for 92% No 1 grade kernel

\$3.50 for 88% No 1 grade kernel

No reason has been found in available literature for the low weight (671 kg) of nuts provided to the Co-operative by members in 1986. As mentioned above, the 1985 crop was estimated at 2.9 tonnes and no news bulletin or circular advised that very unfavourable growing conditions existed during this period. It would seem that many members sold their crop elsewhere or disposed of it to family and friends.

The 1987 crop of 1.5 tonne NIS was put out to tender and sold to a nut processor for drying, cracking, packaging and distribution. Growers were paid \$3 per kg at 10% M C and at least 90% of No 1 kernel. Testing was carried out at the MAF Research Station, Kerikeri. Although this crop was more than double the weight sold in the previous year it

was a disappointing result when compared with the forecasted yield of 20 tonnes. Methods for estimating nut supply were not accurate enough to provide a sound commercial calculation upon which a viable processing schedule could operate. An Australian model for estimating crop was published in the February 1987 News Bulletin (News Bulletin February 1987).

The Australian method suggested by Ian McConachie:

- Step 1 Count crop on every tree in a diagonal line through each orchard block. Each variety is counted separately.
- Step 2 Each tree is quartered by drawing lines on soil below and the nuts counted in each quarter.
- Step 3 The average number of nuts per tree of each variety is calculated.
Note – On average 120 nuts = 1 kilo NIS @ 10% moisture.
- Step 4 Multiply average crops per tree, of each variety, by the number of trees of each variety.

The method was assumed to give results within $\pm 10\%$ of final harvest.

A New Zealand method (“A Stab in the Dark”):

- (a) Beaumont, Own Choice and Renown = 120 nuts equals 1 kilo NIS @ 10% moisture
- (b) *Integrifolias* = 150 nuts equal 1 kilo NIS @ 10% moisture.

Or, *another method* –

Estimates of Beaumont yields at different ages of the tree - high and low estimates given:

4 years = 0 – 1 kilos	8 years = 5 – 15 kilos
5 years = 1 – 3 kilos	9 years = 6 – 20 kilos
6 years = 2 – 5 kilos	10 years = 6 – 25 kilos
7 years = 3 – 10 kilos	

In 1988 some significant changes were made to the operation of the company. Membership options were streamlined to offer only two classes, a commercial membership costing \$1020 and a hobby membership, for those who had less than 100 macadamia trees planted, and an annual subscription of \$150.

More importantly, the executive decided in April to purchase plant and to commence processing the 1988 crop in leased premises in Glenbervie, Whangarei. The marketing name "Aotea" was accepted by members for the new product brand and this was duly registered. The cost of the processing plant was \$35,000 and it was accepted that, in the initial stages, costs of production would be disproportionate to the small quantity available from members. Total crop processed was 2350 kg NIS with a recovery of 665 kg of kernel. Crop figures processed for 1989 and 1990 were 4.9 tonnes and 6.5 tonnes respectively.

By August 1989 the number of shareholders stood at 140 holding founders' shares and 87 shareholders with commercial shares. These numbers became significant when the AGM asked members to pay an annual research levy of \$100 p.a. for the following five years. A postal vote by members brought an 88% majority for the levy and this was confirmed at the 1990 AGM by a 70% majority vote. Although some growers, especially those with smaller orchards, did not contribute to the research fund, most did for the first two years.

During 1989-90 the Board of Directors proposed that the company should change its name to omit the word "co-operative". The Board believed that, with the increase in trading and marketing, the current name was clumsy and the use of "co-operative" carried connotations of collectives and work schemes. As an alternative the Board proposed a new name of Aotea Macadamias Limited. A legal opinion was sought from the solicitor who drew up the original articles of association for the company and his advice was that there was an advantage in using the word "co-operative" in its name under the Co-operative Companies Act. The AGM in August 1990 rejected the Board's proposed change of name.

There were at least three reasons why the meeting rejected the change of name for the company. The legal opinion expressed was taken up by some members as a valid reason for retaining the status quo. Others believed that the change would not be in the spirit which was expressed by the founding members who believed that co-operation among growers was main reason for joining the company. Another reason expressed against the change was that the name "Aotea" had little meaning as a brand name to American, Japanese or other foreign buyers in the future if the stage was reached that exports became a reality. The motion was lost with only four affirmative votes cast.

Results of a tree survey at 31 March 1990 showed that the 79 commercial members of the company had almost 63,000 trees planted. Over 25,000 trees were planted in the Bay of Islands area with Auckland and Whangarei the next most planted areas. The Beaumont variety made up nearly 70% of all trees planted with Own Choice the only other variety named in the survey.

Late in 1990 the Maori tribes in the Far North, the Muriwhenua Incorporation, were quoted in the New Zealand Herald (Fea 1990) as being interested in growing macadamia on a large scale. The plan was to plant 20000 macadamia trees on 60 ha in tribal land. The Incorporation had recently lost a catfish venture and hoped to receive a large compensation from the Government. The article was published in the Bulletin but there were doubts expressed that yield figures were accurate. In the event the venture did not proceed beyond the planning stage.

The crop payout to growers in 1991 was heavily reduced compared to the initial years when the company commenced processing. In 1988 growers were paid \$3.60 per kg and the following year the payment was \$3.70 per kg. These figures were too high as the company was making a small loss on the processing due, in part, to the low volume of nuts received from growers. In addition the Australian and Hawaiian industries were hit by reduced export demand as a result of a worldwide recession and the loss of major market contracts. This resulted in the major producers selling their crops at reduced prices. The local industry was forced to lower prices to meet imported kernel and in 1991

growers were paid \$1.00 per kg within 30 days of supply of produce to the company, a second payment of \$1.00 per kg by 20 January 1992 and a final payment reflecting the trading results at a later date.

A reflection of the concern, held by some of the members of the co-operative, surfaced at the 1991 AGM. A discussion about the future direction of the macadamia industry showed a split between two opposing views. Most of the directors and many members hoped that the company would continue to grow as a commercial venture and that it would lead the industry in quality standards and marketing for superior products. Other members, and the management leaders of the largest grower groups at Helensville and Okaihau, argued for a non-commercial umbrella society, which would include members and those who chose to work in the industry outside the co-operative, and this group would work on quality standards, promote research and present a united front to government.

Following the AGM a questionnaire was sent out to all members asking if the co-operative should continue as a commercial grower group processing crop and developing markets. The company should encourage the setting up of a steering committee to form a Macadamia Society to represent all growers in New Zealand. 87% of those who responded were in support of the proposal. It was suggested that a steering committee, including members and non-members, would be formed and a public meeting held.

Whilst the directors recognised the results of the questionnaire as the wishes of many members the executive would not undertake to be prime movers in calling public meetings or forming a steering committee. However, a sub-committee of the company set up a database of 85 non-members and they were invited to fill in a questionnaire and to attend the AGM in July 1992. No positive move was made to continue efforts to form a national non-commercial society following the 1992 AGM.

Late in January 1993 an extraordinary meeting was called to ask members to pay an administration levy as the crop supply was below expectation. There was extensive

debate and the levy was passed in a modified form so that it applied for the current season only. The levy was \$200 + GST. It was noted that South Head Macadamias had written to members offering to buy their crop and this would be one reason for the low expectation that year. South Head Macadamias was a member of the co-operative and had its own processing facility and marketing organisation.

A very disappointing 1993 crop from growers, 8 tonnes, meant the processing plant again did not work at capacity. This low volume prevented the company from filling all its marketing orders and it was necessary to import Australian kernel to meet obligations to clients. The situation in 1994 was expected to be repeated and the administration levy would be necessary again. However, as nearly half of the members had not paid the 1993 administration levy, or the 1993 research levy, they would automatically forfeit their shares.

The AGM for 1995 resulted in a mixture of tidings for members. There was a small trading profit of \$4,800 from the throughput of 19 tonnes and this allowed a total of \$3.30 per kg for members. Expectations were held for a crop of 25 tonnes for 1995.

As the processing plant was over five years old and was proving inefficient it was felt that it was necessary to upgrade some items before the new season started. The cost of replacements, a new cracker, a new dryer and a new bag packer and scales was expected to be \$13,400.

In addition, the company was operating on an overdraft facility of up to \$30,000 using guarantees provided by three directors. This was felt to be an unsatisfactory situation and it was suggested that members could take up debentures for a term of three years and a minimum investment of \$1,000. The amount to be raised by this method was \$80,000 to upgrade plant and to provide working capital without using a Bank overdraft. In addition the company sought to impose an administration levy of \$100 per member. At this stage the co-operative had 61 members and 29 suppliers.

A year later the AGM reported that the crop for 1995 was 16.8 tonnes (expected 25 tonnes) with a loss of nearly \$9,000. The debenture issue raised \$22,000 which was

much less than the \$80,000 hoped for. Some members had not paid annual levies of the previous 3 years and forfeited their shares reducing membership numbers to 47. The meeting approved the figure of \$150 as an administration levy for the year.

On 12 March 1996 the directors met to consider the general direction of the co-operative. It was felt that as there were only 20 suppliers, the board should have 3-5 directors and the processing manager, secretary and treasurer should not be a director. The new board should focus on processing and marketing. These changes, in organisation, did not receive a majority vote and it was decided that the company should stay as structured with the requirement that members should supply their crop if they wished to retain membership. The board would aim to obtain the best price for growers focussing on processing and marketing.

The Chairman's Review at the 1997 AGM noted that 40 tonnes were processed in 1996 and that members supplied 26 tonnes.

1997 saw a major change in the aims of the company. The New Zealand Macadamia Society was formed on a non-commercial basis. The organisation of field days, industry promotion and research became the main function of the new society and the co-operative concentrated on business activities. Trading and processing functions changed as the company decided not to import kernel from Australia and to restrict the purchase of NIS from non-members. A total of 28 tonnes were processed but the loss of one of the markets (Quality Inns), and a general market down turn, meant most of the production was still in stock. The company could not make any pay out to growers until cash was received.

The AGM held in May 1999 proved to be pivotal to the future of the co-operative. In the previous year only 12 tonnes of NIS were processed leading to an overall trading loss of \$37,170. Low selling prices for kernel, \$18 per kg average compared to previous sales at \$20-\$22, contributed to the extent of the loss. The chairman of directors suggested that

the company should stop trading. He and the factory manager resigned from their positions.

During general discussion about the future of the co-operative it was revealed there had been offers to purchase the processing plant. The offer of \$20,000 was well over the book value for the machinery and members voted to accept the conditions of sale and to liquidate the company and to distribute the capital back to the shareholders.

What then were the main reasons for the failure of the co-operative to grow and succeed as a commercial enterprise?

- (i) The company changed from the original aims as set down in 1982 to a commercial organisation processing macadamia nuts and marketing the products. This change in direction brought about a clear division in members' hopes and ideals and a lack of loyalty especially in the provision of crop to the processing arm of the company.

The original commercial limit to the co-operative's functions was the selling of members' NIS, at the best price, to outside processors or marketing agencies. By extending the range of commercial activities to processing and marketing added-value products some members became disenchanted and left the organisation.

- (ii) The co-operative was under capitalised from the beginning. This lack in funding resulted in purchase of inferior second-hand processing equipment which had to be replaced too soon. This meant that there were insufficient reserves and not enough residual income in any year to build capital.
- (iii) The policies of requiring a commercial share holding and administrative levies brought costs which many members could not afford and membership steadily decreased.

- (iv) The Board using faulty methods in estimating the crop for processing. Each year the evaluation was too high, which did not show a true picture of crop totals and caused inefficient processing operation. This in turn affected marketing strategies.
- (v) When the company sold NIS, belonging to members, a fair market price was received and members were paid promptly. In later years, when the co-operative was processing and marketing products, market prices were lower and trading conditions were difficult. This led to lower prices to members and long delays in receiving the final payments. Some years members had to wait 12 months and the attraction of selling to outside processors for a better price and early payment caused members to discontinue membership.

It was inevitable that the co-operative would cease to function when a number of members failed to send crops to the processing plant and others resigned their membership. The processing plant at South Head was easily able to accept crops from disaffected members and other smaller plants in local areas were happy to expand their production.

3.09 South Head Macadamias

Early in the 1980's a major commercial macadamia venture commenced at South Head, close to the Kaipara Harbour. Mr Lewis Shotter, who was Managing Director of Macadamia Enterprises Limited, had an experimental nursery at Paremoremo near Albany. In addition, he and a syndicate of investors, taking advantage of the current tax incentives legislation, bought a 112-acre holding to plant a macadamia orchard. The main aim was to target the export of a large volume of macadamia products to Japan.

Ian Gordon was appointed General Manager and Neil Whitehead orchard manager. The site had been a sheep farm and was quite close to the exposed coast just south of the mouth of the Kaipara Harbour. The terrain was difficult to develop but the steep slopes were terraced or benched and the slopes were used for planting. There was not adequate

protection from the prevailing westerly winds and artificial shelter was required to supplement the natural plantings of pine and gum. In the process of developing the site much of the best soil was removed.

The plantation was planted in approximately ten thousand trees with Beaumont as the main variety and GT1 or Piper selections as pollinators. These original plantings had only one pollinating row in each block but this ratio proved to be lacking in pollinators. As more knowledge became available regarding the best selection to plant, more pollinators per block were grafted to give ratios of 4:1 or 3:1. A trial block was planted in varieties provided by DSIR or from the home nursery of Mr Shotter in Albany. Included in this trial block were 777, 800 and 741 (these were Hawaiian HAES *integrifolias*) which dropped nuts quite early in the season, five Piper selections and Renown (hybrid) and Hinde (H2) as possible pollinators. Renown became a successful pollinator for Beaumont in New Zealand but it was unpopular with some processors because the spindle shape of the nut made it harder to crack. The HAES selections in New Zealand conditions did not produce high quality kernels, and Hinde produced low yields (Dawson 1991).

All blocks were irrigated by drippers with the lines lying on the ground. When the trees were tall enough the irrigation lines were attached to wires off the ground to keep the drippers clear from weeds or soil blockages which would reduce the effectiveness of the irrigation process.

Spacing of trees was 2.7m between trees and 5.3m between rows with the result that Beaumont, in particular, often grew tall. This produced crowded rows as Beaumonts were unable to retain their normal spreading habit. Some had to be removed and pruning became an annual burden and expense.

The property, sometimes called South Head Macadamias or Mac Farms, developed all stages of processing macadamias. Some of the machinery used was designed and built locally but the more advanced and expensive plant was imported from Australia. Nuts were bought from other growers and South Head became a serious rival for the New

Zealand Co-operative. A wide range of macadamia products was produced from foil bags of natural and roasted kernel to attractive boxes of chocolate-coated nuts. Most products were sold from the orchard shop or marketed throughout New Zealand but a small quantity was exported.

In the 1997 the complete business, including plant nursery, mature trees, processing plant and marketing services, was sold to Mr Robert Garden (Gordon 2002).

In retrospect the three ventures contained elements in their planning which mitigated against speedy commercial success. Macadamia Plantations in Okaihau chose a cool elevated site requiring immediate shelterbelts. This shelter could have been temporary but efficient, to give the new trees a good start. The choice of Hawaiian varieties made retaining warmth a first priority in growing a successful plantation. Another consequence of choosing Hawaiian varieties was that they required more years to produce commercial crops than the more precocious Australian selections. It is not known why the partnership was dissolved but it is likely that a lack of income from the nut trees for a number of years, played a part in the decision to sell the property.

The Nut Growers Co-operative began with two potential handicaps in its philosophy and planning. A co-operative, by definition, required loyalty and unity to be successful. But there were two distinctly different ideologies among the members. One founding group wanted a non-commercial association which would hold field days, disseminate news and research information to members and collect members' NIS to sell to processors. Others believed that the main role of the co-operative was a commercial one. NIS from members should be processed by the co-operative, added-value products would be packaged under the company logo and marketed in New Zealand and for export, if possible. The commercially orientated group gained control of the organisation and commenced processing with inferior equipment. There were not enough reserve funds to sustain a growth and development plan and, as membership declined, it was decided to cease trading.

South Head Macadamias was established to grow macadamias and to process the nuts for sale to the lucrative Japanese market. Despite employing an experienced New Zealand macadamia consultant and nurseryman to manage the project the syndicate owners made a curious choice of site. The development was adjacent to an exposed beach which required tall and dense shelterbelts on the western boundary. The site required extensive earth works, irrigation ponds and internal shelter. A processing plant, machinery and the purchase of more than 10000 trees added to establishment costs.

When trees began to produce nuts the yields were disappointing and more finance was required for grafting more pollinators and for pruning and general orchard maintenance. More staff was employed. Eventually syndicate members decided to cut their losses and the business was sold. New ideas helped to save the enterprise and all present products find ready market in New Zealand.

The lack of commercial success of the three enterprises was an important reason for the New Zealand macadamia industry failing to make steady development in the twenty years from 1980 – 2000. The host of small lifestyle growers produced very disappointing small yields and were unable to afford research for remedial measures. Too many opened processing plants as a means of making greater profits but too often the goods were of poor quality.

3.10 Australian Report on the New Zealand Industry

At the same time as the three major commercial enterprises were being established in New Zealand an Australian visitor arrived to assess local initiatives and to write a report. The report entitled “The New Zealand Macadamia Industry and its Potential” was written by Mr Hillary Brown an Australian Horticulturist who worked for the Colonial Sugar Refinery Company. The paper was prepared for David Reitow, an Agricultural Consultant who had been the President of the Hawaiian Macadamian Nut Association, and was dated 25 April 1983.

Mr Brown spent two days in New Zealand on the 13 and 14 April 1983. The first morning was spent at the Mt Albert Research Station talking with DSIR officials and in the afternoon visits were made to nurseries and orchards belonging to Mr Dick Endt and Mr Ian Gordon. On the second day he flew to Kerikeri to look at the Don Boyes-Barnes Macadamia Centre, to talk to 25 macadamia enthusiasts and to visit two local orchards and the development of the complex at the Macadamia Plantations at Okaihau.

Mr Brown noted that there were significant small plantings in the Kerikeri area, that 140 acres were ready in Okaihau and 180 acres at South Head, and that Beaumont was the favoured selection in most areas except at Okaihau where Hawaiian varieties were preferred.

The area around Kerikeri appeared to have potential as the climate was favourable, soils in some areas were well drained, rainfall was reliable and irrigation was available and pests did not appear a major problem.

Factors against the establishment of a New Zealand macadamia industry included:

- 1 The poor performance of *M.integrifolia* varieties.
- 2 The high cost of land, equipment, fuel and labour.
- 3 Incessant wind requiring extensive windbreaks.
- 4 The excessive rainfall during harvest and flowering periods.
- 5 Occasional frosts in winter.

Summing up Mr Brown said, "Quite obviously, macadamia will grow in certain areas of the Bay of Islands. Unfortunately, it would appear that the persons pushing for the establishment of a macadamia industry are profiteers, e.g. nurserymen and consultants." (Brown 1983). He believed that Beaumont was difficult to market as hybrids were not popular on the world scene with the *M. integrifolias* the market leaders in Hawaii and Australia. He concluded his report indicating that, with the low price being paid on the

world market for high quality kernel, it was unlikely that New Zealand grown and processed kernel would be viable.

Mr Brown spent only two days in New Zealand. This was a short time and his report was not comprehensive as he did not visit many orchards on the trip and he did not travel south of Auckland. However it must be remembered that the macadamia industry in New Zealand, in 1983, included the Co-operative which was only one year old, Okaihau's trees were five years old, and not producing any crop, and South Head was in the very early stages. Brown visited the Mt Albert Research Centre and included in his report a copy of the MAF paper "Macadamias Varieties and Culture for Commercial Production.", by Stuart Dawes. He travelled throughout the visit with Mr Alan Clark, Chief Extension Officer, Ministry of Agriculture, Auckland and Mr Roger Barber, Officer in Charge, Ministry of Agriculture, Whangarei. In addition he met Dr Ross McKenzie, Scientist, Division of Horticulture and Processing, DSIR, Auckland, Mr Ian Gordon Manager of Agricultural Operations, Macadamia Enterprises, Ltd, Auckland, Mr Dick Endt, Nurseryman, Auckland and Donald Boyes-Barnes, Macadamia Centre, Kerikeri, Bay of Islands (Brown 1983).

3.11 Research Stations

Unfortunately there was little money to undertake and/or complete long-term research. Government funding was never generous and macadamias did not have a high profile compared to crops such as kiwifruit and citrus. When the New Zealand economy was in retrenchment, or political plans changed, funds for research were pruned or cut off altogether and projects shelved (News Bulletin, May 1986). At Te Puke, for example, none of the macadamia research projects appeared to have been completed. The trial block of trees was removed in the 1990's and the land used for other purposes mainly for more kiwifruit research.

By September 1990 one orchard block at Te Puke had 78 macadamia trees containing 38 different cultivars and hybrids. In addition macadamia seedlings were planted as

shelterbelts between the various crops at the research Station and an assortment of Piper selections made up the bulk of the shelter trees. There are no written reports or assessments on these plantings. (See Te Puke Orchard Map 1990) Stuart Dawes, and his assistant Mr Ian Gordon, worked throughout the 1970's and 1980's to determine the best varieties to suit the New Zealand conditions. Named varieties from Hawaii, Australia and South Africa were imported and tested and it appeared that the hybrid Beaumont was acceptable here as the best variety for future plantings. Mr Dawes wrote papers intended for public release on macadamia culture in New Zealand (Dawes, 1972, 1985).

Mr Ian Gordon left government employment in 1982 and became a full-time macadamia consultant and nurseryman. He ran a nursery at Titirangi, Auckland and started another one at Woodhill Forest near Helensville. One of the seedlings from Mt Albert was promising and Ian Gordon developed it into a variety named GT1 which has become a valuable pollinator and main crop tree in its own right. He has developed more varieties, bearing the initials GT showing potential. In addition to his own nursery work Mr Gordon has become a valuable consultant to large commercial enterprises such as Mac Nuts, South Head, Macadamia Plantations, Okaihau and Torere Macadamias Limited, Opotiki.

Funding of macadamia research was vital for the future of the industry. The research stations at Te Puke and Mount Albert failed to produce many reports on macadamia projects mainly because projects that did start were never completed because of lack of finance for long-term trials. In addition pressure from other horticultural crops such as kiwifruit, competed successfully for the available government funds. The local industry was too small to fund major, long term research projects on its own although Don Boyes-Barnes carried out private research with the Food Technology Research Centre, Massey University in 1980 (Visser and Boyes-Barnes 1982).

Figure 2: Macadamia : Block 9 : Te Puke Research Orchard
Orchard Plan : Sept 1990

	R O W					
	1	2	3	4	5	6
1		Renown	Nelmac 1	Nelmac 2	Mauka (HAES741)	PB12
1a		Greber	Nutty Glen			PB12
2		Renown	Nelmac 1	Nelmac 2	Mauka (HAES741)	PA30
2a		Nutty Glen	Greber			PA30
3	Rosenut	Maroochy(N7)	G5	Kerim(M9)	Kerim (M9)	PB33
3a	Rosenut	Collins	Collins	Maroochy		PB3
4		Sewell(N3)	Ellimbah	Maroochy	HAES777	PB33
4a				Maroochy		PB42
5		G5	Ellimbah	GT1	HAES777	PB42
5a					PB3	PB11
6		FP4	Jordan (HAES462)	GT1	HAES777	PB11
6a					HAES674	PA39
7		FP4	Jordan (HAES462)	Colliston	HAES689	PB45
7a						PB45
8		Sewell(N3)	Probert2	Colliston	PB3	PB38
8a					HAES800	PB38
9	G		Probert2	Sewell(N3)	HAES800	PA39
9a	U		Stevenson	Teddington	Pendray	Hinde(H2)
10	L			Teddington	Pendray	Hinde(H2)
10a	L	Y		HAES747	Honomalino Hybrid	Taylors Triumph
11	N			HAES747	Honomalino Hybrid	Taylors Triumph

However the Kerikeri station had an additional financial source, the New Zealand Macadamia Nut Growers Co-operative. Mrs Annette Richardson and Mr Ted Dawson, employees of the Horticultural and Food Research Institute (the successor to the DSIR Division of fruit and trees) were able to carry out research for the Co-operative and provide useful reports on such pertinent matters as:

- ❖ Effects of storage on nut quality.
- ❖ Macadamia nutrition trial.
- ❖ The nutrition of macadamia trees in New Zealand (Richardson and Dawson 1988, 1993(a), 1993(b)).

In addition, Mr Dawes set up a trial planting of twenty varieties on Kerikeri Research Station land. (Dawes, 1985). Two trees of each variety were planted including both *M.integrifolia* and *M.tetraphylla* types from Hawaii and Australia. The trees planted in 1984 included seven Piper selections, three hybrids HAES777, Beaumont and Nutty Glen. Six more varieties were planted in 1985 and another twenty cultivars were added in 1986. Eventually the total reached fifty-five but not all trees had enough nuts to evaluate before the trial ceased.

Ted Dawson wrote an evaluation of the trees, over a four-year period, using the yield and marketable kernel as the most important criteria. Yield data was generally low and variable probably because the trees were young and there were only two trees from each cultivar. Unfortunately the recording of data stopped in 1992, and shortly after the trees were cut down. (Tables 10 - 13)

Table 10: Summary of yields, total weight NIS (grammes per tree) Kerikeri Research Orchard 1988 - 1992

Cultivar	1988	1989	1990	1991	1992
PA30			498	638	2485
PA39		282	2522	1216	2970
PB11		180	2427	1043	3141
PB12		147	427	427	676
PB33	56	37	718	1725	948
PB38		33	668	1470	2993
PB45	154	371	1926	1740	3175
HAES344					162
HAES462			644	2201	1120
HAES674		304	780	469	929
HAES747		62			
HAES777		10	16	1487	4720
HAES800			20	335	367
508					64
N7			15	422	3437
Renown	806	385	2397	1770	3484
Greber	6	172	853	220	520
Taylors Triumph	203	820	1387	2446	3134
Beaumont		294	3427	1706	4346
Hinde		125	496	606	2008
Collins			385	1844	1132
Own Choice			802	2223	2391
Probert1					71
Probert2					66
Stephenson					324

(Dawson 1992)

In general, yields increased with the age of the tree. However, there were some variations, with 1991 being an “off” year for some varieties e.g. Beaumont, PA39, Renown.

In the Piper selections only PB 12 and PB 33 were inconsistent. The others had improved yields each year and reached totals of 2.5kg or more. HAES777, a Hawaiian hybrid, was the only one in the group, to produce an acceptable yield. The total of 4.72kg was the highest of all varieties tested.

The other selections all had reasonable yields except Greber and Collins. Three others produced their first crop in 1992. Beaumont, Renown and Own Choice were popular choices for many New Zealand growers but Taylors Triumph was rarely seen in local orchards as the very low percentage of No 1 kernel made this variety uneconomic to grow.

Table 11: Summary of crackout percentages of nuts from different varieties of macadamia grown at the Kerikeri Research Orchard 1988 - 1992

Cultivar	1988	1989	1990	1991	1992
PA30			29.6	34.2	29.3
PA39		40.0	39.4	34.0	36.8
PB11		34.1	42.2	40.2	41.4
PB12		34.9	35.3	37.8	39.4
PB33		40.4	36.8	45.6	42.1
PB38		36.0	34.0	32.0	34.9
PB45		37.0	37.6	39.0	42.5
HAES 344					31.4
HAES 462			33.1	31.1	35.4
HAES 674		38.2	34.0	37.8	39.8
HAES 747			38.0		
HAES 777		50.5	32.0	25.6	28.3
HAES 800			26.8	24.1	29.0
508					23.2
N7			44.8	45.8	47.2
Renown		33.0	35.8	35.5	32.4
Greber		48.5	44.0	44.2	45.2
Taylors Triumph		26.2	30.6	28.8	22.8
Beaumont		39.6	39.1	33.0	35.6
Hinde		21.7	28.1	33.8	28.5
Collins			43.8	44.5	41.2
Own Choice			32.2	31.6	32.2
Probert 1					48.0
Probert 2					52.6
Stephenson					45.4

(Dawson 1992)

Any crackout percentage less than 30% is not acceptable for commercial production.

All the Piper selections had fair to excellent crackout figures with three reaching over 40%.

HAES777 produced variable results ranging between 25.6% to 50.5%. Three of this group securing percentages over 30%.

From the third group only Taylors Triumph and Hinde consistently produced results less than 30% with N7, Greber and Collins achieving over 40%.

Table 12: Summary of percentage of No 1 Kernels obtained from a variety collection of macadamia trees at the Kerikeri Research Orchard 1988 – 1992

N° 1 Kernels obtained (%)					
Cultivar	1988	1989	1990	1991	1992
PA30			96.2	80.0	91.6
PA39		66.2	71.1	73.8	73.1
PB11		60.2	44.2	71.8	79.5
PB12		58.0	38.1	61.6	75.7
PB33		59.6	39.9	89.7	77.2
PB38		0	64.4	61.2	67.7
PB45		29.4	22.4	22.8	26.9
HAES344					95.7
HAES462			78.2	83.8	92.1
HAES674		80.2	23.9	60.3	50.6
HAES747			63.3		
HAES777		0	0	23.6	32.2
HAES800			96.9	86.2	94.4
508					24.2
N7			0	27.4	85.8
Renown		86.8	80.7	89.9	84.6
Greber		90.5	92.4	93.5	94.7
Taylors Triumph		8.7	46.9	37.4	1.4
Beaumont		85.6	90.4	93.9	95.5
Hinde		88.4	63.0	87.5	82.8
Collins			47.8	37.9	86.3
Own Choice			100.0	97.4	97.8
Probert1					90.3
Probert2					97.4
Stephenson					83.8

(Dawson 1992)

In general, any percentage below 80% would be unacceptable for commercial production. The extremely low percentage for Taylors Triumph would appear to show that the kernel was damaged by unusual factors.

PA30 was the only Piper selection with an acceptable No 1 kernel percentage – 91.6%. However the previous year the result was only 80% and more consistency would be required before this selection could be considered for commercial planting.

In the HAES group only HAES800 was consistent and acceptable. HAES344 had only one test result which was a high 95.7%.

In the third group Own Choice, Beaumont and Greber performed best with Renown joining the other three with acceptable test results.

Table 13: Mean cultivar quality figures for 1992, Kerikeri Research Orchard

Cultivar	Yield	Quality attributes	
	Total Wt (G)	Mean Crackout	Mean % No. 1
PB33	948	42.13	77.25
PB12	676	39.41	75.67
PB11	3141	41.39	79.49
PA39	2970	36.79	73.12
PA30	2485	29.28	91.63
HAES800	367	28.97	94.45
HAES777	4720	28.26	32.23
HAES674	927	39.78	50.6
N7	3437	47.2	85.75
Collins	1132	41.15	86.33
PB45	3175	42.5	26.88
PB38	2993	34.86	67.67
HAES344	162	31.44	95.69
Renown	3484	32.35	84.58
HAES462	1120	35.37	92.13
Hinde	2008	28.48	82.84
Greber	520	45.25	94.66
Taylor's Triumph	3134	22.75	1.44
Probert 2	66	52.58	97.41
Stephenson	324	45.44	83.84
508	64	23.21	24.16
Beaumont	4346	35.58	95.52
Own Choice	2391	32.22	97.84
Probert1	71	47.95	90.29

(Dawson 1992)

1. HAES747 was not assessed after 1990.
2. The best performed cultivars for quality and quantity were:
PA30, N7, Beaumont, Own Choice and Renown. These five varieties had acceptable yield figures and results for quality performance.

Another trial then commenced with the Co-operative and the breeder of the 'A' series of trees, Mr Henry Bell, in Australia joining in with a joint research planting. The 'A' series had been developed by Mr Bell in Australia. The main features of these trees are that the nuts drop when mature, and they have a higher crackout and No 1 kernel than Beaumont and other popular varieties which have been grown in New Zealand. For the project at the Research Station in Kerikeri, five selections were planted in the expectation that one or more might be suitable for New Zealand conditions. Results were kept for two years

only. (Table 14). The Co-operative was losing members and could no longer afford the cost of continuing the project. Other sites, in different parts of the northern region, have had the same 'A' series trees for several years and it is hoped that the Macadamia Society will collate and publish the results.

Table 14: 'A' series macadamia nut evaluation at Kerikeri Research Orchard

		1995			1996		
		Yield Kg/tree	Crackout %	No.1 %	Yield Kg/tree	Crackout %	No.1 %
A4	Ground	2.46	44.6	100.0	2.8	40.4	98.1
	Pick	0.94	44.5	96.0	1.0	45.6	99.2
	TOTAL	3.40			3.8		
A16	Ground						
	Pick	0.30	36.5	99.4		35.5	95.0
	TOTAL	0.30			0.2		
A104	Ground	0.68	41.8	82.7	1.4	37.6	75.0
	Pick	1.29	37.7	78.7	0.9	39.6	97.3
	TOTAL	1.97			2.3		
A217	Ground	0.17	29.2	95.6	1.5	33.7	97.7
	Pick	0.65	30.5	93.4	4.0	34.21	100.0
	TOTAL	0.84			5.5		
A268	Ground	2.69	31.1	70.8	3.2	34.6	89.7
	Pick	2.77	33.6	70.7	3.5	36.8	98.3
	TOTAL	5.46			6.7		

(Dawson 1996)

3.12 The New Zealand Macadamia Society Incorporated

The New Zealand Macadamia Society was formed in 1997 as a non-commercial organisation, modelled on the Australian Macadamia Society. Mr Ted Davenport, who was secretary of the Australian Society, was invited to attend the meetings to set up the new society. His experience and knowledge were important in writing a constitution and avoiding many early pitfalls in organisation. The aims and objectives, powers and classes of membership of the Society were set out in the constitution. (Appendix 3.)

The Society was a non-commercial organisation with no powers to buy or process nuts nor sell or market nut products. It aimed to promote the industry in New Zealand, to encourage the exchange of ideas and information among members, to encourage research and to develop a set of criteria and quality standards in all stages of the local industry.

Membership came from disaffected Co-op members and those with an interest in macadamias but had no other affiliations. From the beginning, under the strong leadership of Chairperson, Mrs Virginia Warren, the new society set out to represent all sectors of the industry, to become the mouth-piece to government on industry matters and concerns, to undertake research and to strive to attain the highest quality standards in orchard management practices, processing and marketing. The aim was to ensure that a Macadamia Society Quality Mark was attached to all New Zealand macadamia products that reached a pre-determined and accepted quality standard.

Generally the Society has catered for the needs of its members and has carried out several projects successfully. For example, research projects are being carried out on two pests, the Green Vegetable Bug and the guava moth. This work funded by the society, is being carried out at the HortResearch Stations in Mt Albert and Kerikeri.

However, the Society has not been able to attract all the major figures in the industry into membership. This weakens the stature of the Society, as it is unable to speak out with a

united voice. There are too many small independent growers and processors selling inferior products at roadside stalls and in small food outlets.

The quality of the macadamia products, sold on the wider market in New Zealand varies from top quality export standard to very poor condition which does nothing for the reputation of the Society. The Australian Society found the same wide variation in quality during its first years of existence but, as the membership increased and products grew in volume the Society was able to set and enforce, international quality standards and to gain government support.

3.13 Overseas Influences

Australia had the first and continued interest in the development of the New Zealand macadamia industry. The first known tree planted in Takapuna, Auckland in about 1875 was almost certainly from Australia. The first evidence of macadamia trees in New Zealand was in 1932 when Mr Jolly obtained seed from Australia and planted these in his own property in Kerikeri.

In 1948 the New Zealand Department of Agriculture introduced six strains of macadamias from the New South Wales and Queensland Department of Agriculture. This set up a growing interest in the species and its possibilities as a commercial crop. Most of the owners of plant nurseries, from the Bay of Plenty northwards, which specialised in semi-tropical plants, visited Queensland to gain knowledge on the best varieties to concentrate on the warmer areas of the North Island. Variety selection evaluations, carried out by MAF and the DSIR, listed Australian varieties as the best commercial options and Beaumont became the most favoured selection.

When local macadamia enthusiasts and lifestyle planters sought knowledge and expert contact with growers in Australia, a number of local growers joined the Australian Macadamia Society. Government horticultural workers joined too and there has been close co-operation with Australian research organisations. Visits became a two-way

feature and these continued to add knowledge to growers. The New Zealand Co-operative and South Head Macadamias had close ties with Australia and a number of advisers and specialists have visited New Zealand. The largest new macadamia initiative at Torere, in the eastern Bay of Plenty, has frequent mutual contact with the Australian Macadamia Society and Mr Ian McConachie and Mr Henry Bell are consultants.

Two other countries, Hawaii and South Africa have had an important influence on the development of the local macadamia industry.

Mr Dick Endt, nurseryman in Auckland who specialised in producing plants for exotic fruit, became interested in growing macadamias and visited Hawaii and California in 1974. Mr Endt became a member of the Californian Macadamia Society. Mr Don Boyes-Barnes and Mr Mike Collins visited Hawaii in 1979 on a fact-finding mission before setting up a nursery in Kerikeri. American industry specialists and academics from Hawaii and California have visited New Zealand irregularly and written articles for the California Macadamia Society Newsletter and New Zealand publications (Schroeder and Fletcher 1965, Hamilton and Ito, 1979).

The largest New Zealand macadamia planting, Macadamia Plantations of New Zealand in Okaihau, is the only commercial operation to plant Hawaiian varieties as the major crop. It is unclear why these choices were made as the site was cooler than most macadamia locations and the trees did not produce useful yields of quantity or quality nuts.

South Africa has become of interest in the world macadamia scene. The areas planted in macadamias in South Africa, and the increasing yields obtained indicate that this country will become the second largest producer in the next fifteen to twenty years. Hawaiian production appears to have levelled off and declined in the last few years.

Mr Jim Pringle visited the South African industry in the early 1970's and bought scion wood from the hybrid varieties Nelmac 1 and 2 which became an important pollinator for Beaumont in some orchards. More recently Mr and Mrs Charteris of New Plymouth

visited South Africa and purchased processing machinery for their modern plant which performs at the highest international standards.

3.14 Profiles of Pioneers

This chapter concludes with eleven profiles of New Zealand and Australian people who have been important in the growth of the New Zealand macadamia industry. Photographs have been included.

The list is presented in alphabetical order as the careers overlap; some have died and others have retired.

All, however, are worthy of special praise for their roles and efforts to make the local macadamia industry a commercial enterprise.

HENRY BELL

“On 22 March 2000 Henry Bell was awarded Life Membership of the Australian Macadamia Society for rendering distinguished, exceptional and valued services to the AMS and industry over 40 years. His election was unanimous” (AMS News Bulletin, May 2002).

Henry Bell arrived in Australia from a rural background in Otago, New Zealand, and planted his first macadamias in 1961 at the Hidden Valley Plantations, Beerwah, Queensland. Since that time he has established close contacts with the University of Hawaii, other bodies of learning and South African researchers.



From 1978 Bell commenced a plant breeding programme and the ‘A’ series varieties has been one part of his achievements. A4 and A16 were the first plants in Australia to be granted Plant Variety Right Protection. In addition to his plant breeding programmes Henry Bell has achieved wide-reaching research and development success including:

Plate 2: Henry Bell

- 1 Initiated an Insect Recognition Booklet for the macadamia industry.
- 2 Initiated the Macadamia Reference Library for the AMS.
- 3 Initiated herbicide trials in NSW.
- 4 Undertook the first Australian Ethrel trials. Ethrel is an argano phosphate used in the horticultural industry. It has been used in several countries to improve nut abscission from macadamia varieties, such as Beaumont, and to shorten the harvest period.
- 5 Developed machinery to aid under-tree sweeping, nut harvesting, processing (de-husking, drying, grading, cracking and separating and classification of kernel and general farm use.

(Photo H. Bell)

- 6 Developed propagating techniques for cuttings and this has enabled his business to propagate the Australian germplasm collection.
- 7 In 1997 he completed the Hidden Valley Plantation Research Laboratory.
- 8 In 1976 he produced the first chocolate-coated macadamias in Australia.
- 9 Assessed high-density planting and tree management including trellis training.
- 10 Developed potential dwarf varieties and rootstocks for future high density planting.

Henry became a Foundation Member of the AMS in 1974 and then served on its Executive for some years. He was the driving force in establishing the Research Committee in 1977, later named the Technical Advisory Committee and now the Research and Development Committee and he was the first Chairman.

Henry Bell makes regular visits to New Zealand and advises a number of local growers and industry groups. His friendly manner, wide background in all aspects of the macadamia industry in Australia and his readiness to share his knowledge and advice makes him a welcome visitor to New Zealand.

Current activities being carried out at Henry Bell's Hidden Valley Plantation include:

- ❖ Methodologies for measuring heat and cold resistance of the tree in order to expand planting limits are being developed.
- ❖ Roasting parameters for varieties are being developed.
- ❖ Pollen has been irradiated to induce mutations for dwarf varieties.
- ❖ Varieties suitable for home gardens are being selected.

DON BOYES-BARNES

The late Donald Boyes-Barnes was an architect in Wellington and, on a visit to Mr Gerry Clark in Kerikeri, saw two macadamia seedlings on the property. He liked the Kerikeri lifestyle and believed that there was a commercial future for macadamias in New Zealand. Boyes-Barnes joined in a joint venture with Marjorie Clark in 1975. He bought land in Kerikeri and established a nursery, The Macadamia Centre.

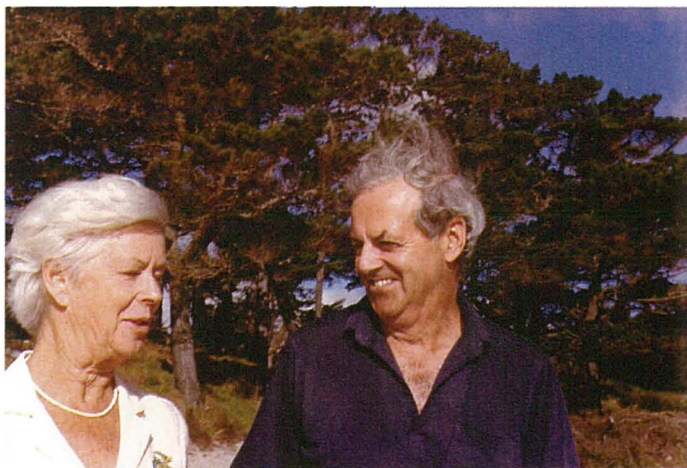


Plate 3: Fay and the late Don Boyes-Barnes

To start the nursery he purchased seedling nuts from local orchards but mainly from John Graham in Hall Road, Kerikeri. The seedling nuts were planted in polythene bags and placed in tunnel houses and, in search of better quality trees, Boyes-Barnes bought some of each variety grown by Dick Endt. About 60 trees were planted in the Clark orchard.

In 1978 he went to Australia to look at their industry and he arranged for a grower to visit Kerikeri and to bring some scion wood from various Australian varieties. The Australian grower showed Donald grafting methods and provided many tips about orchard management. Mrs Boyes-Barnes became the expert at grafting in the Macadamia Centre. An innovation used by Donald was the placing a baby's teat, filled with water, on the top of the scion wood when the trees were grafted.

(Photo: V. and D. Kerr)

The following year he and Mike Collins visited Hawaii. They made an extensive tour of all aspects of the industry and met many of the local experts. They arranged to import scion wood from some of the better Hawaiian varieties and these were grafted at the Macadamia Centre and planted in the Clark orchard. The lessons learned from the visits, from experience gained through growing the Endt varieties and from his own variety trials convinced Boyes-Barnes that Beaumont and Own Choice were the best varieties for New Zealand.

This choice of Beaumont as the recommended nut to be planted as the main crop for New Zealand conditions, was reinforced by research carried out by the Food Technology Research Centre, Massey University, Palmerston North, in 1980 (Visser and Boyes-Barnes 1982). When there was sufficient crop from each variety in the nursery, or in the Clark's orchard, samples were sent to Massey University, Palmerston North. These samples were tested to see which varieties processed well. The nuts were required to have a good appearance, good taste and to have a reasonable shelf life. Their report concluded..."The overall quality of these nuts seemed quite acceptable, and this variety of macadamia nuts may well develop into a viable horticultural product for New Zealand, especially Northland."

From 1980 sale of trees from the nursery started to increase. Early field days and Boyes-Barnes's reputation as chairman of the northern branch of the Tree Crops Association, made it natural for him to become a leading figure in the setting up of the Macadamia Co-operative. Boyes-Barnes, who was a founding director of the Co-operative, wanted to use some of the reserve funds to invest on the stock market. This happened just before the market crash in 1987 but the vote, held by the other directors, went against him after which he left the meeting and then withdrew as a director. From this time hence Boyes-Barnes took no major part in the Co-operative affairs. Boyes-Barnes had formed an informal partnership with Mr Vince Kerr who had a nursery in the Hokianga at Rawene and this was formalised in 1987.

From the outset Boyes-Barnes did not employ organic principles in his nursery or consulting business. It was necessary for him to build up a financially successful new career and his joint partnership with Mrs Clark had some sharp disagreements. Perhaps because he lacked any formal horticultural training or background, and perhaps because of the need to quickly make his nursery viable, Boyes-Barnes advocated several fundamental macadamia management propositions which are now seen as being faulty.

Many of the macadamia orchards in New Zealand planted in the 1980's had the trees, mainly Beaumont, planted too close in rows and between rows and Boyes-Barnes had dense planting as a first dictum. Two metres between trees and three or four metres between rows became common with the trees growing tall and the rows meeting. The lack of light caused by the complete canopy over the whole area often resulted in small yields, and difficult management and picking conditions. These conditions often were made worse as Boyes-Barnes advocated substantial shelterbelts which further limited sunshine and light levels in the orchard.

It was quite common in early orchards to have all trees planted being one variety – usually Beaumont. Boyes-Barnes seems to have had an incomplete knowledge of the need to have complimentary pollinators spread throughout the orchard. Some orchards had alternate rows of Beaumont and Own Choice with the latter variety being self-pollinating and Beaumont receiving little assistance from its neighbour. Fortunately top grafting of pollinators subsequently improved yields in many of those early orchards.

Don Boyes-Barnes will be remembered for leadership, vision and enthusiasm for the commercial success of the New Zealand macadamia industry. He was an important promoter of the Co-operative and founding member director of that body. He took an early lead in using research organizations in New Zealand, worked with Maori groups in the North and he grew and sold high quality macadamia trees.

MARJORIE CLARK

The late Mrs Marjorie Clark bought Homelands Orchard in 1958. Most of the land faced south overlooking the Kerikeri Stone Store Basin. The orchard was planted in citrus trees but there were other fruit trees including two macadamia seedlings. Mrs Clark believed that the seedlings came from Jock Graveson's nursery. In 1961 Mr and Mrs Clark decided to operate their orchard on organic principles.



Plate 4: The late Marjorie Clark

During a visit to England and Scotland in 1974 Mrs Clark stayed at a Religious Community for four months and on her return to New Zealand she received a spiritual message to refrain from eating the fallen nuts and to plant them. A local nurseryman, Robin Booth, offered to graft some trees but, as an alternative, fifty trees were bought from Dick Endt in 1975 and inter-planted with the existing citrus. By 1982 the number of macadamia trees increased to over 290, representing seventeen varieties.

Approximately half of the macadamia trees were Beaumont and the rest were selections from Hawaii, Australia and South Africa.

Don Boyes-Barnes visited the orchard in 1975 and was impressed by the number of fallen nuts from the two seedlings. He believed that there was commercial potential in growing macadamia trees in New Zealand and he formed a partnership with Mr and Mrs Clark. The Clarks would grow the trees in their orchard and Mr and Mrs Boyes-Barnes would start a macadamia nursery using bud-wood from the orchard.

(Photo: B. Coleman)

Marjorie Clark maintained her organic philosophy until she died in 2003. She used compost based on natural materials such as grass, sheep shed sweepings, fish waste, “paunch” from insides of cow’s stomachs, fowl manure and wood chips. She replaced chemical spraying by encouraging insect predators, such as the praying mantis, the German wasp and the Australian paper wasp, to visit the orchard and control the insect pests such as red mite, thrips and the Green Vegetable Bug.

During the 1990’s Mrs Clark decided to process her crop. She created a drying room under her house and her husband made a grader. A local inventor made a cracker and Mrs Clark purchased the first one to be manufactured. The scale of her operations was little more than a cottage industry but Mrs Clark filled a niche market for organic produce. She concentrated on raw kernel which she sold on local market days and to traders specialising in organic food stuffs.

TED DAVENPORT

When the New Zealand Macadamia Growers Co-operative was coming to the end of its operations and a new New Zealand Macadamia Society was being formed Ted Davenport was invited to visit New Zealand to advise on constitutional matters. Mr Davenport was eminently suited for the task as he had had a long involvement in the Australian macadamia industry.



*Plate 5: Ted Davenport –
always the snappy dresser!*

Ted was born in London and worked in Fleet Street in advertising. He came to Australia as a teenager in 1950 by himself seeking adventure and a new life. He found this new life in Queensland working on a banana plantation, dropped the first two bunches of bananas and headed south. He then worked as a builder's labourer and saved enough money to attend university.

Ted Davenport completed a Degree in Agricultural Science from Sydney University.

He was employed by the Colonial Sugar Refinery Ltd for 31 years as the Chief Sugar Agronomist and then as orchard manager, research and plant nursery and manager of the new macadamia processing plant. The CSR Ltd was the largest macadamia producer and the company changed its name to MacFarms of Australia.

In 1986 CSR sold their macadamia division and Mr Davenport resigned and became the Executive Officer of the Australian Macadamia Society. He was a member for 23 years and served in a variety of positions including Board member, marketing co-ordinator and led initiatives on exporting and marketing. In 1994 Ted was made a Life Member of the AMS. On his visit to New Zealand in 1996 Ted Davenport guided the writing of the Constitution for the Society and advised on many administrative and organisational matters.

(Photo: I. McConachie)

STUART DAWES



Plate 6: Stuart Dawes

Stuart Dawes, a DSIR scientist, first became involved with the macadamia industry in the early 1970's. Mr W Fletcher, a horticultural advisory officer for the MAF in Auckland, had, in the 1960's, co-written an article for the Californian Macadamia Society Yearbook about the potential of the species as a commercial crop. Mr Dawes became interested in the possibility of macadamias in New Zealand and, although there were no government funds available for research, there was some land at the Te Puke Research Station under-utilised. There were trees already planted at Mt Albert and these became the source of the first trees planted at Te Puke.

Working with Mr Ian Gordon as his assistant, Stuart Dawes planted the strains N3 and N7 from Mt Albert and used them with the Piper seedlings as shelterbelts and for trials. In addition he planted three *M.integrifolia* varieties, Nutty Glen and Hinde (Australian) and Keauhau (Hawaii) from cuttings grown by Mr Fletcher. Over the next few years more Hawaiian and Australian varieties were planted and evaluated.

As land was limited at Mt Albert work shifted to a government research orchard at Kumeu with more imported varieties and more trials and then more plantings at a site in the Woodhill Forest near Muriwai. From these trials the local selection GT1 emerged as a useful pollinator for Beaumont.

(Photo: S. Dawes)

Stuart Dawes organised a variety trial at the Kerikeri Research Station starting in 1985. Twenty macadamia cultivars were established there and once again a shortage of funding caused the trial to be abandoned before long-term assessments could be made. The trees were cut down and newer varieties planted but, after a few years, a lack of money brought a stop to the keeping of useful trial results. Mr Dawes lived in retirement in Takapuna, Auckland. He believed that to obtain better yields in New Zealand growers, should choose better sites, plant better selections and improve their tree management routines. There was a need for more informed long-term research to achieve the maximum advantage for a special species in a cooler environment.

Stuart Dawes died in July 2005.

DICK ENDT



Plate 7: Dick Endt

In the late 1960's, Mr Dick Endt, a nurseryman at Oratia, Auckland, became interested in macadamias when he visited Kerikeri and observed seedling trees growing in several orchards. At about the same time he received a copy of the Macadamia Society yearbook published in California, USA. In addition he met Dr Art Schroeder, professor of botany, UCLA who worked on several projects one of which was to evaluate the macadamia seedling trees growing in Kerikeri.

(Photo: D. Endt)



In 1974 Mr Endt visited Hawaii and California to observe the methods of growing and processing in these two areas and he also visited commercial orchards in Australia. With this background Dick Endt commenced large-scale production of grafted macadamia trees using Californian and Hawaiian varieties. He had two main problems about the future of macadamias in New Zealand. He had noted the extreme variability of the kernel of the nuts found in Kerikeri. In addition he found it was difficult to graft the plants successfully. Eventually he adopted a method of grafting pioneered in Rhodesia. Based on the technique used for grafting tea plants.

Plate 8: Mr & Mrs Endt at their Oratia Nursery

On his nursery property at Oratia Mr Endt planted about 20 different varieties from Hawaii, Australia, South Africa and Rhodesia. Most proved to be unsuitable and he settled on Beaumont and Elimbah. These became the basis of his macadamia commercial business until the 1990's when he decided to concentrate on other exotic and semi-tropical species and to drop macadamias from his catalogue.

(Photo: D. Endt)

IAN GORDON

Ian Gordon has had a long and varied career in the New Zealand macadamia industry. He was introduced to macadamias in 1966 while he was a horticultural cadet at the DSIR Research Station at Mount Albert, Auckland. The following year he planted 300 seedlings, on family land at Titirangi, mainly the N3 and N7 varieties. Later he purchased land at the Woodhill Forest near Helensville and planted a wide variety of Australian seedlings there on trial blocks.

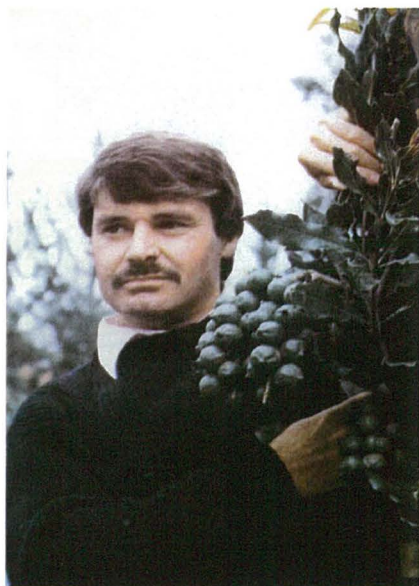


Plate 9: Ian Gordon

In 1975 he chose the selection GT, (Gordon, Titirangi) as a promising New Zealand hybrid suitable as a pollinator for Beaumont. GT has become a popular tree for New Zealand conditions and in some situations it has become the main crop tree. Ian Gordon has continued his search for ideal trees that grow and crop well in our cool wet springs and he has bred the hybrids GT205, GT288 and GT207 which show potential as main crop varieties or as pollinators.

Stuart Dawes and Ian Gordon moved to the DSIR Oratia Research Orchard to conduct a survey of seedling trees in Northland and the Bay of Plenty. It was at this stage that they introduced seed lines from Australian and Hawaiian varieties.

In 1980 Ian met Lou Schotter who offered him the opportunity to plant and manage 10000 macadamia trees at South Head. The orchard had an added value processing plant. In 1981 he left government to manage Macadamia Enterprises Limited.

Ian Gordon has continued his work on his Titirangi nursery and Woodhill Forest. At the Titirangi nursery research and development continues with 3000 – 4000 young trees available commercially including varieties such as GT 207, A4, A38, PA 39 and A268.

(Photo: I. Gordon)

He has been sought after as a consultant in macadamia projects in the eastern Bay of Plenty, New Plymouth, the Coromandel, North Auckland and for the New Zealand Macadamia Society.

In 1999 Ian Gordon was given the Dr Don McKenzie Award by the New Zealand Tree Crops Association in recognition for his work in the macadamia industry.

VANESSA HAYES

Vanessa Hayes has a working background in the Department of Maori Affairs and the Justice Department. In 1983 she took a horticultural course at the Tairāwhiti Polytech and made her first contact with macadamias. Following the course Vanessa became increasingly interested in horticulture and she became a founding member of the East Coast/Te Whānau ā Apanui Tree Crops in 1987 and in 1992 planted 30 seedling Beaumont in a trial block on her whānau land at Torere, near Opotiki.

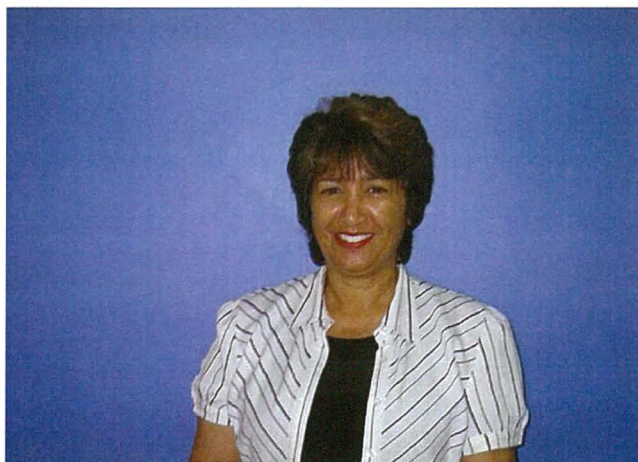


Plate 10: Vanessa Hayes

Whilst she operated a busy and expanding Life Insurance business first at Opotiki and later in Gisborne, Vanessa developed Torere Macadamias Limited. Her vision is to concentrate on dropping varieties of macadamias in the suitable parts of the 11 hectares of family land and to encourage other land owners in the Eastern Bay of Plenty to plant macadamias too.

It is hoped that local landowners may form a co-operative to grow, process and produce macadamia products for the New Zealand and export markets. Torere Macadamia

(Photo: V. Hayes)

Limited had planted 800 grafted macadamias by 2001 and have established a commercial nursery capable of producing 20000 grafted trees per year. In co-operation with Australian growers and advisors Henry Bell and Ian McConachie, Vanessa Hayes has built a tree quarantine facility and has imported 15 new dropping varieties from Australia in an effort to find the best variety for New Zealand conditions. She has been successful in obtaining Plant Variety Rights for the imported varieties.

Torere Macadamia Limited employs up to six staff. Grafted trees have been sent to Northland macadamia orchards. Vanessa, with her partner Rod Husband have been successful in obtaining Government Grants including funding to pay for a Government Keyworker and a Social Entrepreneur grant to commence research on the establishment of a national Growers Co-operative for growers of the new commercial varieties and to set up a centrally located Growers Co-operative Macadamia Processing factory.

VINCE & DIANE KERR

Vince immigrated to New Zealand from the USA in 1979 with a B.Sc., specialising in Biological Science, from the University of Oregon. He had a background in forestry and held a Diploma in Secondary and Tertiary teaching.

Diane Kerr had a B.Sc., in Zoology, from Otago University and a Diploma in Secondary teaching.



Plate 11: Diane and Vince Kerr
(Photo: V. and D. Kerr)

Vince worked for the Hokianga County and was responsible for developing the Hokianga Experimental Training Nursery in Hokianga in 1981. The previous year he had joined the Kerikeri branch of the Tree Crops Association and, with Don Boyes-Barnes, participated in research on the commercial



Plate 12: Vince Kerr with the late Don Boyes-Barnes

development of macadamias. During the next few years Mr and Mrs Kerr set up a macadamia propagation unit at Rawene and established the Tree Song Nursery and Consultancy at Omapere. In addition they planted a 1,500 macadamia plantation at Whirinaki in a joint venture with a Maori family and the Hokianga County.

Working with Don Boyes-Barnes they hosted several macadamia field days in the Hokianga and in 1983 they were involved with the setting up of the Growers Co-operative. Vince was a founding director and a member of the executive for a number of years acting as the research director. During his time with the Co-operative he carried out trials on pollination, variety evaluation and orchard practices and he organised field days. Diane meanwhile concentrated on management of the nursery and performed contract field grating.

In 1992 they shifted the Tree Song Nursery to Kamo, Whangarei, on a ten acre site and diversified to raising avocado trees, capsicums and cherimoyas. Diane continued to specialise in macadamias and raised a number of old and new varieties for commercial sale. They used the Elimbah variety as a root stock and grew and grafted approximately 2000 trees per year.

Both the Kerrs assisted in the setting up of the New Zealand Macadamia Society in 1997 and were involved in the first years of its operation.

From 2000 Vince and Diane have gradually run down the nursery activities. Vince is researching and writing proposals for a marine reserve at Mimiwhangata..

Diane has grafted her last trees and is pursuing other interests.

(Photo: V. and D. Kerr)

IAN McCONACHIE



Ian McConachie is a macadamia enthusiast who has been interested in macadamias since the early 1960's. He built and operated Australia's second processing factory in 1975. Ian was a foundation member of the AMS in 1974 and has been on the Board since then and is currently Vice President.

Plate 13: Ian McConachie

He founded Suncoast Gold Macadamias at Gympie and was instrumental in forming a co-operative of growers, which provides the bulk of the nuts for their factory the second largest in Australia. Ian is the Chairman of the co-operative. In the last few years the factory has developed a system of using the waste macadamia nut shells as fuel for the drying operation of wet nuts, as well as to providing enough electric power for over twenty houses in the nearby township.

Mr McConachie is currently writing a world history of the macadamia industry. Other interests include searching for wild macadamias in the rainforest, raising macadamia nut quality and promoting the health benefits of eating macadamias in moderation.

Ian and his wife have a 6,000 tree macadamia orchard a few kilometers outside Gympie. He has visited New Zealand several times and currently he is advising the Torere Macadamia Limited experimental block near Opotiki and assisting with evaluation of the new varieties being grown there.

At the end of 2003 Ian McConachie retired from his management role with the Suncoast Gold processing plant at Gympie but retains his keen interest in his plantation, the AMS and the Co-operative.

(Photo: I. McConachie)

VIRGINIA WARREN

Mrs Virginia Warren became interested in macadamias by chance. She and her mother attended a Tree Crops avocado field day and they spotted some macadamias growing there. Next day her mother bought two macadamia trees as a birthday present for Virginia. The two trees were planted in 1981 in drums and while they flourished some avocados growing there withered and died of Phytophthora. Virginia thought that macadamias were a viable crop and more trees were planted. Mrs Warren read



everything available and attended local field days to improve her knowledge. Selling nut-in-shell was not a profitable business and when an ex engineer arrived with a prototype nutcracker she bought it, started her processing business and began sales of kernel.

On her Chineka three hectare property at Pukekohe her plantings continued and whilst the trees were growing, she purchased and processed nuts from other growers to increase her sales.

Plate 14: Virginia Warren

By 1994 Mrs Warren realized the potential of her business and she obtained some Business Coaching to improve the business side of her venture. In 1996 she went in to the corporate market with added-value macadamia products. Virginia had a limited supply of kernel and decided to concentrate on eye-catching packaging to showcase her products. Raw and roasted nuts combined with chocolated and honey roasted nuts were placed in presentation baskets. These were sold to corporates to be available as gifts to favoured clients. This was so successful that she was chosen as 1996 Business Woman of Year by the Business and Professional Women of New Zealand. When the New Zealand Macadamia Growers Co-operative was seen as not fulfilling the aim of many Macadamia growers Virginia Warren became a leading figure in setting up the New Zealand Macadamia Society and held this position as President until 2003. After acting as the Secretary of the Society in 2003/04 Virginia chose to step down from any executive position to pursue other macadamia interests.

(Photo: V. Warren)

3.15 Discussion

During the period 1980 – 2000 the local macadamia industry had experienced nearly twenty years of growth as a result of the emergence of three commercial enterprises at Okaihau, Whangarei and South Head. In addition a number of small lifestyle blocks, with up to 1500 macadamia trees, were planted in areas north from the Bay of Plenty. Some blocks were sold and the macadamia trees removed. For example an orchard of nearly 1000 trees, in Whangarei, was sold and the new owner cut out and burnt the trees. Eventing horses now graze the land. All three commercial operations failed to sustain growth and ceased trading and two were sold to new owners.

Without a strong commercial base the local industry failed to develop during the last six or seven years of the twentieth century. Many growers were unhappy with the yields obtained from their trees and some turned to grow other crops such as olives and grapes.

There were several reasons why many New Zealand macadamia growers failed to meet crop standards obtained in Australia, Hawaii or South Africa. These reasons include:

- ❖ Inappropriate varieties for New Zealand conditions. Over 90% of all macadamia trees in New Zealand were of one variety – Beaumont. Problems with cross pollination, cool or unsatisfactory sites, pests and plant diseases and the owners' inadequate management techniques tended to depress yields that were too low to sustain a profitable business.
- ❖ Inadequate research and development. There has been little industry generated research particularly on variety selection and cross-pollination and government funded research was limited in scope and eventually withdrawn
- ❖ Climate is an important determinant for succesful growing of macadamias in New Zealand. As the macadamia is a native of south-eastern Queensland sites in northern areas from the Bay of Plenty northward had to be carefully selected to ensure adequate flowering, pollination, nut set and growth. Even in these warmer areas selection of varieties suitable for cool climate sites, was critical for achieving economic yields and this was not always done.

The following chapter looks at the local macadamia industry in 2000. Visits were made to a selection of growers, processors, nurserymen and consultants and scientists to gain an overview of the industry. It will note problem areas such as orchard management, pests and pollination and will conclude with a description of the main varieties growing in New Zealand.

CHAPTER 3 : REFERENCES

- Auckland, DJW. 1972. Report from New Zealand. California Macadamia Society.
43- 45
- Boyes-Barnes, Donald. 1987. The New Zealand Macadamia Industry. Proceedings of
the Second Australian Macadamia Research Workshop, 15– 9 September: 249 –
250.
- Brown, Hillary. 1983. Report of New Zealand's Macadamia Industry and its Potential,
25 Apr. The report was prepared for D. Rietow, Colonial Sugar Refinery Ltd.
- Burstall, S W and Sale, EV. 1984. Great Trees of New Zealand, AH and AW Reed Ltd:
p 243.
- Clark, Marjorie. 2002. Personal notes from Mrs Clark.
- Collins, R M. 1981. Notes taken from orchard note book, 16 Jun.
- Collins, R M. 2003. Audio tape No. 18, 6 Jan.
- Dawes, Stuart. 1972. Macadamian Nut Culture. Reprinted from the proceedings of the
Citrus and Subtropical Symposium, held at Waitangi, Bay of Islands, 24 Aug.
- Dawes, Stuart. 1985a. Macadamia Cultivar Improvement. Internal MAF Research
Project HortResearch, Kerikeri. Aug.
- Dawes, Stuart. 1985b. Macadamia Varieties and Culture for Commercial Production.
Information Services, MAF, Private Bag, Wellington, New Zealand. Nov.

Dawes, Stuart. 2002. Audio tape No. 11 23 Oct.

Dawson, Ted. 1991. Macadamia nut evaluation at Kerikeri Research Orchard.

Dawson, Ted. 1992 HortResearch, Kerikeri (Tables 8 – 11)

Dawson, Ted. 1996 HortResearch, Kerikeri (Table 12)

Dawson, Ted. 2003. HortResearch, Kerikeri. Note on the Rangataua variety in Kerikeri orchard.

Dictionary of New Zealand Biography, 1769–1869. 1990. Allen and Unwin, Wellington.
Vol 1: pp 586 – 587.

Endt, Dick. 2002. Audio tape No. 12, 25 Oct.

Fea, Roger. 1990. Muriwhenua interest in macadamias. Reprinted in News Bulletin,
Nov, p 10. (from NZ Herald, 9/10/1980)

Fletcher, WA. 1976. Growing Macadamia Nuts. NZ Journal of Agriculture, Nov: 26–28.

Food Briefs. 1983. Food and Technology Research Centre, Massey University,
Palmerston North. Series P, Aug.

Gordon, Ian. 2002, 2003. Audio tapes No. 10, 29/9/02 and No 19, 11/2/03.

Graham, John. 2003. Audio tape No. 19, 24/4/03.

Graveson, Nell. 2002. Audio tape No 3, 11/6/02.

Hale, Allen M. 1955. Pioneer Nurserymen of New Zealand. AH and AW Reed.

Hamilton, R.A. and Ito, P.J. 1979. Macadamia Possibilities. Journal of the NZ Tree Crops Association. H (1): 44–50.

Henry, Alf. 2002. Audio tape No. 1: 26/4/02.

Lens, Hans. 1986. Proceedings of a Seminar held at Mangatarata, July 1986 (Updated 1988). Seminar organized by NZ Tree Cops Association, Inc., Thames Coromandel Branch.

New Zealand Macadamia Nut Growers Co-operative – sent out to members the following news letters.

- ❖ MacNews 1 – (no date but after 17/4/1982). The letter consisted of eleven pages.
- ❖ Macadamia News – April 1983, No 2
July 1983, No 3
September 1983, No 4
- ❖ Macadamia Growers – November 1983 – February 1986
- ❖ News Bulletin – From May 1986 until the company ceased trading in 1999.

Mac News 1. 1982a Apr : 1

Mac News 1. 1982b Apr : 2

Mac News 1. 1982c Apr : 3 – 7

Macadamia News 1983 July, No 3

Macadamia Growers 1983a Nov: 6

Macadamia Growers 1983b Nov: 6 – 7

News Bulletin 1986 May: 9.

News Bulletin 1987 Feb: 15.

McConachie, Ian. 1986. Macadamia in New Zealand. AMS News Bulletin, Vol. 13, No 2, Jul: 104 – 105

NZMS Newsletter No 27. 2002. Apr: 4 – 6.

Northern News. 1980 29 Jan: p5.

Pickmere, Nancy Preece. 1994 Kerikeri Heritage of Dreams, Northland Historical Publications Society Inc., Russell, New Zealand. Chap 2, p 4.

Piper, Brian. 2002. Audio tape No. 13, 2 Dec

Pringle, Jim. 2002 Audio tape No. 11, 3 Dec

Richardson, A., Dawson, T. 1988 Macadamia Maturity Assessment And Determination Of The Effects Of Storage Both On And Off Trees After Maturity On Nut Quality. News Bulletin, Dec: 5 – 11.

Richardson, A., Dawson, T. 1993 The nutrition of Macadamia Trees in New Zealand. Orchardist of New Zealand, Oct: 37 – 40.

Richardson, A., Dawson, T. 1993 Effects of Orchard Factors and Drying Methods on the Incidence of Basal Stain of Macadamia Kernel . News Bulletin, Nov. 20 – 28.

Schroeder, CA., Fletcher, WA. 1965 Macadamia Nut in New Zealand. California Macadamia Society Yearbook: 65 – 70.

Simcock, Tim. 2004. Notes taken on a visit, Apr.

Te Puke Research Orchard. 1973. Laying Down Report of the Macadamia Block. 2 Mar.

Veldhuizen, Frank. 2003. Audio tape No 22. 20 Jun.

Visser, FR., Boyes-Barnes, DJ. 1982 Influence of seasonal variations upon the size and composition of New Zealand grown macadamia nuts. NZ Journal of Science, Vol. 25: 237 – 238.

CHAPTER FOUR : THE INDUSTRY TODAY

A plant which is indigenous to the coastal, subtropical rain forests of south-east Queensland and north-west of New South Wales requires selected microclimates in northern New Zealand for success in producing a crop in profitable quantities. The area of land north of Auckland is the most likely to be suitable for macadamia production and it was the first area to be planted in commercial and lifestyle blocks. Okaihau and South Head are still the largest macadamia orchards in New Zealand and Whangarei had the processing plant owned by the New Zealand Macadamia Growers Co-operative until the late 1990's. In 1991 there were approximately 80 members of the co-op with almost 62,000 trees planted (Richardson and Dawson 1991).

4.01 Effects of Climate

In general macadamias may be planted in areas in which the climate favours the successful production of avocados and citrus. Four main climatic factors affect the sites where macadamias could be planted to achieve commercial success (Bull, et al, 1985).

- 1 Temperature. This is the most important single variable. Macadamias are susceptible to frost in the first three years after planting and the length of the frost-free growing season may determine whether or not this species may be grown commercially. In Australia research on temperature showed that 25°C was the most favourable for vegetative growth and below 18°C for fruiting (Trochoulias 1992).(sic) In the Trochoulias quote the use of "below" appears to be unnecessary. Temperatures below 18°C, e.g. 10°C, would decrease the chance of succesful fruiting. In Hawaii the best yields were obtained at a mean temperature of 19°C (Dawes 1972). Temperatures below -3°C may kill young trees (up to 4 years of age) and at -2°C damage may be caused to leaves, young twigs and new growth (Dawes 1985).

- 2 Water. Nut tree plantings are dependent on either a reliable rainfall or access to irrigation. Macadamias grow in Queensland and Hawaii in areas having between 1300mm – 3200mm p.a. with peak rainfall during the summer. In northern areas of New Zealand there is sufficient rainfall to grow macadamias successfully but much of it falls during the winter and spring months when it is cooler than in other overseas growing areas. These conditions may affect early product maturation, harvesting efficiency and pollination and nut set.

- 3 Humidity. Excessive humidity may create conditions to produce fungal disease in trees and delay drying of the crop. Although humidity figures are high in Australia and Hawaii the drier winters and spring allow the fallen crop to dry effectively. The nuts are held on the trees in New Zealand until late winter and early spring and strip picked and must be de-husked and dried immediately to prevent mould and rancidity.

- 4 Wind. Wind may cause considerable damage to nut trees and shelterbelts may be required to protect trees from cool prevailing winds (Bull et al 1985).

4.02 Climate figures

Climate figures provided by NIWA in 2004, highlight the reality that many areas, which already have plantings of macadamias, are marginal for producing commercial yields.

Some small areas with suitable micro-climates may produce good yields in most years but, in general, the area north of Hamilton and in parts of the Bay of Plenty are the places most likely to succeed. Before purchasing land, future growers should carry out careful investigation to find out if the site is suitable. Hobby growers often purchase some land because it has a nice view or has some attractions which makes the site for a retirement retreat. If the macadamias do not do well the land use may change to another choice. Serious growers who intend to make a living out of growing macadamias, commercially, would be wise to obtain expert advice on the suitability of the site to achieve the stated aim. Favourable climate must be an important determinant.

The following figures illustrate the relatively small area in New Zealand which may grow macadamias successfully in commercial quantities (Table 15, NIWA 2004). Macadamias are likely to be damaged by ground frost especially in the first three years after planting. The length of the frost free, or growing season, is one determinant of suitability for growing macadamias commercially. New Plymouth, for example, has relatively few frosts per year (15) spread over five months. Although there have been some plantings in Nelson (88 frosts p.a.) this area is suitable only for hobby growing in the warmest areas.

Table 15: Climatic data for various districts in New Zealand

Place	Heat Units (°C) Oct-Apr (incl) Base 10°C	Annual Rainfall (mm)	Screen Frosts Average Number of Days with Screen Frost		
			Sep.	Oct.	Apr.
Kerikeri	1,432	1,648	0.1	-	-
Auckland (Albert Park)	1,601	1,268	-	-	-
Auckland (Oratia)	1,265	1,579	0.8	0.1	-
Tauranga (Airport)	1,365	1,348	0.5	0.1	-
Whakatane	1,401	1,304	-	-	-
Gisborne (Manutuke)	1,266	998	0.5	0.2	0.2
Hamilton (Ruakura)	1,147	1,197	1.2	0.2	0.4
Hastings	1,362	767	2.6	0.5	0.3
Taupo	964	1,199	4.1	1.3	0.7
New Plymouth	1,144	1,584	-	-	-
Wanganui	1,232	899	0.2	-	-
Palmerston North	1,114	1,002	0.9	0.2	-
Levin	1,005	1,095	0.2	0.1	0.1
Masterton (Waingawa)	1,003	964	2.7	0.9	0.6
Wellington (Kelburn)	976	1,271	-	-	-
Nelson (Appleby)	1,090	967	0.7	0.1	-
Motueka (Riwaka)	1,039	1,372	1.7	0.3	0.1
Blenheim	1,123	738	1.9	0.9	0.2
Westport	829	2,152	-	-	-
Christchurch (Central)	923	658	2.3	0.4	0.6
Christchurch (Airport)	820	626	3.9	1.1	0.3
Akaroa (Onawe)	1,029	993	0.1	-	0.1
Darfield	826	814	5.1	1.7	1.2
Ashburton	923	776	5.3	1.4	1.4
Timaru	830	601	2.2	0.3	0.3
Waimate	811	654	1.7	0.3	0.1
Alexandra	908	339	5.2	1.6	2.0
Dunedin (Musselburgh)	682	772	0.5	0.2	0.1
Dunedin (Taieri)	564	687	5.5	1.6	2.5
Invercargill	388	1,042	4.3	1.3	1.4

(NIWA Table 1)

Summer temperature has a bearing on successful growing. Temperatures below 10°C may reduce growth. A system of measuring heat units has been devised comparing the suitability of areas to plant various species. The heat unit figures are added to (Table 2, Appendix 7) showing “Summary Climate Information For Selected New Zealand Locations.”(NIWA 2004). The heat units are calculated over the seven growing months (October – April) using the following formula.

$$HU = \frac{\text{Mean monthly Max temp} + \text{Mean monthly Min temp}}{2} \times \text{Number of days in the month}$$

(Bull et al 1985)

It should be noted that a sheltered site facing north may add up to 180 extra heat units in the growing season. In general a minimum of 1200 heat units would be necessary for successful macadamia production unless new varieties are developed which may tolerate cooler temperatures.

However, other climate factors are important and the differences between Kerikeri and Kaikohe are interesting, as there are contrasts between the production and quality of macadamia nuts grown in the two areas.

The statistics of two Bay of Islands towns indicate very similar climates with Kerikeri being wetter, having more sunshine and many frost days. The number of rain days, mean temperatures, relative humidity and wind speed figures are very comparable (Table 16)

Table 16: Climatic figures for Kerikeri and Kaikohe

	KERIKERI	KAIKOHE
Rainfall p.a. (Mean)	1709 mm	1598 mm
Rain days >1 mm (Mean)	136	144
Sunshine hours p.a. (Mean)	1996	1873
Mean air temperature	15.2°C	14.7°C
Very highest temperature	34.3°C	30.5°C
Very lowest temperature	-2.0°C	-0.9°C
Ground frost (days)	18	3
Wind – Mean speed m/sec	2.00	3.17
Mean relative humidity %	84.3	85.9

(NIWA Tables 2 – 7, Appendix 7)

Apart from the different social developments of the two towns, with Kerikeri attracting a number of retired or semi-retired folk and lifestyle seekers, there are important geographical differences. Kerikeri is at sea level and is perched on an extensive inlet. Kaikohe is inland and sits on a plain at several hundred metres altitude. The following set of statistics for Kerikeri and Kaikohe compare the winter and early spring when macadamias are harvested and the new flowers are pollinated. (Table 17) Macadamia Plantations at Okaihau is close to and is at a similar situation to Kaikohe. The many Hawaiian varieties in this plantation commence their flowering in June – July and the bees struggle to pollinate in the cold and windy conditions. Beaumont, on the other hand, sets its flowers in September – October when the weather situation is more favourable for bee flights.

As a consequence it would be more important to locate a suitable site in the Kaikohe area which would satisfy the requirements for growing macadamias successfully. In addition the choice of varieties to be grown would need careful consideration.

Table 17: Winter and early spring figures for Kerikeri and Kaikohe.**Mean Daily Wind Run (km)**

LOCATION	MAY	JUN	JUL	AUG	SEP	OCT
KERIKERI	116.9	116.7	134.9	134.4	150.6	156.4
KAIKOHE	226.8	264.2	264.8	271.3	286.9	309.1

(NIWA Table 16 2004)

Mean Wind Speed (M/sec)

LOCATION	MAY	JUN	JUL	AUG	SEP	OCT
KERIKERI	1.85	1.86	2.16	1.94	2.03	2.26
KAIKOHI	2.91	3.10	3.30	3.44	3.53	3.83

(NIWA Table 15 2004)

Mean Total Sunshine Hours

LOCATION	MAY	JUN	JUL	AUG	SEP	OCT
KERIKERI	135.31	123.27	136.92	143.93	156.85	178.14
KAIKOHE	139.90	108.68	126.04	130.25	138.33	167.15

(NIWA Table 14 2004)

Mean 10cm Earth Temp (°C)

LOCATION	MAY	JUN	JUL	AUG	SEP	OCT
KERIKERI	13.3	10.9	9.6	10.3	12.5	14.9
KAIKOHE	13.1	10.9	9.8	9.9	11.4	12.8

(NIWA Table 9 2004)

4.03 Industry Growth

Generally the growth of the macadamia industry in New Zealand has declined. The Co-operative had approximately 80 – 90 members just before it was wound up in 1999. In 2002 the New Zealand Macadamia Society carried out a telephone survey of its 63 members and 43 non-member growers and found that growers had 69,754 trees planted, with Beaumont the most popular variety having 36,517 trees. Approximately 60000 were over 7 years old and another 8000 were between 4 - 7 years. The Far North, with 30303 trees, had the most trees with the area from Wellsford to Auckland next with 17659 trees.

Unfortunately the survey did not record the weight of the crop (NIS) for 2001 but the total quantity of kernel sold in New Zealand in 2001 was 53,608 kg (NZMS Newsletter April 2002).

The Society survey indicates that the average weight of NIS per tree is much lower than in countries such as Australia, Hawaii or South Africa. The important feature for growers is to find out why our cropping figures are so low and to then improve results to yield much closer to overseas totals.

4.04 New Zealand Industry Changes

From approximately 1995 there were a number of important changes in the structure and scope of the New Zealand macadamia industry. The previous year Macadamia Plantations of New Zealand had been sold and had an uncertain future growing macadamias. The other two commercial ventures were to be sold in the next few years.

4.05 South Head Macadamias

South Head Macadamias changed hands in 1997. Mr Robert Garden bought the complete business including the plant nursery, mature trees, processing plant and marketing services. The main tree planted blocks held approximately 7000 producing trees and nearly 3000 others which were young or poorly sited, diseased or were inferior varieties. Up to 1997 the best yield was 20 tonnes. Mr Garden decided that it needed a new direction and he made major changes in organisation and structure.

The orchard was split up and sold as five private blocks of 10 – 12 acres each. The new owners could keep the trees and sell the crop to Mr Garden or other processors or alternatively the trees could be pulled out and the land used as the owner wished. All five blocks stayed in macadamias and by employing heavy pruning methods, cutting shelter belts lower, the elimination of the rat problem and the use of sheep to replace mowing the yield in 2002 was 45 tonnes with lower running costs. It would appear that previous

management practices, before the 1997 change over, had failed to provide acceptable yields and returns.

Mr Garden leased out the orchard shop which had a regular turnover because of many visitors to the property. He retained some producing trees and took control of the processing plant. In his modern factory he dries nuts, cracks, sorts kernel and adds value in a number of ways. Kernel is processed as natural, salted and hickory smoked in the factory and chocolate and honey coated is done off-site. All products are sold in New Zealand and there is no rush to get into an export market.

Unlike some in the local industry Mr Garden is satisfied with the existing selections such as Beaumont and other non-dropping varieties. He believes that picking is not a problem and employs part-time staff as needed. One way of attracting pickers is by weighing the crop picked in a day and giving a fair weight of processed kernel as payment. Rob Garden employs four permanent staff in the processing plant, one in marketing and one in the office.

To increase the extent of his business Mr Garden has imported NIS from Australia in addition to the crops bought from New Zealand growers. This allows him to process throughout the year assuring customers that products will be available all the time.

Table 18: South Head Macadamia production figures NIS 2000 - 2004

SOURCE	2000/01	2001/02	2002/03	2003/04
	Tonnes	Tonnes	Tonnes	Tonnes
Home Orchard	3.5	3.5	4.0	4.0
Bought in NZ	40.0	73.8	93.5	90.0
Bought from Aus.	0	33.4	17.5	17.0
TOTAL	43.5	110.7	115.0	111.0

(Garden, 2004)

Rob Garden believes that he will continue growing picking varieties as it is too wet in the winter/spring to harvest droppers easily. Should an early dropping variety drop its crop in the April – June period, then it would have a future at South Head if the yield produced was of good quantity and good quality (Garden, 2004).

Other New Zealand changes included:

4.06 The Co-op

Another of the three major commercial enterprises, the NZ Macadamia Nut Growers Co-operative Company, ceased trading in 1999. This affected a number of growers some of who pulled out their trees, discontinued the maintenance of the orchard practices and/or sold nuts at the orchard gate. Some sold nuts to another processor often receiving a better price more quickly for the crop than they did with the Co-operative. Many members of the Co-operative felt that waiting until the kernel was sold before they received payment was a serious financial disadvantage.

4.07 Macadamia Plantations of New Zealand

Dr Anatoly Lykho purchased this property in 2000. It is the largest macadamia plantation in New Zealand and consists of 38ha of flat to gently sloping land. It is situated about 3 km from the village of Okaihau on the Horeke Road. Dr Lykho decided not to sub-divide the orchard but to keep it as a working unit and to improve its management, to increase yield and to reduce running costs. There are nearly 12,000 macadamias planted including 25 varieties. (Table 19). Dr Lykho has not been able to locate all varieties as some were planted in small numbers and may have died or been taken out by previous owners.

Table 19 **Macadamia varieties planted at Macadamia Plantations of New Zealand from 1978**

1. N246	2. N508	3. N462	4. N741
5. N800	6. N344	7. N33	8. N660
9. N777	10. N3	11. N7	12. A30
13. PA39	14. GT1	15. GT207	
16. Beaumont	17. Own Choice	18. Nutty Glen	
19. Renown	20. Tauranga 1	21. Nelmac	
22. Greber	23. Tauranga B	24. Sewell	
		25. Colliston	

(Lykho 2004)

It should be noted that more than half of the trees planted were Hawaiian varieties, which drop their crop, and many of these trees had little or no fruit after more than 20 years. Most of the non-Hawaiian varieties were either pollinators for Beaumont or were trial plantings to find out if they could be commercial.

It should also be noted that Tauranga 1 and Tauranga Beaumont have not been mentioned before in this study and it is possible that they may be another name for Nelmac. Jim Pringle, in Tauranga, brought Nelmac 1 and 2 to New Zealand from South Africa and the sample nuts observed at Okaihau were the same size and shape as Nelmac fruit. A search of the few records available from the Te Puke HortResearch Station did not list any variety call "Tauranga".

Over the past four years Dr Lykho has commenced a programme of grafting over all Hawaiian trees except for N741 which flowers early and produces a reasonable crop every second year. Varieties N344 and N246 (Approx. 1200 trees) will be cut out and not replaced at the moment. Various Hawaiian varieties (1500 trees) showing some promise will not be removed at the moment to see if another two or three years growth results in a larger yield.

The grafting programme includes:

- ❖ 3000 trees have been cut back to a single stump and have one or more grafts using Beaumont or GT1, GT207, PA39 and Tauranga 1 as pollinators.
- ❖ 3000 trees have been cut back with a stump plus one other branch and grafted as above.
- ❖ 1200 trees have grafts on existing trees i.e. the new graft was added to the best leading branch and all other branches remain until the result of the graft is known.
- ❖ 300 trees are still to be grafted as above.
- ❖ 600 (N344, N246) trees will be cut to a single stump and have one or more grafts added.
- ❖ 300 (N741) will remain as is.

Dr Lykho has bought in cattle to graze the existing grass areas of the property and sheep feed under trees to reduce mowing. Although there is a modern machine in the orchard to harvest dropped nuts it is not used, as there are few viable dropping varieties left and Anatoly sees no difficulty in picking from the trees in the future.

The crop is dried down to 10% moisture in small metal silos with fans blowing in ambient air. The crop is sold to Macnut Farms, South Head and in 2000 the yield was approximately 8 tonnes but less after grafting commenced. (Notes of visit 7/7/04)

4.08 Other Changes

In some areas, such as Kerikeri, the number of producing macadamia trees decreased in the period. Some disenchanted growers cut down trees, or left them unattended, when the Co-operative discontinued operation. New owners prepared to spend the time and money for the resurrection could bring some of these orchards back to production, perhaps. However there are several factors which reduce the chances of this happening in most cases.

Alternative horticultural crops have become popular with some people who had some spare land available. Others, who are looking for a lifestyle which was fashionable, sought a crop which could be processed away from the harvest area. Two crops, grapes and olives in particular may be cited.

Grapes flourish in a large range of climates in New Zealand. In addition, grapes grow well in a variety of soil conditions. From the Far North to Central Otago plots of grapes have been planted in the expectation that the crops will be bought by a large winery.

The planting of small tracts of olives has become popular from the Far North to Canterbury. In some cases the olive growers join a co-operative and the crops are sent to a central pressing, processing factory.

Another reason for the diminishing number of macadamia trees is the rapid increase in cost of land in some areas. Pressure to create new subdivisions has seen much horticultural land swallowed up for housing. This is particularly so in the Bay of Islands, in areas with a view and/or with access to the coast. Auckland and Tauranga have similar changes being made. Macadamias are not the only crops to suffer. Citrus, arable market gardening and even kiwifruit orchards are threatened by the need to provide housing and commercial buildings. Fertile, productive land is no longer available for food production.

4.09 Search for New Varieties

In the last ten years in particular, there has been eagerness shown by some growers to find varieties which have heavier yield, with a good crack-out and high percentage of number one kernel and, importantly, which drop its crop to the ground. Beaumont is seen as an inferior variety with the disadvantage of requiring an expensive picking operation. Henry Bell, an Australian macadamia plant breeder, has developed a series (the 'A' series) of dropping hybrids some of which have been tested in New Zealand. At the moment there is no information available to indicate if any of these are suitable for New Zealand conditions. It will take some years evaluation before a satisfactory conclusion as to their suitability may be made.

4.10 Orchard Visits

The following descriptions of orchards, nurseries or processing plants represent a wide variety of sites.

4.11 Mr Bruce Henderson, in Kaitaia, first became interested in macadamias in 1980 when he planted some seedlings in plastic pots. In 1981 he visited Hawaii and toured plantations and processing plants there. On arrival back in New Zealand he planted 500 trees on 2 hectares of flat land bordering hill slopes containing native bush.

Mr Henderson chose varieties which were available at that time with Beaumont as the main crop and others such as GT1, Renown and Nelmac 1 as pollinators. The trees were planted in good soil and grew readily. However rats and possums were early problems requiring extensive baiting and trapping to give the trees a chance to yield. Some trees have been damaged and others have not produced worthwhile yields. A number of these have been culled and replaced by PA39 and some dropping varieties as experimental in this orchard. In 2001 the orchard produced 2 tonnes NIS and further nuts were purchased from other growers for processing on site.

Being an engineer Mr Henderson was able to build his own processing machinery including a dehusker, dryers, conveyor belts and cracker. His visit to Hawaii provided an opportunity to obtain specifications for his machinery and that was professionally constructed by him subsequently. In his own purpose-built small processing unit he has been able to add value to his kernel including roasting and salting, chocolate coating of the kernel and the manufacture of macadamia butter. He has a ready market for his products in Kaitaia and surrounding districts (Henderson 2002).

4.12 Laetitia and Lindo Ferguson bought the 20.8ha Butler Point property in 1974. The land and buildings are listed as an Historic Place and are situated overlooking the Mangonui Harbour, Doubtless Bay.

In the late 1970's the Ferguson's decided to plant macadamias on some of the hill slopes facing the harbour. An initial order of fifty mixed varieties was placed with Dick Endt and over the next fifteen years twelve varieties were planted. In 1996 four 'A' series were added making approximately 400 trees in total in eight blocks covering about 5 ha. Beaumont was the main variety (154 trees) and other varieties included Own Choice, Nelmac 1, Renown, Sewell, the twelve 'A' series and a few minor varieties some of which have been replaced.

Yields have been small with just over a tonne (NIS) in 2003 and only half a tonne in 2004, a very wet season. Reasons for the low production included soil deficiencies such as heavy clay, insect damage (particularly GVB and Guava Moth) and over sheltering on the northern and eastern sides of the orchard. No one variety stood out for good yield and the 'A' series in general, produced a lower yield than Beaumont, Renown and Own Choice.

In an effort to raise the production the Fergusons have sought expert advice on two matters. From 2002, using HortResearch expertise, they hoped to control the Guava Moth infestation. All husks and debris under the trees was collected, soaked in water in large containers and later used in mulching. In addition eight pheromone traps were placed in the orchard and careful records of results were kept. The traps were put out in January 2003 and are still there in 2005. Current results indicate that, in general, counts are lower than they were in 2003.

In mid-2004, Laetitia and Lindo obtained advice regarding benefits of soil and leaf analysis. As a result of subsequent analyses obtained, a programme to improve deficiencies commenced. Dolomite was applied by hand and a plan for regular foliar feeding of the required nutrients and trace elements has been implemented through to

mid – 2005. Most trees look more healthy than before but whether an increased yield results is to be established.

One surprising feature was that the ‘A’ series trees did not drop their crop before Beaumont were ready to be picked in August. It had been hoped that the ‘A’ series varieties would drop all, or most, of their crop making for an earlier and easier harvest. As it was they were hand picked at the same time as all other varieties were harvested (Ferguson 2005).

4.13 Searles’ Orchard: The orchard of 5 hectares owned by Mr and Mrs Searles in Kerikeri was planted in a mixture of macadamias and citrus. A total of 1100 macadamia trees were planted between December 1988 and April 1991 with six blocks of Beaumont and Renown on a ratio of 8 to 1 and two blocks of Own Choice. (Figure 3) Yield increased annually from 1991 to 1998, except in 1996 which was a poor year, with a crop exceeding 1 tonne. (Figure 4.) Mr and Mrs Searles did all the picking of the crop but they considered employing pickers/pruners in future years.

In January 2000 they noticed that some trees looked under stress with leaves having a pale green colour. By mid-2000 die back was noticeable in some trees but the problem did not look too serious and soil was sent for analysis. A pH reading of 5.3 was low and was typical of sub-soils in the region containing high manganese levels and inadequate lime (Richardson and Dawson 1991).

Figure 3: Orchard layout – Searles

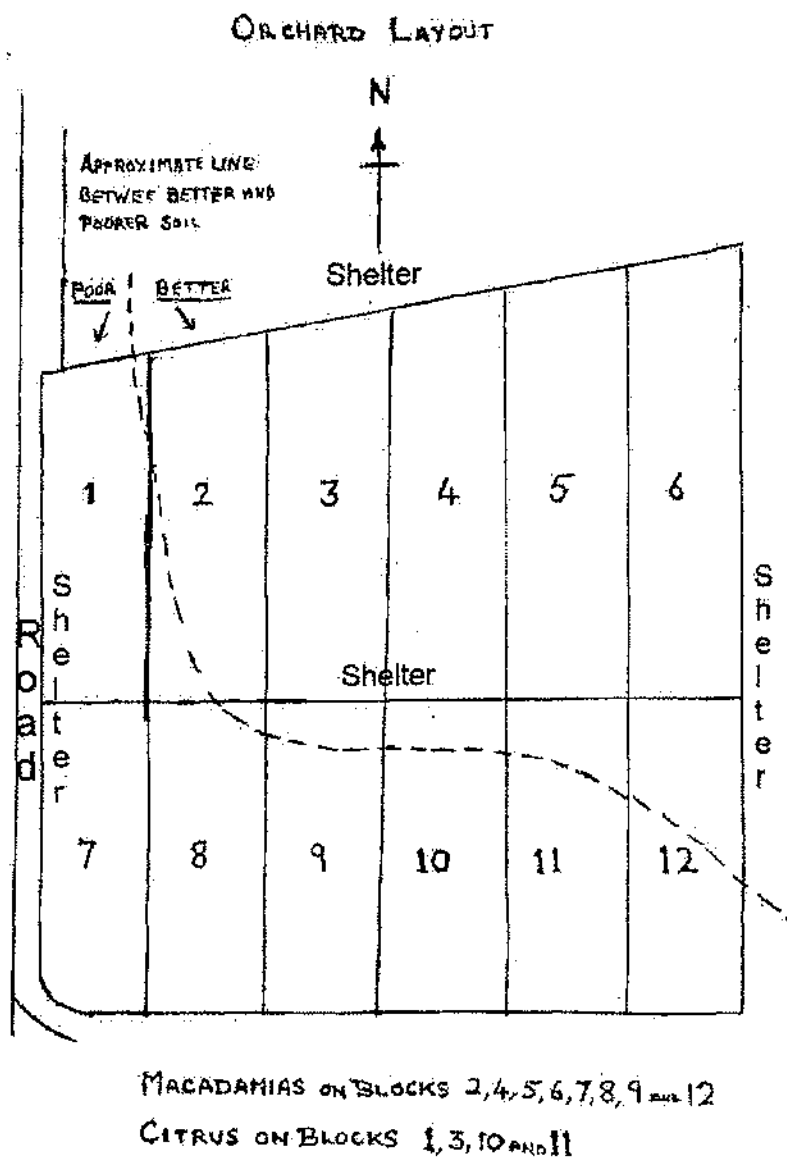
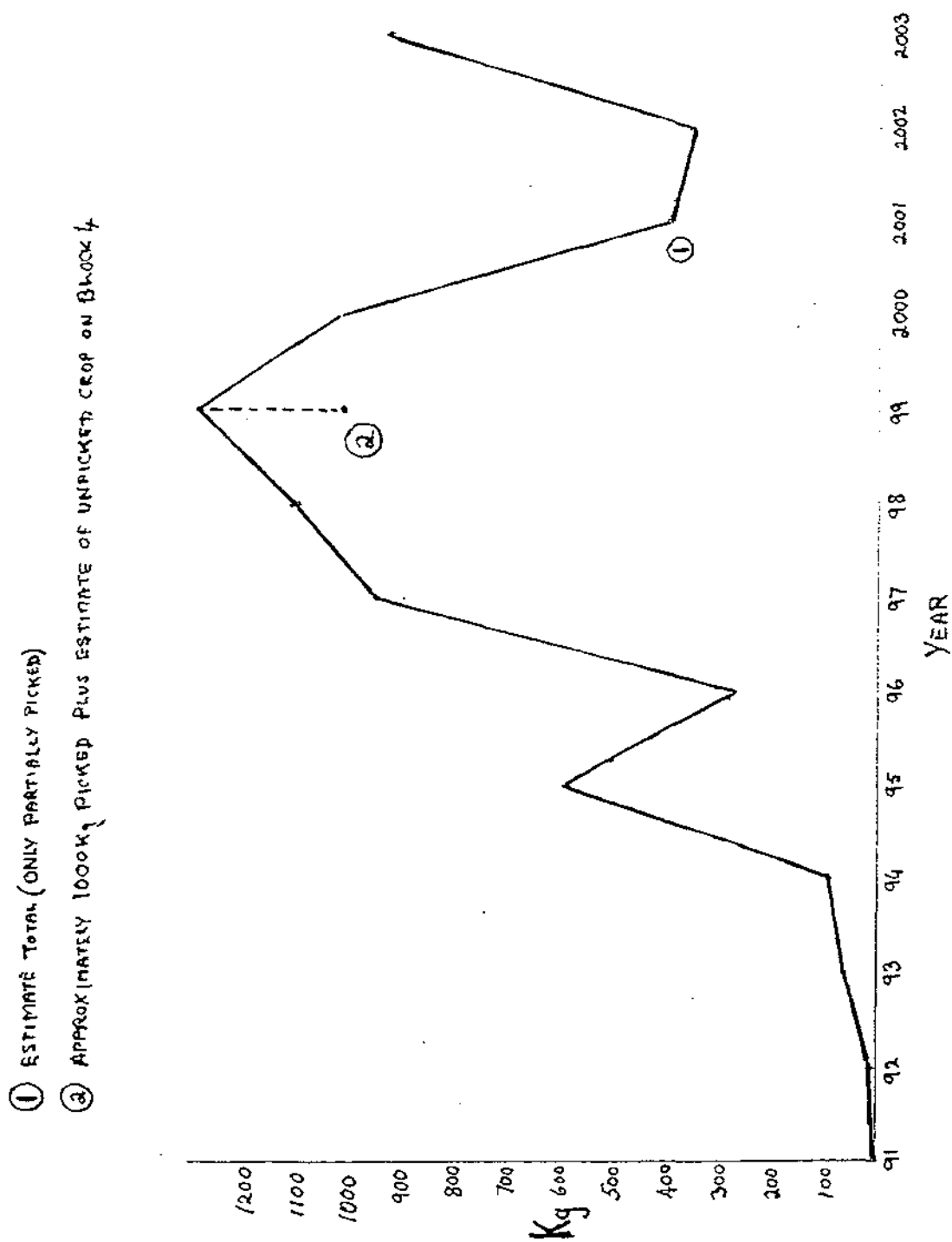


Figure 4: Total crop – Searles



In October 2000 the crop was picked and the weight of approximately 1000 kg was normal. Nuts were sent to the local processor and although there was a small rejection of kernel due to Green Vegetable Bug damage there was a very high exclusion (over 10%) of small, very hard nuts. These nuts resembled polished ivory and the processor noted that he had not seen a similar nut on any other crop.

After picking was completed, in late October, the family tried a trial pruning in one block and decided to apply lime in six blocks (leaving two blocks untouched) and to apply NPK fertiliser on a few selected trees. In January 2001 more lime was put on but there was no apparent difference between the treated and untreated blocks. Die-back persisted from the edges and middle of the trees.

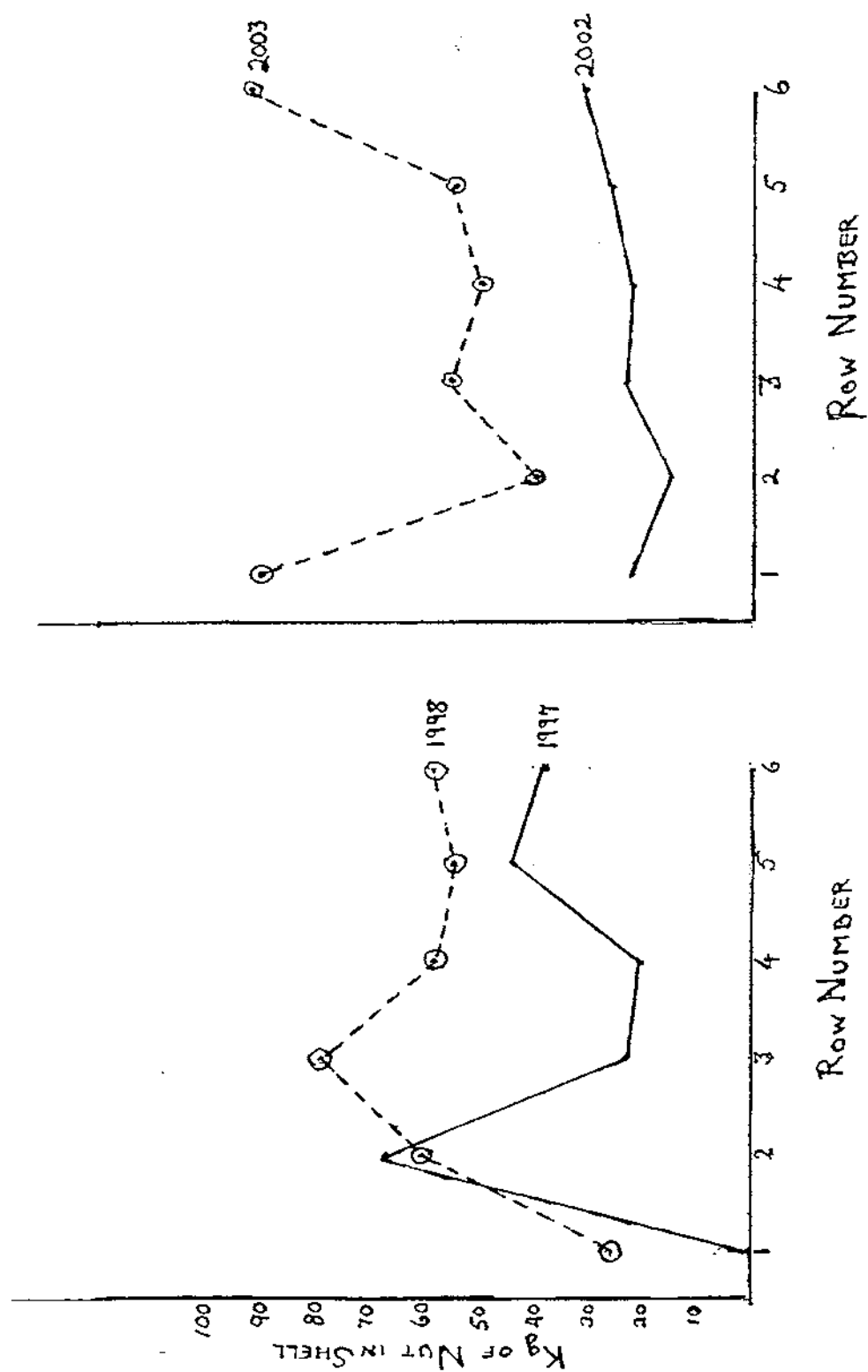
By September 2001 there was an estimated crop of 400 kg but only a small amount was harvested for their own use. The orchard looked a mess with increasing die-back and unhealthy leaf colour and the Searles were reluctant to sell any of the nuts. Another orchard, which was approximately 3 km distant, seemed to have similar problems but not as extensive. This orchardist blamed spray drift from a neighbouring kiwifruit orchard which had sprayed with Hi-Cane.

An unusual feature of the damaged orchard was that the macadamia rows next to shelterbelts were the least distressed. In a healthy orchard it is common for the rows adjacent to the shelterbelts to be smaller and less vigorous because of the competition for light, moisture and nutrients. (Figure 5.)

In September 2001 Mr Searles contacted HortResearch for advice on spray drift damage but he was informed that there was no funding available for spray drift research.

Looking for expert help Mr Searles approached the Environmental Section of the Northland Regional Council. Some weeks later a reply was received indicating that the Macadamia Society believed that some macadamia varieties were not resistant to *Phytophthora* and that was a possible cause of the damage.

Figure 5: Crop on block 4 – Searles



At harvest time in September 2002 a careful pick realised only approximately 360 kg. An approach to HortResearch brought the opinion that neither *Phytophthora* nor Roundup was responsible for the tree conditions but that the problem might be nutritional.

The Searles next contacted Forest Research who advised that in July 2000 a shelterbelt of gums had debilitating symptoms. A specialist from Forest Research visited the orchard in October 2002 and took a number of samples for laboratory testing.

During that spring the orchard trees showed the first signs of healthy regrowth especially where the trees had been pruned heavily.

In November 2002 Forest Research advised that they had not been able to identify any fungal or bacterial cause of the problem. They revisited the orchard in April 2003 and expressed the opinion that the trouble may have been nutritional and suggested that a leaf analysis should be carried out. Two leaf analyses were done in May on both good and discoloured regrowth. In July another analysis was made on leaves from the least affected trees near the pine shelter. The results of these three analyses followed a similar pattern although there was a higher level of nutrients from the least affected trees.

An encouraging crop was harvested in September 2003 with approximately 900 kg of nuts. The trees showed further healthy regrowth following heavier pruning. In addition the shelterbelts on four blocks were trimmed down to 2.5 metres over the summer of 2003/2004 and extra fertiliser (phosphorus and nitrogen) was applied to selected blocks in October and December 2003.

In summary:

- ❖ The sequence of damage caused by die-back became more advanced from the 2000/2002 seasons.
- ❖ Trees in the north-eastern blocks (4, 5 and 6) were worst affected.

- ❖ During pruning it was found that most trees had trunks which were half dead (dry and cracked) and the other half live and comparatively healthy.
- ❖ Most damage occurred in the centre of each block. Figure 5 shows that rows beside the shelter blocks performed better than centre rows.
- ❖ Suggested causes of the tree damage in the orchard include:
 - 1 Use of Roundup The Searles used Roundup for weed control under the trees and along the margins from the first years of planting. The sudden appearance of die back in 2000 and the following recovery in 2003/2004 did not fit any known pattern in the Kerikeri area except for one other orchard which did not use Roundup.
 - 2 Phytophthora The opinion given by the Macadamia Society was not based on an actual visit to the orchard nor from a qualified research organisation after testing. The Searles did not accept the Phytophthora theory for the following reasons:
 - ❖ The sudden appearance of die back throughout several orchard blocks in a year does not fit the normal progress of Phytophthora attacks on orchard trees. It would take a number of years for a thousand trees to suffer fatal root disease.
 - ❖ Phytophthora is a fatal disease and the affected trees weaken and die eventually. Apart from a small number of trees which died (less than 5) in the worst affected block (block 6) all trees on the Searles orchard have recovered.
 - ❖ Examination of the root system of a sample of trees in the orchard showed that the systems were in good condition. Many of the trees, in 2003/2004, sent up strong water shoots from the graft something which had not happened since the trees were very young.
 - ❖ Consultants did not accept the Phytophthora theory.
 - 3 Lack of nutrients Although some of the soil and leaf analyses indicated that lower than recommended levels for some nutrients did occur the pattern throughout the orchard was more or less the same for good trees producing well and poor ones yielding only a few nuts. The rapid and extensive damage caused in the orchard affected trees of all ages, varieties and positions. In areas where experimental lime applications were made, in some blocks and in some rows, there was no visible difference in the damage caused.

Pruning experiments carried out in selected areas showed that although much wood at the ends of branches was alive the branches were so damaged that the flow of nutrients was restricted with the result that die back was inevitable. When pruning was carried out severely back to healthy wood healthy regrowth was rapid.

- 4 Spray drift This seems to be the theory which fits the sudden and patterned damage caused in the orchard. Regrowth and increasing yields are encouraging but the Searles feel vulnerable to the possibility that the same thing may happen again (Searles 2004). They had a kiwifruit orchard on their eastern boundary and it is known that Hi-Cane was used there.

4.14 Anne and Hugh Canning bought a 7.5 hectare plot of land in Kerikeri in 1972. From the beginning they did not know what trees to plant but in 1975 they read an Australian article about growing macadamias. At that time macadamia trees were not readily available but in 1976 they bought fifty Beaumont trees and planted them on their Waipapa West Road property. The trees came from Dick Endt and the following year another block of fifty mixed varieties was planted. Varieties included in this block were Own Choice, Elimbah and Nelmac 1.

The Cannings were original members of the Macadamia Growers Co-operative and remained in that body until it ceased operations. Anne was a director for four years and carried out many supportive roles including research projects and organising field days in the Kerikeri area. Hugh was the editor of the News Bulletin for some time in the mid 1980's. They were part of a group of members who believed that the Co-op should not carry out commercial operations such as processing, marketing and selling kernel products. It was their philosophy that the role of the Co-op was to disseminate news and information to members, to carry out research on macadamias and to collect macadamia NIS and sell on to processors providing a monetary return to members.

This split among members regarding the commercial role of the Co-op was an important reason for the failure of the Co-op.

Anne and Hugh had approximately 1.5ha in macadamias planted in a wide spacing at 6m x 6m and regularly achieved up to 15 Kg (NIS) per tree from their main crop variety, Beaumont. In addition they conducted a successful macadamia nursery business on the site.

Anne experimented with hand pollination methods and she noted that moths visited macadamia flowers. In addition, Anne noticed that honey bees collected pollen early in the day. Her interest in pollination of macadamia flowers led to research in England on the subject (Corbet 1986). A research paper "Macadamia Some Questions on Pollination" was published in 1989 and this is discussed later in this chapter

Following the closure of the Co-op and the death of her husband, Anne sold off most of her property. She kept a few mature macadamia trees and the tree nursery and maintained an interest in the industry (Canning 2002).

4.15 The Barry Williams Suzanne Watson orchard in Kerikeri was planted in 1987. It has 2.5 hectares of nearly flat land, fertile volcanic soil, and good shelterbelts protecting from the south east to west. The orchard had grown excellent citrus for many years and the 400 macadamia trees were planted at a spacing of 8 x 4m among the citrus. As the macadamias grew the neighbouring citrus were taken out and it was 10 years before the last mandarins were removed.

An interesting feature of this orchard was a row of mixed seedling macadamia trees which had been used as a shelter block between two blocks of citrus. The seedlings were planted a metre apart and were 10 – 12m tall. They originated from the same stock planted by Mr L Anderson in the 1940's (Graham 2003). The seedlings remain on the orchard as a useful pollinator but were topped to allow more light in the orchard.

The main varieties planted were Beaumont, as the main crop, Elimbah as a pollinator in one block and Renown as pollinators in the other two blocks. It became obvious that the block which had Elimbah had too few pollinators and a number of Nelmac 2 were

interplanted in an attempt to achieve a better yield. The results were little better and it seems that more GT1 or PA39 grafted into this block would result in an increased crop.

Growth, particularly in the Beaumonts, was rapid from the start with a few trees producing some nuts in the second year. By the fourth year almost all trees had nuts in small bunches or as singles per raceme. However, from the sixth year on the Beaumont trees grew rapidly in height and in a bushy habit. (Plate 21) The crop tended to grow on the outside of the trees and there were few bunches. Some trees reached a height of 4 – 5 metres. Advice from HortResearch, Kerikeri and Mr Henry Bell, a visiting orchardist and plant breeder from Queensland suggested that the trees should be pruned to 3 metres and much of the growth inside pruned away.

At this stage the orchard was sold to the present owners and they pruned heavily. Current yield (2003) from the 400 trees was 4100 kg NIS, and crop bought from other growers in 2003 was 11,200 kg NIS.

There is an efficient processing plant on the orchard. It was set up in the early 1990's as the orchard yield increased and became an alternative processor to the Co-operative. A number of growers had not joined the Co-operative and this Kerikeri facility saved the long journey to South Head the nearest alternative processing operation. When the Co-operative ceased operating some local growers sold NIS to this orchard. In 2003, 15,300 kg NIS was processed producing 4,200 kg of useable kernel.

The machinery was bought from Australia and included a dehusker, grader, cracker and sorter. A local engineer made a conveyor belt and drying is all in done in a converted container fitted with its own air pump. It is possible to dry between 6 – 8 tonnes NIS at one time to 1.5% moisture in 8 – 10 days after which the crop may be held indefinitely before processing (Williams and Watson 2004).

4.16 Mr Jim Mackie was a foundation member of the New Zealand Co-operative and remained as a member until the Co-operative was wound up.

Mr Mackie purchased land a few kilometres west of Kaikohe. He decided that he wanted to grow food on trees but ruled out the planting of kiwifruit as the type of ground and climate were unsuitable. After obtaining information from the Tree Crops Association and MAF, Jim purchased macadamia trees from Don Boyes-Barnes in 1980. The initial planting comprised 60% Hawaiian varieties and a mixture of Beaumont, Own Choice, Renown, Nelmac2 and PA39. Within seven years Mr Mackie cut out all the Hawaiians as they proved to be uneconomic on his site. Many of the nuts had very thin shells with the kernel showing, were very small and only a few nuts dropped at any one time.

From the start the orchard was planted on a 4 x 2m spacing which clearly was too close. When the Hawaiians were removed the orchard spacing became 6 x 5m and the number of trees was 900. Pine shelter was planted on the southern and western sides and temporary internal shelter was planted around 50 x 50m blocks of nut trees. The internal lupin shelter was removed after five years.

Mr Mackie planted pecan nuts as an alternative crop but they were not very successful. They produced small yields which were not economic. After a few years the pecans were removed from the orchard.

The orchard has produced high quality NIS for some years. Although his annual yield quantities were not as high as some growers the processor who bought Mackie's crop, rated them as top grade. This quality was achieved because Jim Mackie attended to basic orchard practices and had regular soil analysis tests made.

There was little pest damage in the orchard. Rat control using poisoned bait was successful, birds' nests were removed and there were no problems with opossums. There was only a low-level damage by Green Vegetable Bug and Mr Mackie believed that the paper wasps in the orchard control this pest. Within the last few years there had been the appearance of the Guava Moth and the wastage was small in 2002. Mr Mackie has sold his property and moved away from the district (Mackie 2002).

4.17 Mr Grahame Richards planted the first of his 1200 macadamias in 1984. His orchard is 4 ha of sloping northerly facing and fertile land at Glenbervie a few kilometres east of Whangarei. Varieties planted include Beaumont, GT1, PA39, Elimbah and recently a few of the A varieties were planted as an experiment but no conclusions may be reached at present regarding their suitability for large orchard planting. It is noted that Elimbah and PA39 are more seriously damaged by the Green Vegetable Bug causing early dropping.

By 2002 the yield had increased to 4 tonnes NIS (3.30 kg per tree). Over the years little leaf or soil analysis has been done and no attempt to run a suitable tree nutrition programme.

Mr Richards was a member of the NZ Co-operative from 1984 and he ran a processing plant on his property from 1988. When the Co-operative was wound up he purchased the processing machinery and continues to do this work. At present Mr Richards has a dehusker and drying facility which he uses for his own crop (Richards 2002).

4.18 Mr Clive Chamberlain had a 6.2 hectare macadamia orchard on a hillside in Kamo, Whangarei. His first plantings were several hundred avocado trees but in the seventh year the trees began to die. His interest was in growing organic tree crops so with the failure of the avocados he turned to macadamias. In 1991 he planted 400 trees, in 1992 another 400 trees and in 1993 the last 400 trees. The trees came from South Head and he chose three varieties – Beaumont, PA39 and GT1. Clive found that GT1 yielded small nuts which were not very popular with customers.

In 2002 the orchard yielded 4 tonnes NIS. This was sufficient to fill his orders with two organic markets. As macadamias keep well in good storage conditions Clive was able to supply kernel throughout the year.

Pests in the orchard were not a major problem although PA39 had more Green Vegetable Bug damage than the other two varieties. Mr Chamberlain used no sprays in the orchard

but companion planting of known hosts for Green Vegetable Bug lessened the threat of severe damage to the crop. Clive had not had any tests for leaf or soil and he had not been able to carry out a fertiliser programme for some years due to ill health.

The orchard had some of the best processing equipment with the capacity of drying, cracking and sorting 20 tonnes per year. The equipment was imported from Australia and, with only 4 tonnes picked from the orchard, the processing plant was barely used. Mr Chamberlain would not process crops from growers who were not organic. Although there is an export market for organically produced macadamias Clive did not have the production required to satisfy these demands.

The orchard was sold in late 2003 (Chamberlain 2002).

4.19 Mr Tom McClelland was Secretary of the Co-operative for several years and was the Chairman when that body lost members and ceased to exist.

His orchard of 4 ha. is on the northern slopes of the Brynderwyn hills some 50 km south of Whangarei. He had 1200 trees planted in 1986 mainly Beaumont with GT1 and Renown as pollinators. In 2001 his yield was 6.5 tonnes of NIS and in 2002 the yield was 5 tonnes making an average per tree of 4.8 kg NIS approximately. Mr McClelland believes that the dropping varieties, such as the 'A' series, are not suitable for orchards which are wet in the winter/spring months. A variety which dropped its crop between April-June would be acceptable.

No leaf nor soil analysis have been done for the past four years. Mr McClelland has only minor damage caused by Green Vegetable Bug as he sprays Deltaphar 25 EC 3 or 4 times between late December and early March. Rats are a constant problem and a baiting programme is carried out.

Mr McClelland believes that the Co-operative was successful in several ways:

- ❖ By funding macadamia research through the Kerikeri HortResearch station;
- ❖ By processing members' crop and promoting and marketing the products.

He suggests that because there was not enough capital (he thinks that a figure of \$200,000 - \$300,000 was needed to continue processing at full capacity). There was a steady loss of members and the consequent loss of NIS to process. The directors were unable to raise the capital from the banks because the support by members was not guaranteed. (McClelland 2002).

4.20 Virginia Warren started with two macadamia trees in 1980 on her 3 ha property at Pukekohe. The land is sloping to the north and west and poplar and willows were planted for shelter. By 2000 most of the shelter trees had been cut down.

More trees were planted and by 2000 there were 450, most of which were Beaumont (60%) and GT1, Renown and other pollinators making up the rest. At the beginning Virginia planted the trees in a 6m x 3m spacing but this proved to be crowded and later plantings were 7m x 5m.

The site is not a warm one and current production is between 3 – 4 tonnes NIS. Leaf analysis is carried out each year and the fertiliser programme applied was based on the information received from the analysis. Soil testing is done less often. Picking is done by hand and dehusking is done on the same day. The nuts are placed in a dehumidifier until they reach 6% moisture. Chocolate coating was done by outside contractors and Virginia did her own selling.

GVB was a problem in the early days but spraying with Deltaphar 25 EC at the appropriate times between late December and early May had reduced the problem and rats were controlled quite well with regular poison baiting.

Recently Virginia has relinquished her roles as President then Secretary of the Macadamia Society. She has joined a joint venture with a processing and marketing firm and is pursuing a wider commercial role (Warren 2002).

4.21 Mr James Lin purchased some flat pasture at Waiuku south west of Auckland in 1984. He planted 650 macadamias on six acres leaving some room for possible expansion in the future. The varieties he chose were A4, PA39 and GT1. PA39 was planted on 6m x 4m spacing and the other two varieties at 7m x 5m. In 2002 he had a total yield of 4 tonnes NIS.

James has his own beehives. His testing of leaves and soil is somewhat irregular and, at the time of the visit (27/10/02), he believed that an application of fertiliser was needed. 4 tonnes NIS from 650 trees, aged 8, was a disappointed yield and he thought better tree nutrition was required.

All three of the varieties drop their crop and harvesting is done, by hand, from May to August. The picking up is done almost daily and wet winter weather has not caused problems of nuts splitting or sprouting on the ground.

He built a modern processing factory near his house. The processing machinery is a mixture of local and Australian manufacture and Mr Lin notes that his cracker gives approximately 70% wholes, 20% halves and 10% pieces. He buys NIS from other growers and in 2002 he processed 20 tonnes NIS.

James has designed his own packaging and products are sold in New Zealand. Chocolate coating is done outside on contract, and roasting and salting is done in his own factory (Lin 2002).

4.22 Christine and Bill Charteris have 10 ha. at Oakura near New Plymouth. The property is on the northern hill slopes of Mt Taranaki and originally was part of a dairy farm. For some years the farm had been a successful kiwifruit orchard and in about 1980 Christine and Bill became interested in macadamias after talking to Dick Endt and Don Boyes-Barnes. They joined the Co-operative and planted Beaumont, with Cate as

shelter for the kiwifruit. Although they experimented with more varieties such as GT1 and GT2, most of the macadamias were neglected, as the kiwifruit was the priority.

Just when a high quality kiwifruit export crop was almost ready for harvest in 1988 cyclone Bola savaged the orchard wiping out the kiwifruit and most of the macadamia shelter. As the new vines began to produce excellent fruit the price of kiwis slumped and another severe storm caused further damage. The couple decided to visit Australia to learn something about the macadamia industry there and returned to their property and removed the wires and kiwifruit frames in 1992.

That year Christine and Bill commenced planting at a spacing of 6m x 4m with grafted Beaumont, Renown and Nutty Glen. Further varieties were planted including A4, 205, 207, A38 and A29 plus PA39 and GT1. Those trees, or varieties, which did not perform well enough to be commercial, or had nuts of poor quality, were cut out. By 2002 there were approximately 3200 trees of varying ages.

Mr and Mrs Charteris made trips to Australia, South Africa and Hawaii and through Northland, the Auckland region and the Bay of Plenty to gain knowledge and to learn about all aspects of the macadamia industry.

They have built a very large processing building (opened in 2001) which will conform to the highest health and quality international standards. A large range of processing machinery was imported from South Africa but, as the 2002 yield was only approximately 400kg, this was not large enough to fully test the processing functions and methods. There are no plans to buy crop from other growers unless the growers agreed to meet the highest quality standards and methods and have the varieties Christine and Bill require. All varieties will be kept separate for cracking and sorting, as they believe that each variety has different qualities and taste. Thus, for example, Beaumont should not be roasted with Renown as the Beaumont contains more sugar and burns more easily.

Added value products being made on site include kernel in natural form, roasted kernel, salted kernel, dark and milk chocolate, nut spread in tubes and soaps containing nuts made in a factory in Opunake (Plates 15-17) (Charteris 2002).



Plate 15: Processing Plant at Oakura - Dehusker and Conveyor Belt



Plate 16: Processing Plant at Oakura – Coming from the Cracker



Plate 17: The Finished Products

(Photos: B. and C. Charteris)

4.23 John and Lorena Oldham purchased an existing orchard at Patetonga, Highway 27, Hauraki Plains. The former owner was Murray Kessel who owned a mixed-nut outlet at Gordonton near Hamilton. Mr Kessel processed macadamias, walnuts and chestnuts and his orchard at Patetonga included 1600 macadamia trees.

Mr and Mrs Oldham had recently come from dairy farming and were looking for a change of lifestyle when they moved on to the sloping property in 2000. The original varieties planted were Beaumont, GT1 and Renown and three different 'A' series had been planted in 1999 - 2001. Records from the orchard showed that yields averaged approximately 8 tonne per year, but when the Oldhams took over the crop was only 3 tonne per year. Tree management practices had been run down and new owners began a fertiliser programme and sprayed for Green Vegetable Bug as there was a high percentage of damage to the 2000 crop. In addition they pruned the Beaumonts heavily and the yield in 2001 and 2002 rose to 7 tonnes and 7.5 tonnes respectively. They have commenced a plan of action to record the soil and leaf analysis every two years and to act on the results.

In addition they have built a processing plant and shop to sell their products to passers by. They have an Australian made cracker with the rest of the machinery locally made. They produce dry roasted and salted kernel and chocolate coating was contracted outside. Products are in foil bags and/or glass jars and sold to Hamilton outlets.

In the two and a half years of ownership Bill and Lorena have turned the business around to become profitable. They believe that growers should cut out any trees which have a low yield below 10 kg NIS. In addition they hope that the New Zealand macadamia industry will become unified to set national standards of quality of product and health and safety. Coming from a highly united dairying industry they feel that if the fragmented, "doing own thing" structure which exists at the moment continues, low quantity and quality standard will result.

Mr and Mrs Oldham sold the orchard in late 2003 (Oldham 2002).

4.24 Mr Ernie Beer has returned to Tauranga and left his property in the Athenree Gorge to his son to operate. Returning to New Zealand after working in Queensland for some years, Mr Beer thought that growing macadamias was a good idea and he bought 14.2 ha. This included 2.2 ha. of frost free land, sloping and facing north-east. He contoured the property for easier tractor and orchard work.

The first trees were planted in 1980 and by 1982 there were 800 trees planted, all Beaumont. Over the next 6 years 100 Own Choice were planted and the remainder were a mixture of GT1, Nelmac 1 and Renown. Spacing was 6 x 3m. Ernie sought advice from many people and bought his trees from Dick Endt, Ian Gordon, Boyes-Barnes and Jim Pringle. By 1995 he had enlarged his orchard to 1000 trees which yielded approximately 6 tonnes NIS. After heavy pruning the crop was only 1.5 tonnes NIS in 1996. From then on the yields recovered markedly.

He was an early member of the Co-operative and enjoyed trucking his crop to Whangarei and meeting other growers and members. He found that Beaumont had the heaviest crop per tree followed by GT1.

He bought an Australian made double-bed de-husker and his drying down of crop to 10% moisture, which was the figure acceptable to the Co-operative, was done in two ways. He had a rat proof cupboard in which he placed approximately 1 tonne on five single bed wire wove shelves. There was a large fan blowing from the bottom and this took approximately four weeks to take the nuts down to 10%. The main storage was a second hand grain hopper which had a 2 tonnes capacity. An air duct holding a fan blew from the bottom and this took about four – five weeks to dry down.

Ernie Beer took tree nutrition very seriously. He had soil and leaf analyses taken regularly and had a fertiliser programme including:

- ❖ cow shed effluent when available locally;
- ❖ sheep and chicken manure; and
- ❖ used foliar spray to raise deficiencies of calcium, magnesium and boron (Beer 2002).

4.25 Debbie and Phil Ward purchased the Whanarua Bay property in the eastern Bay of Plenty in 1996. There were approximately 400 trees planted on a 6 x 4m spacing. There were 80 'A' series trees which were eight years old. These trees were planted on a quite steep slope beside the main orchard in poor soil and generally were not producing well compared to the original trees. Beaumont was the main variety and these were averaging over 25kg NIS per tree. The pollinators include Nelmac 1, Renown and GT1. In 2000 and 2001 the yield was approximately 10 tonnes NIS and in addition the Wards purchased crop from other growers for processing in their unit.

The results from this quite small, 2 ha. orchard, are much better than most other New Zealand macadamia properties. The site has several advantages. Facing north and with bush covered hills sheltering the orchard from cold from the south, west and east the site was virtually frost-free throughout the year. Mr Simcock, the original owner, believes that a warm ocean current sweeps down from the Great Barrier Island to Whanarua Bay and this raises the air temperature by 2°C. The site is gently sloping and the soil, especially after 25 years of care and attention, is fertile. Rainfall is evenly spaced through the year.

Debbie and Phil carry out all processing and added value activities. NIS is dried down to 10% moisture on open racks in a shed. Another shed has fan heated racks for the final drying to 1.5% moisture. There is an orchard shop to cater for passing tourist trade and visitors have a choice of natural kernel or salted, roasted, chocolate coated, honey-roasted kernel and specialities such as macadamia fudge. Half the sales are made from home and half are marketed within New Zealand through an agent.

The Wards have worked on Beaumont trees, by shaping them to a central leader and this has allowed more light and easier access to flowers to improve pollination. The trees are topped to about 3m in height making picking easier (Ward 2002).

4.26 Vanessa Hayes has two macadamia blocks, a 2.3ha trial block, nursery and quarantine facility at sea level and 7.5ha on an exposed site on top of surrounding hills at Torere. There are 800 trees of several different varieties in the trial block and in the

higher block there are less than 300 mature trees and the rest of the area is planted in corn until new shelter is grown.

The future plan is to have over 4,000 trees in the top block and an anticipated annual sale of 15,000 trees from the nursery. In addition research and development will take place in the trial block area. Rootstock for the new grafted varieties will probably be from Own Choice and Beaumont seedlings if present indications are correct.

The top block is very exposed and the yield is small but Vanessa sends the nuts-in-husk to Gisborne. She employs an engineer in Gisborne who has developed a de-husker and is working on a cracker. The NIS is dried in Gisborne, cracked and marketed with other kernel from a Maori block to local outlets (Hayes 2002).

Vanessa will feature in more detail in the chapter dealing with the future of the industry in New Zealand.

4.27 Orchard Management and Problem Areas

Historical attitudes defined the ways the New Zealand macadamia industry would develop. Nurseries led the growth in tree planting and the yield results often indicated that too many trees were planted in poor sites, too close in and between rows and few, or no, compatible pollinators planted. Growers were encouraged by some nurserymen to plant macadamias as they required little maintenance or pruning, they produced a crop of high value on world markets and the crop could be kept for up to a year in good conditions. This advice was basically correct compared with the labour intensive demands required for horticultural crops but ignored the need for sound orchard practice, when to apply the correct fertilisers and sprays and the control of pests.

A first step in improving crop yields concerns the enhancing of heat and light levels in the orchard. As the macadamia is a native of a semi-tropical climate success in producing commercial quantities of high quality nuts in New Zealand requires a site with a warm micro climate. Young macadamia trees are prone to light frost and wind-chill damage for

the first three or four years and severe frost may kill older trees. In addition, it is common in New Zealand for mature trees to have a poor nut set. This is partly due to low temperatures and light levels during the winter months leaving our macadamia trees with insufficient carbohydrate reserves for the spring growth spurt (Kerr 2000).

The angle of light in Northland is less than in Queensland or Hawaii as the sun is lower in the sky. As a result less light is striking every square metre of the orchard. To make up for the deficiency the need is for wider spacing between the trees and/or shorter and more open trees. Higher light and heat levels would encourage greater yields.

Permanent shelter belts should be limited to cover the south-east south-west boundaries and should not be planted so close to the plantation trees that orchard tree performance is affected. Shelter should not contain dense material, such as bamboo, which would provide cover for nesting rats. Perhaps the best shelter could be provided by cheap macadamia seedlings or damaged trees from a local nursery.

Although macadamias grow well in a range of different soil types the orchard site should provide good drainage. Heavy clay which does not allow the free run off of water may lead to appearance of the root disease *Phytophthora cactorum*. The selection of the orchard site is a major influence on the capacity to produce a commercial yield. (Appendix 4; Tim Trochoulis 2004.)

Many of the New Zealand macadamia orchards were planted as lifestyle blocks to supplement retirement income. Owners did not always carry out important orchard operations either because they did not have the time or inclination or because they were ignorant about what was needed. It was not unusual for some owners to live and work in the city and visit their orchard blocks at infrequent intervals. While it is true that

macadamia trees are comparatively easy care there are certain management duties which should be carried out at the correct times during the year. Often the small grower, with less than 500 trees, did not have a background in horticulture and lacked an understanding of tree growth patterns and the nutritional needs of their trees.

Macadamia orchards in New Zealand occupy a wide diversity of site, and, owners who want a satisfactory crop should take leaf and soil samples annually in the autumn. The samples should be sent to a licensed laboratory for analysis and subsequent recommendations for the next year's fertiliser programme. There are no accepted nutrient recommendation for macadamias grown in New Zealand. Therefore many growers use the Australian standards as a guide for New Zealand trees. In general New Zealand trees require higher levels of the nutrients nitrogen, iron, boron and zinc and toxic levels of copper and manganese than recommended in the Australian standard because of the different origin of local soils. (Tables 20 & 21 Richardson & Dawson 1993 c). Because of the variations which exist between regions, orchard and varieties no one programme is recommended. For any worries over tree nutrient problems, growers can consult with specialists at such facilities at the Crown Research Institutes or a laboratory such as the Hill Laboratories in Hamilton which has made up a macadamia nutrition chart for New Zealand conditions (Hill, 1998).

Table 20: Spring leaf nutrient levels in macadamia trees growing on four orchards in the Bay of Islands, and optimum levels suggested for trees growing in Queensland, Australia.

Nutrient	Queensland Optimum Levels+	Beaumont Levels* 1990-1992		Keauhou* 1992	
		Mean	Range	Mean	Range
Nitrogen (%)	1.4-1.5	1.2	0.9-1.5	1.3	1.2-1.4
Phosphorus (%)	0.08-0.10	0.07	0.03-0.09	0.07	0.05-0.09
Potassium (%)	0.6-0.7	0.5	0.2-0.7	0.4	0.4-0.5
Calcium (%)	0.6-0.9	1.0	0.8-1.3	0.8	0.7-0.9
Magnesium (%)	0.1	0.08	0.6-0.1	0.05	0.04-0.05
Sulphur (%)	0.18	0.31	0.14-0.29	0.14	0.12-0.15
Iron (mg/kg)	107	85	27-230	66	47-94
Copper (mg/kg)	4.5	29	3-208	6	4-11
Manganese (mg/kg)	100	1057	253-2209	529	442-681
Zinc (mg/kg)	15	13	4-143	7	6-9
Boron (mg/kg)	40-75	38	23-68	28	23-33

(Richardson & Dawson 1993 (c))

+ Derived from the Hawaiian cultivars "Keauhou" and "Kakea"

* Levels were averaged from September to November

Table 21: Preliminary recommendations for nutrient levels of macadamia leaves sampled in autumn in New Zealand

Nutrient	Recommended Levels
Nitrogen (%)	1.25 – 1.40
Phosphorus (%)	0.10
Potassium (%)	0.60 – 0.70
Calcium (%)	0.80 – 0.90
Magnesium (%)	0.90
Sulphur (%)	0.20
Iron (mg/kg)	70 – 80
Copper (mg/kg)	5 – 15
Manganese (mg/kg)	<500
Zinc (mg/kg)	10 – 15
Boron (mg/kg)	30 - 50

(Richardson & Dawson 1993 c)

Damage to crops caused by pests in New Zealand orchards is not as severe as in countries such as Hawaii, Australia or South Africa. However, without careful and regular inspection there is the potential for serious loss in quality and quantity in the nut harvest. Included in the pest category are insects, rats and plant disease.

4.28 Insect Pests

Two insect pests in New Zealand may cause serious damage to macadamia crops. They are the Green Vegetable Bug and the Guava Moth.

4.29 Green Vegetable Bug *Nezara viridula*

Growers attending the field days, held by the emerging New Zealand Macadamia Growers Co-operative in the early 1980's, urged the Co-op to organise research to develop a control programme for the Green Vegetable Bug, (GVB) *Nezara viridula*. The GVB pierces the husk and hard shell of the nut and introduces a fluid in to the kernel. It is not until processing that the impairment is found and the kernel is unsaleable. If damage caused by the GVB to more than 10% of the crop, in a season, then harvesting and

processing the crop would be uneconomic. In some orchards, especially organic orchards, damage from insects could affect over 50% of the nuts making them unusable.

A two year research project, designed to develop a sustainable GVB management system on macadamias was commenced in 2001 by HortResearch for the Macadamia Society assisted by an AGMARDT grant (Jamieson et al 2003a).

For this research project nut bunches were tagged at three sites:

Swanson (PA39 and Beaumont)

Waiuku (PA39 and Beaumont)

Kerikeri (Beaumont)

Trees were assessed every two weeks for signs of GVB or other pests. Leaf roller caterpillars were found to cause significant damage by making nuts fall off when the leaf rollers were making their webbing shelters. No GVB were found at Waiuku, 5 at Swanson (late February – mid April) and 11 at Kerikeri (late December – March). Only adult GVB's were seen on weeds growing under the trees. It appeared that GVB's had an irregular distribution within orchards and individual trees and Beaumont were more affected when compared to the PA39 trees.

In the first year of the study the researchers determined the spread of GVB within the tree canopy. Using the Kerikeri HortResearch orchard they picked a number of nuts at three different height zones (0-2m, 2-4 >4m.) and when the nuts were dried and cracked it was found that most damage was caused in the top and lower areas. (Table 22)

Table 22: Percentage of harvested nuts with GVB damage from different height zones on macadamia trees in Kerikeri 2001.

Height Zones	No. Nuts Assessed	Percentage Nuts with GVB Damage
0.2m	576	6.08 a
2-4m	600	0.67 b
> 4m	409	4.89 a

(Jamieson et al 2003 a)

In the second year eleven blocks were monitored for GVB by either HortResearch staff or growers.

Two sites each in Kerikeri and Auckland were monitored fortnightly for a low action threshold, of one GVB per sampling occasion. If GVB was found monitoring was carried out weekly. Blocks 1 – 4 had threshold monitoring and very few GVB were found.

In five of the blocks (5, 6, 7, 9 and 11) the average % infestation of nuts with GVB damage at harvest ranged from 0.3% to 3.3%. Only block No8, received damage greater than the uneconomic range of 10%. (Table 23).

It seems that only adults feed on the nuts and they moved on to the new bunches in December in Kerikeri and later (January) for Auckland and the Bay of Plenty. When one GVB is found in an orchard monitoring should begin on a weekly basis. Growers should monitor at least ten nut bunches on 15 trees and in the first two metres of the tree height. There is a relationship between the number of GVB found in a season and the level of damage in nuts. For example if one GVB is found in a block there is an estimated 5% of nuts damaged and if two GVB are found, then just 8% may be damaged.

Table 23: The number of GVBs found in each block during the season and average % of nuts with GVB damage.

Block No.	Location	Threshold	No. of Sampling Occasions	Total No. GVB Found	Average % of Nuts with GVB Damage at Harvest
1	Kerikeri	None	14	1	2.67±1.43
2	Kerikeri	1 GVB	14	0	1.71±0.83
3	Auckland	None	22	2	1.14±0.54
4	Auckland	1 GVB	22	0	0.38±0.26
5	Kerikeri	-	16	0	1.0±0.7
6	Kerikeri	-	12	0	0.3±0.3
7	Kerikeri	-	13	0	2.7±1.0
8	Auckland	-	17	163	27.3±8.5
9	Auckland	-	12	0	3.3±1.4
10	Bay of Plenty	-	24	26	7.7±2.3
11	Bay of Plenty	-	16	1	2.0±0.6

(Jamieson et al 2003 a)

Some conventional macadamia growers have found that the spray, Deltaphar 25 E.C., used three or four times at intervals of three weeks, was effective in controlling the pest. Organic growers found that the introduction of the *Scienoid* wasp (egg parasite) has been partially successful as a means of reducing GVB infestation.

4.30 Guava Moth

Perhaps the most serious insect pest to arrive in New Zealand which may decimate macadamia drops is the Guava Moth, or Fruit Driller Caterpillar. *Coscinoptycha improbana* Meyrick. It was first found in New Zealand in Kaitia in May 1997 on feijoa fruits (Jamieson, et al 2003 b).

This moth originates from Australia where it is found from Queensland to Tasmania. It is regarded there as an unimportant common garden pest and naturally occurring pathogens, predators or parasites keep it under control naturally. Because of its non-pest status in Australia, very little research has been carried out there.

The moth, in New Zealand has the potential to become a major pest on subtropical crops and common soft-fleshed fruit including plums, fejoas, loquat, macadamias, citrus, nashis and peaches. There is a possible danger to kiwifruit and avocado crops, which grow in the same climatic regions as the other subtropicals fruits.

In 2001 MAF decided not to initiate any official control action. However increasing concerns by commercial fruit growers and the general public, in 2003, led HortResearch to commence an integrated Pest Management programme. This first step of the project was to develop an easy reference taxonomic key to enable the identification of the guava moth larvae (Jamieson, et al 2003b).

Moths were found to lay their eggs at different sites on different fruit. On macadamias, for example, eggs were laid in crevices on the nut surface and also around the stem end of

the nuts. Moths laid their eggs at the style end of fruit in loquats and yellow guavas and at the stem end of oranges.

Guava moths emerged from pupae collected in debris, leaf litter and loose soil from under moth-infested macadamia trees showing that the larvae leave the fruit to pupate. They pupate for approximately 14 days at 21°C before emerging as adults. Growers in guava moth affected areas were advised to remove and destroy fallen fruit/nuts and associated debris every 2 weeks to minimise adult emergence.

A pheromone that attracted guava moth adults was identified in 1999 and has been available commercially since 2002. Using pheromone traps, Bio Security officers from the Northland Regional Council, Auckland Regional Council, Environment Waikato and Environment Bay of Plenty took part in a survey to find the extent of the spread of moth in the north. Male guava moths were trapped in Northland only with Whangarei being the southern boundary of the infestation. Guava moth larvae were found in orchards during all months of the year as indicated (Table 24).

Table 24: Guava moth larvae found in pheromone traps in Northland in 2002

Macadamias	January-November
Plums	January-March
Feijoas	March-June
Peaches	March-April
Satsuma Mandarins	May-August
Loquats	September-December
Encore Mandarins	October-November

(Jamieson et al 2003b)

In feijoa orchards adult flights peaked often corresponding with rainfall peaks, indicating that rainfall may stimulate adult emergence from pupae on the ground.

Research is ongoing and it is too soon to make firm judgements on methods to control the spread of the moth progress or means to reduce the effects on existing fruit damage (Appendix 5; Ferguson & Ferguson 2005).

4.31 Rat Control

There is no New Zealand research regarding the extent of the damage caused by rats on producing macadamia orchards. In Australia Kerr (1996) showed that rat damage caused 20–30% loss of production on some older macadamia plantations and damage of 10–12 % loss on others was noted. It is likely that similar losses occur in New Zealand macadamia orchards.

Commensal rodents are those that exist in and around man-made structures including macadamia orchards. The three most common rodents include the Brown or Norway rat, the Black or Roof rat and the House mouse. The Brown rat (*Rattus Norvegicus*) is a natural burrower and lives underground near its food and water supply. The Black rat (*Rattus rattus*) is an excellent climber and will nest in higher places, rather than burrowing and therefore it requires a warmer climate than the Brown rat.

Rodents are nearly blind, using their sense of touch for guidance. They have sensory pads on their feet which are very sensitive, therefore metal bait stations should be avoided. Rats would refrain from using metal stations as the metal floor would be unattractive to their sensitive feet. In addition, they exhibit kinaesthetic sense in which they memorise their environment, much like a blind person. Rodents use their sense of smell to find food and as they are creatures of habit they will travel the same paths repeatedly.

There are two basic methods to control the rat infestations in macadamia orchards, traps and poison. The use of traps is not recommended as they catch and maim household pets such as cats and dogs and protected species such as kiwi. In addition rats will detect any metal or other strange object in the environment and they also become aware of a trapped creature and so avoid the hazard in the future.

Poison baits have two fundamental methods of killing. Acute baits act quickly and the rat becomes ill shortly after eating the bait. If the rat does not consume a lethal dose in the first eating then it is unlikely that it will eat the bait again and hence not die. No matter

how palatable an acute bait is there will likely be some rats that will not die after ingesting the poison. ZP Rodent Bait from Bell Laboratories is an example of an acute bait.

The other form of poison baits are the anti coagulants which act by inhibiting blood clotting through Vitamin K antagonism causing fatal bleeding. Although the anticoagulants begin working quickly they remain in the body for several days before mortality occurs.

Any bait that is not palatable or simply does not taste too good, will not be effective in controlling the rats.

There are a wide variety of commercial bait stations on the market. Some are made to be mounted on trees off the ground and may be used for any form of bait, including liquid. The best ones are water – proof, easily serviced for replacing old bait, not accessible to non-targeted animals and bait scraps cannot be kicked or shaken outside.

Some bait stations are constructed to be placed on the ground near a stream banks or known nesting sites or on rat runways. These should have the same safety features as the tree mounted stations.

Commercial bait is available in many forms including meal, pellets, seeds, liquids and gnawing blocks. If for some reason bait becomes unpalatable or rats show shyness or resistance to a type of bait then periodic rotation with other baits may be needed.

The first step in setting up an effective rat control programme is to thoroughly inspect the orchard including within and beneath trees, shelter belts, sheds or barns, ditches or streams for signs of rat infestation. If rats are seen in the orchard during the daylight hours it is likely that infestation is high. Any site that might harbour rodents should be removed including weeds or any other vegetation under trees, old birds nests in trees and dense shelter such as bamboo hedges.

A baiting schedule should be established and begun with a pre-bait programme lasting 3 – 4 nights using no poison but attractive baits such as chopped nuts, cheese or golden syrup or peanut butter in biscuit. This phase is important as it serves to assess the extent of the rat population, indicates the best sites to place the bait stations and allows rats to become used to the a new object in their environment.

The poison bait system should be used in the spring to kill winter survivors, the breeders for the next season. This baiting programme should last for at least 2 months. This poison baiting session should be repeated in January – February to keep numbers down and catch the young juveniles and new arrivals from neighbouring areas. A final clean up poison baiting effort should be undertaken in April – June. This is necessary to maintain the rat population as low as possible.

In a typical macadamia orchard in New Zealand it is suggested that bait stations may be placed on a 50m x 50m grid. If bait placements are being completely eaten and repeatedly replaced over a period of weeks then the programme is under – baited. This indicates that more bait stations are required on a 40m x 40m grid or it may indicate that the rats are resistant to the poison used and a more toxic anticoagulant should be tried (Pest Management Services 2003).

4.32 Research Initiatives – The Co-op

An important aim of the Co-op from inception was to fund macadamia research projects. This desire was an important feature for the Macadamia Co-op pioneers. Three important projects carried out by HortResearch, Kerikeri were the use of Ethephon Spray (to hasten nut fall), determine the causes and control of Basal Stain and to evaluate the effects of storage, both on and off trees on quality of mature nuts.

4.33 Ethephon Sprays.

The Macadamia Society survey of 2002 showed that over half of the macadamia trees growing on members' orchards were the Beaumont variety. Although this variety is not popular in Australia and Hawaii it is extensively grown in South Africa, California and

Israel. As Beaumont does not drop its crop the high cost of harvesting is a major disadvantage especially on plantations with over 5000 trees. In South Africa where some Beaumonts produce 35kg NIS per tree per year (NZMS Newsletter No 30 2002) cheap labour for picking is economical.

In an effort to reduce harvesting costs the Nut Growers Co-operative commissioned HortResearch, Kerikeri, to carry out a trial, using (2-chloroethy) phosphoric acid (ethephon) to enhance abscission of mature nuts (Richardson & Dawson 1993 b). Ethephon had been used in other countries to shorten the harvest periods of macadamias. For example, in Israel, a 500 mg/litre ethephon solution sprayed on to Beaumonts resulted in 95% abscission compared to 5% on untreated trees (Kadman & Ben Fal 1983). Using a weaker solution of ethephon, (200mg/litre) similar results of nut drop were achieved on the Keauhou and Kakea in Australia in 1986 (Gallagher & Stephenson 1986).

The New Zealand trials were conducted on 6-year-old trees at two different orchards in Kerikeri in 1988 and 1990. In the first trial the trees were treated with 200 or 400 mg/litre of ethephon two weeks after nut maturity. Different trees (now 8 years old) in the same block were selected in 1990 and treated at maturity (400 mg/litre), two weeks later (500 mg/litre), and another two weeks later (600 mg/litre) (Table 25).

Table 25: Abscission of Beaumont macadamia nuts following application of ethephon at different concentrations and times in 1988 and 1990.

1988		1990	
Rate (mg/litre)	Total Nut abscission %	Rate (mg/litre)	Total Nut abscission %
0	6	0	7
200	30	400	36
400	70	500	45
		600	56

(Richardson and Dawson 1993 b)

Note: The highest abscission of 70% was recorded from the 6 year old trees in 1988 with a 400 mg/litre solution of ethephon plus a surfactant (HCO3 + Agral LN)..

Findings - In 1988 nut abscission increased from 6% on untreated trees to a maximum of 70% on trees treated with a 400 mg/litre. However trees treated with ethephon at this concentration showed a large and significant reduction in yield in the following year.

In the 1990 trial, after three sprays of increasing strength and over a four week period, 56% of nut abscised compared to only 7% on untreated trees. However, the later spraying caused significant flower damage and crop losses in the following season.

As a result of these trials it was recommended that ethephon should not be used on macadamias in our relatively cool climate. The abscission rates achieved would reduce harvesting costs but this would not make up for the loss of value of the following year's yield (Richardson and Dawson 1993 b).

4.34 Basal Stain

Some macadamia cultivars grown in New Zealand are prone to a grey discoloration on the basal half of the kernel. This feature is called basal stain and is most noticeable on the kernel of Beaumont and Own Choice varieties.

Badly stained kernel can not be sold directly but may be processed and used in confectionery products. From the samples tested in the three years 1990, 1991 and 1992, 3 - 8%, 10% and 18% of kernels respectively were stained and rejected.

In 1990 the New Zealand Macadamia Co-operative engaged HortResearch to investigate the effect of orchard factors and drying methods on the incidence of basal stain of macadamia kernel (Richardson & Dawson May 1993 a).

Results of the study included:

- 1 Cool conditions in 1992 delayed the harvest and affected the quality of the nuts. Samples were collected every two weeks beginning on 6 July and ending 31 August. The percentage of kernel affected by basal stain increased as nuts became more mature. (13.6% on 6 July and 41.1% on 31 August). This indicates that if maturation was delayed by cool conditions or by delayed harvesting practices, then

the incidence of basal staining would increase (Table 26, Richardson & Dawson 1993 a).

Table 26: Quality characteristics of air dried macadamia kernels as a function of harvest date, 1992.

Harvest Date	Moisture Content (%)	Crackout (%)	No.1 Kernel (%)	Basal Stain (%)	Adherence (%)
06 July	28.2	35.2	76.2	13.6	5.7
21 July	27.9	36.2	81.9	22.8	11.1
03 August	27.3	36.9	83.3	20.3	13.5
18 August	27.4	36.9	86.8	33.9	12.4
31 August	27.4	37.0	87.1	41.1	12.0
SED	0.5	0.5	2.2	6.2	1.8

(Richardson and Dawson 1993 a)

- The incidence of basal stain appears to be affected by the position of the trees in the orchard and within a single tree between the outer and inner canopy. In this study, there was a significant relationship found between the extent of basal stain and tree spacing and highly shaded, central rows. Nuts from the outer rows, and in orchards with widely spaced trees allowing good air movement and light penetration were less affected than those from closely sheltered orchards. Shading and canopy density appear to be orchard factors which may increase the occurrence of basal stain in some cultivars (Table 27, Richardson & Dawson 1993a).

Table 27: The effect of row position on the quality of macadamia kernel.

Row	Moisture Content at Harvest (%)	Crackout (%)	No.1 Kernel (%)	Basal Stain (%)	Adherence (%)
Row 1 (South)	26.2	35.9	87.4	24.6	15.6
Row 3 (Centre)	27.1	37.3	80.1	48.2	15.7
Row 6 (Centre)	27.2	37.2	81.3	44.0	17.0
Row 12 (North)	28.8	35.1	78.5	10.6	14.7

(Richardson and Dawson 1993 a)

4.35 Macadamia Maturity Assessment and Determination of the Effects of Storage, Both On and Off Trees after Maturity On Nut Quality.

It seems that nut quality depends on temperature and moisture levels during nut development and after harvest. On farm practices, at harvest, should require:

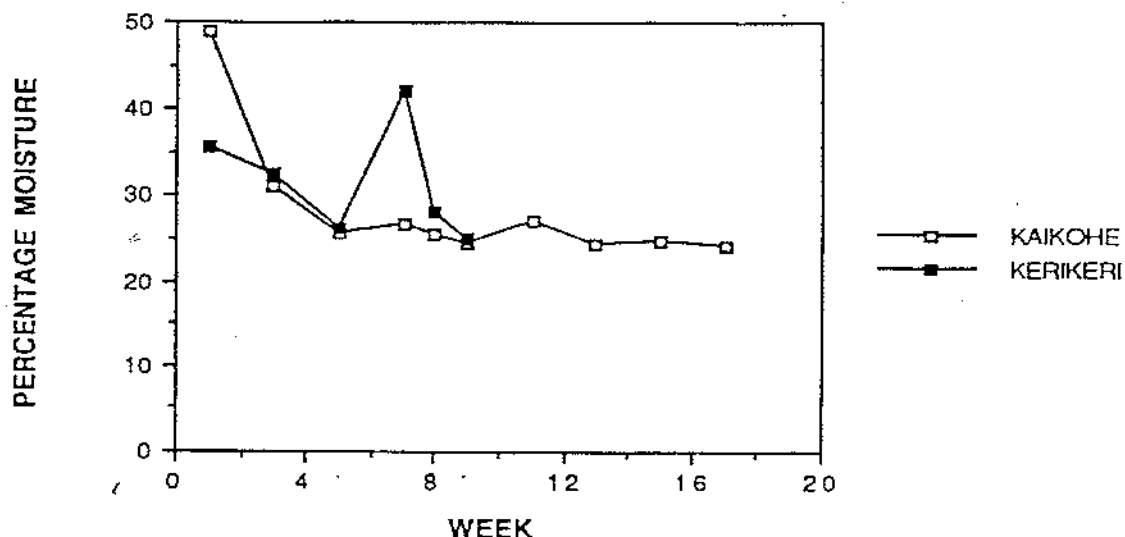
- (1) Dehusking within 24 hours to avoid excessive moisture and fungal growth on the kernel (Hobson 1976, Wilkinson 1983).
- (2) Kernel moisture content should be reduced to 1.5% soon after harvest but high temperatures should be avoided in the early stages (Liang et al 1984).
- (3) Quality is dependent on variety, nutrition, irrigation and maturity at harvest.

Trials on orchards in Kerikeri and Kaikohe in 1988 had the following objectives:

- ❖ To find the date of maturity in 1988 for Beaumont nuts in two sites.
- ❖ To find out how long harvested mature nuts may be kept drying on-farm before nut quality deteriorates.
- ❖ To find out what would happen to nut quality if harvest was delayed for some time after maturity (Richardson and Dawson 1988).

Trial to assess nut maturity a sample of 50 nuts were collected every two weeks from 6 May till end of June. Kernel moisture content, percentage crackout, percentage of number one kernel and kernel recovery was determined. Moisture content (25% as indicated) and percentage of number ones (contain more than 72% oil) were the best indicators of maturity. Nuts matured at different times at the two sites perhaps because of differing environmental conditions and the amount of rainfall accumulated between harvests had a major effect on nut maturity and quality. (Figures 6 - 9)

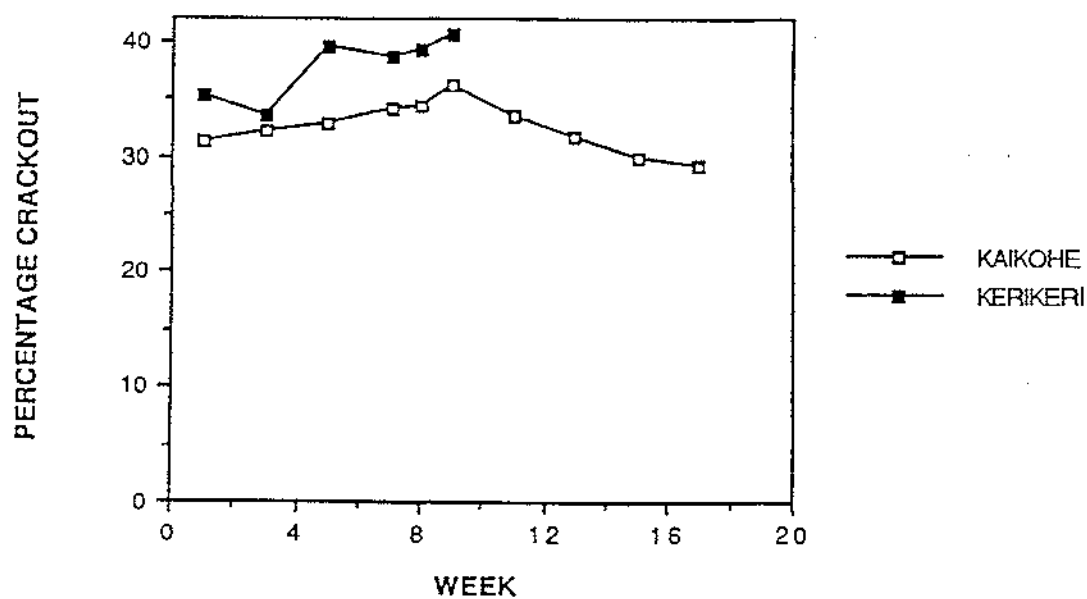
Figure 6: Moisture content of Beaumont macadamia kernels on trees at Kerikeri and Kaikohe in 1988 from 6 May until the end of June.



(Richardson and Dawson 1988)

Moisture Content Although the nuts collected at Kaikohe started with a high moisture content (approximately 50%) this figure dropped within 2 weeks to 30%. This dropped down to 25% in another three weeks and stayed at this figure. The nuts from Kerikeri started the trial at 35% and after a month were down to the lowest level (25%). Except a high reading of nuts collected at Kerekeri in week 6 (nearly 45% M.C) the level of 25% until the end of this trial.

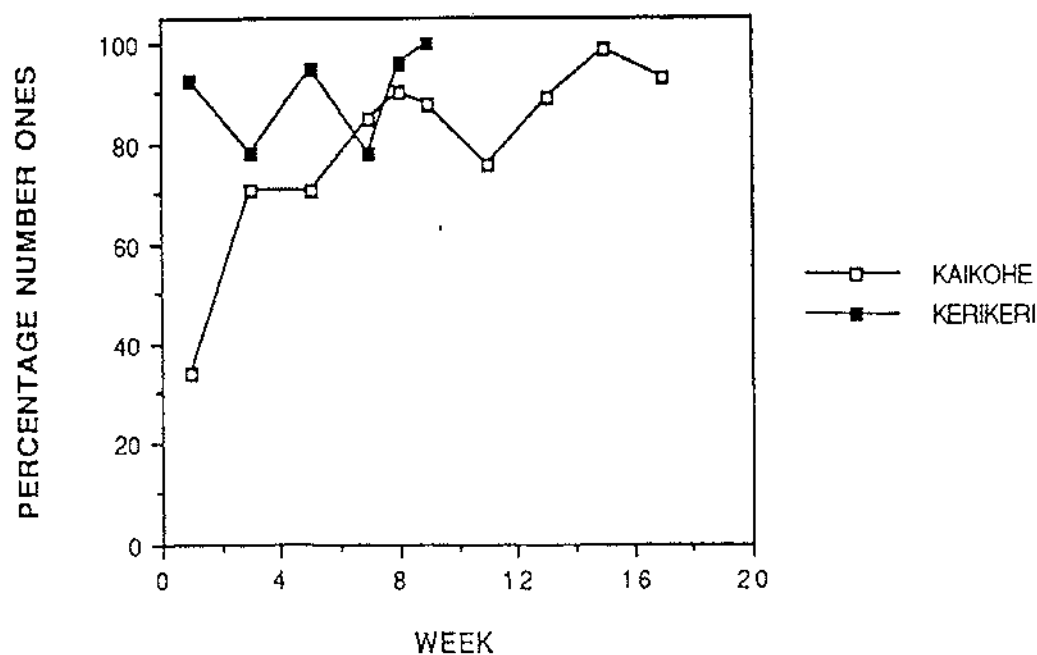
Figure 7: Crackout of Beaumont macadamia kernel on trees at Kerikeri and Kaikohe in 1988 from 6 May until the end of June.



(Richardson and Dawson 1988)

Crackout The crackout of the Kerikeri nuts started at a satisfactory 35% and rose to 40% by the end of the trial. The Kaikohe nuts started at a crackout of approximately 31% and reached 35% by the end of the trial. Tests were continued at Kaikohe for 8 more weeks and the crackout declined to just below 30%.

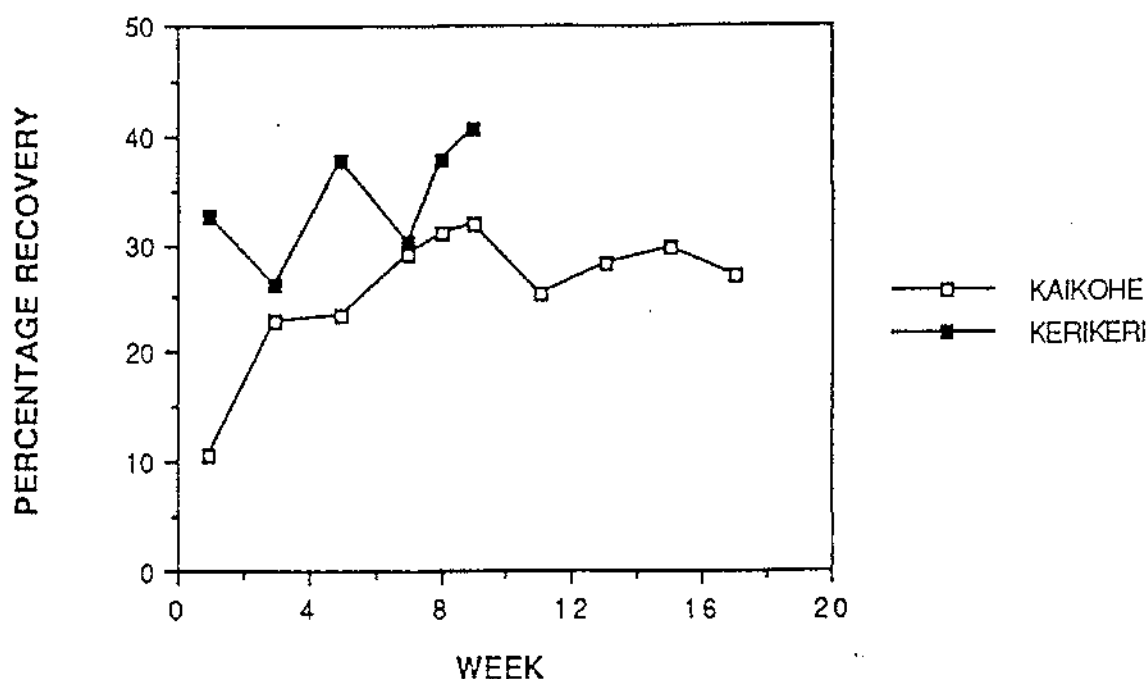
Figure 8: Number 1 kernel of Beaumont macadamia trees at Kerikeri and Kaikohe in 1988 from 6 May until the end of June.



(Richardson and Dawson 1988)

Number 1 Kernel. Kerikeri nuts varied between 30% No 1 kernel to 100% No 1 at the end of June. The Kaikohe nuts started at approximately 33% No 1 kernel and reached nearly 90% No 1 by the end of the trial. The trial continued for the Kaikohe nuts for 8 more weeks and the No 1 kernel reached 100%.

Figure 9: Percentage recovery of kernels of Beaumont macadamia trees at Kerikeri and Kaikohe in 1988 from 6 May until the end of June.

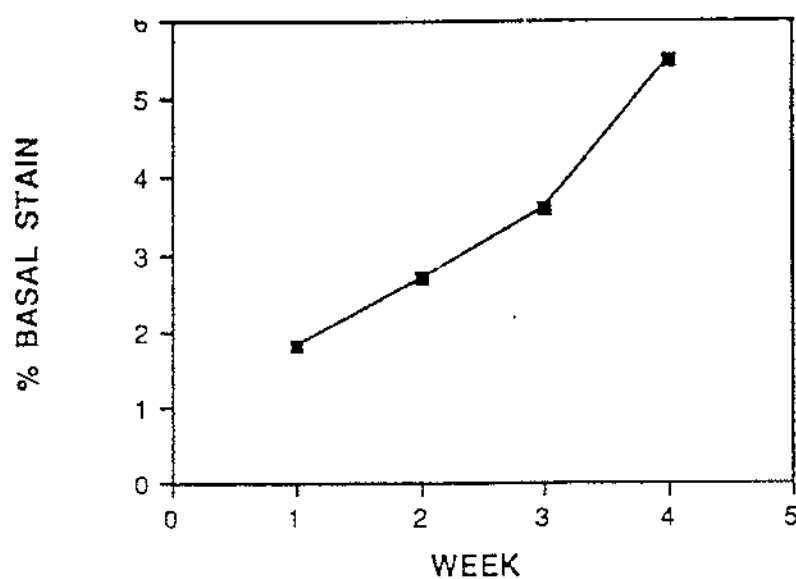


(Richardson and Dawson 1988)

Percentage Recovery. The nuts from Kerikeri had a low percentage recovery of 25% early in the trial but by the end of June this had risen to acceptable 40%. Nuts from Kaikohe started with a recovery of a low 10% but rose to just over 30%.

From these four trials it seems that the Kerikeri site was better and earlier for Beaumont macadamia production than the Kaikohe site. However, the Kaikohe site produced acceptable results for moisture content and No 1 kernel but took more time, perhaps until the end of July, to reach maturity.

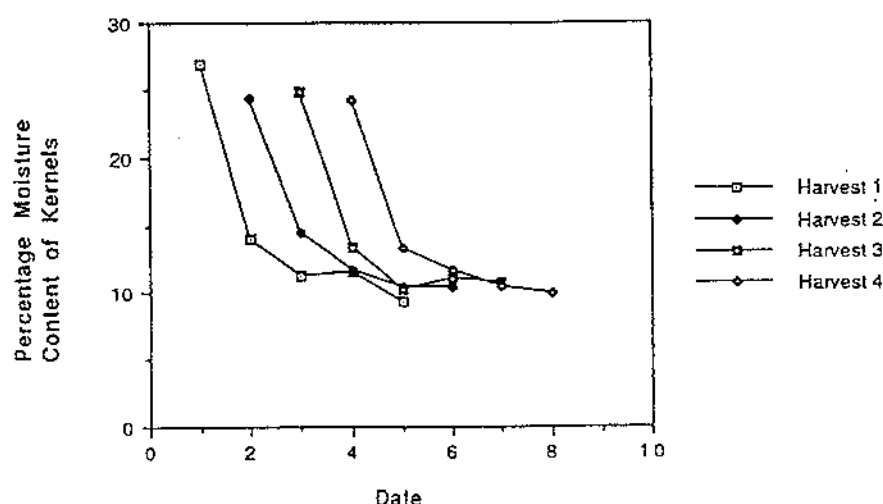
Figure 10: Changes in the incidence of basal stain Beaumont macadamia nuts left on the Kaikohe trees in July 1988.



(Richardson and Dawson 1988)

In the trial to evaluate the effect of harvest date on nut quality, nuts continued to be harvested at fortnightly intervals from the Kaikohe site during July. This was done to assess the effects of harvest date and storage on the quality of nuts after maturity at week 9 (end of June). Kernel defects were recorded and basal stain increased at a steady rate from the first harvest after maturity from less than 2% to over 5% in the month of July.

Figure 11: Postharvest moisture content of macadamia kernels harvested at different times during the season.



(Richardson and Dawson 1988)

The influence of postharvest storage on macadamia nut quality was also investigated. At harvest moisture content was about 25% regardless of harvest date; during 8 weeks of subsequent storage at ambient temperatures the moisture content decreased to about 10 – 11%.

4.36 Pollination and Nut Set

The Macadamia species has two varieties which produce edible nuts. The flowers of both varieties are protandrous (Vithanage et al 1986) with 100 – 500 tubular flowers borne on racemes between 6 – 12mm long (Rhodes 1986). The flowers are creamy – white (*M. integrifolia*) or pink (*M. tetraphylla*) and a mature tree may produce up to 15,000 racemes in a season (Rhodes 1986). (Plates 18 and 19 show flowers on a mature Beaumont tree and the cream flowers of A4.

Macadamia flowers are monoecious, containing both reproductive organs, and are largely self incompatible. (Heard 1993). The flowers demonstrate protandry as the male organs develop before the female to avoid self-fertilization. The species is acknowledged as a good example of a plant which selectively drops its self-pollinated ovules. (Corbet 1986).



Plate 18: Beaumont Blossom Racemes

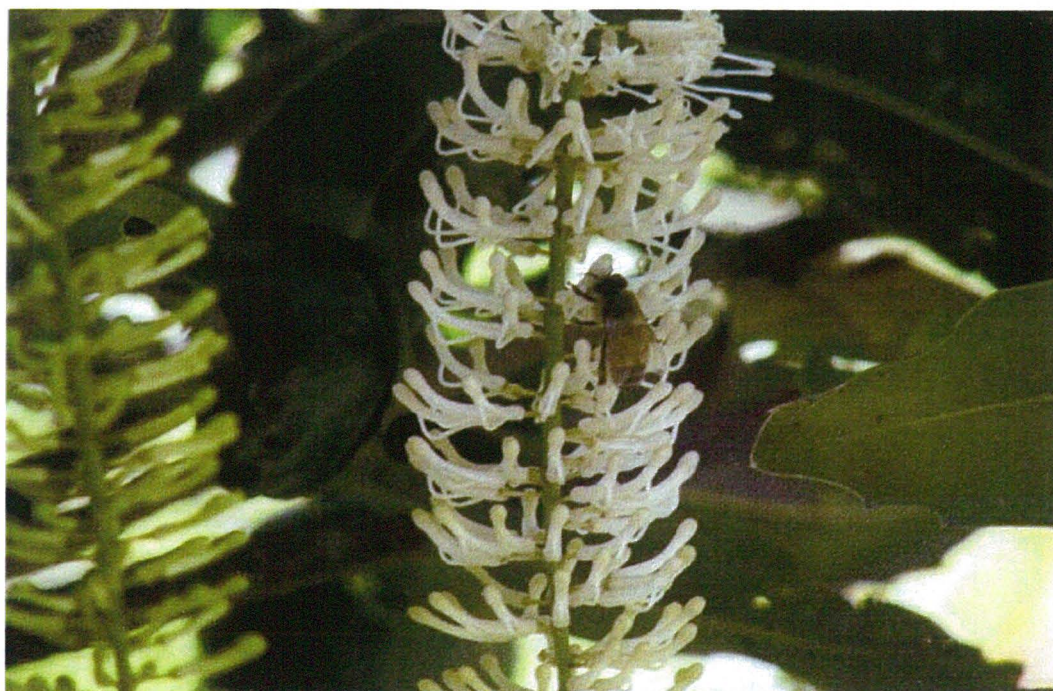


Plate 19: A4 Blossom Raceme

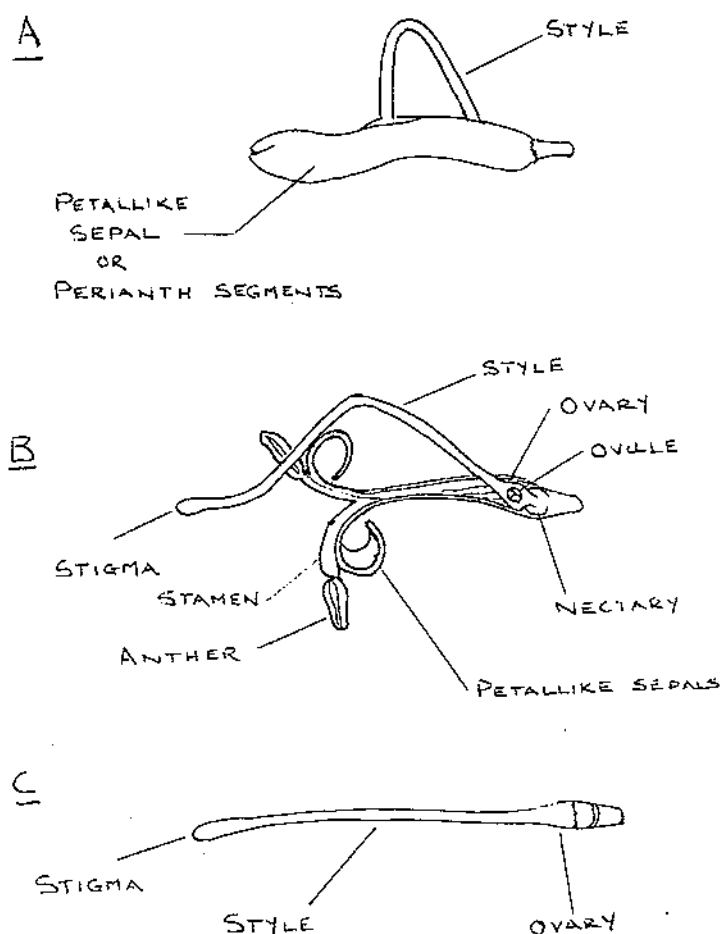
(Photos: B. Coleman)

The macadamia flower structure is complex (Figure 12) (News Bulletin 1986). The florets do not have petals. At the bud stage the end of the style is hidden within the petal-like sepal with the stigma and the anthers. Pollen is released from the anther at this stage. On opening the extending style pushes the anthers apart as it straightens and thrusts the pollen-covered knob forward. Then the anthers separate and curve back and most of the pollen is on the style end, although a little remains in the anthers (Stace 1986, Corbet 1986).

Figure 12: The Structure of the Macadamia Flower

Enlarged flower of Macadamia (*Macadamia integrifolia* x 20)

- A Complete flower with reflexed STYLE just before petal like SEPALS separate to release STAMENS.
- B Longitudinal section of the open flower.
- C STYLE straightened after pollination has occurred.



(News Bulletin, Aug 1986, p.7)

An effective pollinator agent must contact the remote tip of the style, in a young flower, to pick up pollen and again in an older flower in which the stigma is receptive (McGregor 1976) and deposit it (Corbet 1986). Another factor which may be important to the successful pollination process is the amount of pollen carried by the bees and the frequency of the visits (Vithanage et al 1986).

In the orchard, in normal conditions, the amount of pollen carried by individual insects probably varies considerably. Other flowering crops around the macadamia orchard pose a competing attraction for pollinating insects. The pollination process does not commence for up to two days after flowering as the stigmas on the racemes are not receptive until then. By this time much of the pollen may have been removed by insects and fresh pollen may be needed (Heard 1993).

The accepted agent used to accomplish insect pollination is the honey bee (*Apis mellifera*). In Australia the native *Trigona* bees were found to be slightly more efficient pollinators than the honey bees (Heard 1993) and moths, although they probably visited the flowers at night, did not transfer pollen onto stigmas (Heard 1993 Vithanage et al 1986).

Macadamia flowers are open for about seven days and the stigmas are not receptive for the first one to two days. The flowers remain attractive to insects for approximately three days (Heard 1993). In Australia, in an experiment on pollinator requirements, it was found that approximately fifty bee visits per day were made to racemes and it was concluded that 150 visits per raceme were required to effect adequate pollination (Heard 1993).

After watching foraging bee patterns it was assumed that nectar flow finished by 10am (Stace 1986). By 7.30am hives were busy and bees were foraging for nectar and would stay on a raceme for up to two minutes. At about 10am the bee noise changed to a higher pitch and the bee time on a raceme decreased so that by noon it was only for a few seconds. Heard (1993) found that six hours per day of exposure to bee visits was sufficient

to ensure maximum final nut set (FNS) and that ten hours per day was superfluous as many initial nut set (INS) fruit were aborted.

Although macadamia trees in New Zealand produce up to 250,000 flowers per tree each year, less than half of one percent of flowers produce edible nuts (Richardson and Dawson 1991). Flowers in the centre of the tree, where it is cool and damp, produce few nuts as the flowers are not attractive to pollinating insects. Many early orchards in New Zealand contained only one variety, usually Beaumont. In Australia and South Africa Beaumont has an open habit but in New Zealand the variety is dense and bushy. (Plate 21).

Attempts have been made in Australia to improve pollination to enhance FNS (Heard 1993). Both INS and FNS improved with increased bee visitation and a much improved FNS was achieved with visits for six hours per day compared with visits for three hours per day. Another Australian study found that INS after 14 days was always improved by cross-pollination. However this did not always result in an improved FNS as other factors were important (Trueman and Turnbull 1993).

Sedgley et al (1990) noted the following elements affected the final yield;

- ❖ The capacity of the tree to support the load of developing nuts. The greatest premature drop usually occurs within the first two months following anthesis.
- ❖ Environmental stress caused by climate factors, such as colder or wet, sometimes may be important.
- ❖ Losses caused by pests such as rats and insect damage from GVB and Guava Moth infestation may be severe.
- ❖ The initial selection of which cultivars to plant and the combination of the cultivars for cross-pollination could be very important.

Sedgley et al study (1990) found a reduction of nearly 50% between the successfully pollinated pistils at seven days and the INS at 21 days.

Rhodes (1986) found that the nut drop for the varieties 246 and 508 between INS and FNS was 88.2% and 52.4% respectively in the 1984–85 season. In New Zealand additional elements could be important to achieving improved nut yield. These could include:

- ❖ Adequate rainfall, correct soil nutrition, weed control under trees and around orchard boundaries, and sound orchard practices.
- ❖ The orchard site should be chosen with care. Research in Australia (Rhodes 1986) shows that a minimum temperature during the flowering period is very important with 18°C considered to be ideal for maximum production. Temperatures lower than the 18°C would produce progressively lower yields. No areas in New Zealand achieve this temperature consistently during the flowering period. Depending on the site of New Zealand macadamia orchards most cultivars flower between June – October. The following climate figures were obtained from NIWA (2004).

12.7°C – 14.5°C mean temperatures (Kaitiaia),
 11.6°C – 14.1°C mean temperatures (Auckland), and
 10.4°C – 13.6°C mean temperatures (Tauranga)

Some well chosen sites with warm microclimates would achieve better results without reaching the ideal. In addition, Auckland and Northland usually have a wet winter from July until September/October. The combination of cooler temperatures and wet and cloudy days makes conditions unfavourable for maximum bee activity in the mornings when the insects are most effective. This contrasts with the Queensland climate of warmer winter temperatures and a dry winter period.

In New Zealand most macadamia trees are *M. tetraphylla* and hybrids and flower August – October. In Australia most trees are *M. integrifolia* and flower several times a year especially in spring and autumn with two main crops from March – May and September – October (Trochoulias 1989). Further research in New Zealand to find varieties which would flower in March – April would be worthwhile as the mean

temperatures for these months are 18.6°C – 16.9°C (Kaitaia) 18.5°C – 16.2°C (Auckland) and 17.9°C – 15.4°C (Tauranga). (NIWA 2004)

There is little published research in New Zealand, about the best pollinators to use to achieve maximum nut set of main crop macadamia trees in the orchard. Few growers understood the pollination process and most nurseries suggested that any of the common varieties would suffice. Consequently a range of varieties were planted, with little or no informed research base, and often with disappointing yields resulting.

In Australia there have been several trials to identify the best combinations of varieties which would improve yields in different situations. At an orchard within New South Wales in 1991 it was found that the variety 660 produced more final nuts when cross-pollinated with the varieties 333 and 246. In the same experiment 660 had fewer final nuts when crossed with the 334 variety (Trueman and Turnbull 1994). The authors concluded that “post-zygotic incompatibility may exist in macadamias...”

Other experiments in Nambour and Hidden Valley in Queensland in 1983, 1985 and 1986 tested self-and cross-compatibility of six cultivars. The varieties used were 246, 344, 660, 741, 800 and 508. Selection 246 showed consistently high fertility as both male and female parent. The crossing of 741 x 660, 741 x 800 and 800 x 660 consistently showed rather low fertility. (Sedgley et al 1990).

Rhodes (1986) reported on pollination trials held at Maleny, Queensland. The results, using the selections 246 and 508, included the following observations.

- ❖ The varieties benefited from having visits from a honey bee pollinator during flowering.
- ❖ Cross-pollination from two varieties should achieve a high INS as this would carry over to a higher FNS.
- ❖ When varieties are separated by a distance INS and FNS decreases significantly.
- ❖ 246 attracted nearly three times more bee visits than 508.

Recent field trials in Australia (Vithanage et al 2004) which did not artificially control bee or flower numbers showed that blocks of five rows of a good pollinator on either side of a block of ten rows of A16 brought record yields for A16's. The pollinator on one side was A4 and on the other side were the varieties 344/741. The yields from A4's were significantly higher than for the 344/741's which indicated that the pollinator should be a good bearer or the overall yield of the orchard would drop.

The trials showed that blocks of pollinators produced better results than single or double rows or the use of alternate trees within a row. An earlier trial showed that using 246 and 660 selections cross – pollination levels declined after the next adjacent row (Vithanage et al 2004).

These results suggest new ways to set out an orchard to maximise the benefits of cross-pollination of proven pollinators. Patterns in New Zealand orchards have often followed designs with single rows of main crop trees alternating with single rows of pollinators. Sometimes pollinators alternate with main crop trees in the row.

Example 1

.....A Maincrop
B Pollinator
A
B

or

Example 2

.....B
A
A
B
A
A
B

Examples 3 and 4

Sometimes even ABABAB
 or AABAAB

Using the five rows block methods of pollinators we could have
 5B x 10A x 5B x 10A or even 5A x 5B x 5A x 5B.

It appears obvious that the New Zealand macadamia industry needs to commence pollination trials to find varieties which bear good yields and enhance the harvests from the main variety in the orchard. These need to be long-term trials conducted by scientists with help from growers. As Corbet noted in 1986 “Further research will be required to identify the best compatible selections for New Zealand growers. The only sure way to identify compatible selections is to try them but style length may give some clues to help growers decide which to try first.” (Corbet 1986)

4.37 Varieties

This chapter concludes with a list, and description, of varieties which may be found growing in New Zealand orchards. It includes important trees planted at different times in the history of the macadamia industry in New Zealand. Some varieties have gone out of fashion due to lack of production and profitability. Others have been planted in recent years in an attempt to find varieties which drop their fruit to make harvesting easier using mechanical means. Some varieties flourish in one site and perform badly in others. Factors which may influence the size of a yield include choice of site, choice and number of pollinators, orchard management and knowledge of appropriate tree nutrition factors, the size of the orchard and whether it is to be run as a lifestyle project or as a commercial operation. There are some large orchards in New Zealand growing Beaumont and the owners do not find hand picking a disadvantage (Garden 2002 and Ward 2002). Others see the future of the industry in New Zealand moving to dropping varieties and mechanical harvesting and a co-operative scheme for processing and marketing.

Unfortunately some varieties have not been in the ground long enough to generate accurate production figures for New Zealand comparison. The variety trials at Torere indicate that growth of trees in New Zealand is markedly different from the habit in Australia (Hayes 2002). Generally macadamia varieties in New Zealand are taller and more dense than the same varieties growing in Australia.

The following list, and descriptions, in no particular order includes varieties which have been the mainstay of the early days of the New Zealand industry. This is followed by some of the more recent selections which have been planted either, to increase the quality and quantity of yields, or to make harvesting from the ground a cheaper method of gathering the crop.

The cross section of observations, making up the descriptions, was achieved by this writer from his own experience as grower, processor and marketer of macadamias and from his visits to orchards and processing plants. In addition there have been some written reports on the performances of varieties in New Zealand. These have been written in Co-op and Society newsletters, reports of HortResearch officers and by professional growers in their nursery publications.

It should be noted that some cultivars have been given numbers (eg A4 or H2) and some have names and /or numbers (695 or Beaumont).

In New Zealand the earliest plantings in Kerikeri were seedlings. Later many seeds were taken and planted at the Mount Albert and Te Puke Research Stations and around horticultural crops as shelterbelts. These spread as far south as the Bay of Plenty.

From the 1960's MAF imported trees of several Queensland selections and Endt and Pringle travelled to Hawaii, Australia and South Africa to gain expertise in growing and grafting practices. They brought back seeds and scion wood to extend their commercial sales of the best varieties. As sales increased grafted varieties were sought by orchardists as grafted trees were more quickly in to production than seedlings.

Beaumont became the most popular grafted cultivar and nurserymen chose their own favourite rootstock. Common choices included Own Choice, Renown and Elimbah. Often, when an existing orchard had poorly performing trees, top grafting methods were employed. This has happened on a large scale at Macadamia Plantations at Okaihau where thousands of trees have been cut down to approximately one metre in height and the new chosen variety grafted on to the stump. Vanessa Hayes, at Torere, has planted thousands of Beaumont seed to use as rootstock for her 'A' series grafts.

Successful nurserymen obtained their scion wood from selected mother trees.

Beaumont (Tet.) “Beaumont is worth growing simply for its flowers. In spring it festoons itself in curtains of pink-cream tubes that impregnate the air with heady perfume.” (Laurenson 1998) (Plate 18) It is a NSW hybrid which was discarded in Australia because it does not drop its crop. The kernel is sweet compared with the kernel of the *integrifolias* which are favoured for processing in Australia and Hawaii. This variety does crop well in California, Israel and South Africa, and recent statistics from South Africa show an average yield per tree of 35kg NIS (Atkinson et al 2002). Cheap labour costs for pickers make the African large plantations viable. 80% of macadamia trees in New Zealand are Beaumonts (Kerr 1997) and some good yields are achieved (Ward 2002 and Canning 2002). At Kerikeri, Mrs Canning picks an average tree yield of 15kg NIS and, in the eastern Bay of Plenty, Mr and Mrs Ward pick 25kg NIS on their Whanarua Bay property.

Features of Beaumont include:

- ❖ Nuts don't drop.
- ❖ Requires a compatible cross-pollinator.
- ❖ Has a sweet kernel.
- ❖ Has the best cropping figures in New Zealand over a number of years.
- ❖ Has a good quality kernel but basal stain can be a problem in some orchards.
- ❖ Usually has a high percentage of No 1 kernel.
- ❖ The crackout of approximately 32 – 36% is lower than for newer varieties.
- ❖ Tends to be too vegetative, too bushy in colder blocks or when planted too closely in rows. (Plates 20 – 21)

Note One grower has pruned Beaumont trees to a single main trunk which has opened out the tree allowing light and air in the branches (Ward 2002).



Plate 20: Bunches of Beaumont Nuts on 4 year old tree



Plate 21: Bushy habit of 8 year old Beaumont tree. The smaller tree in front is a 2 year old Nelmac 2

(Photos: B. Coleman)

GT1 An Ian Gordon selection developed from a seedling at the Mt Albert
(Tet) Research Station. This seedling appeared to be the most promising at
the Station and was planted at the Gordon's nursery at Titirangi. The
name devised as - G = Gordon
T = Titirangi
1 = the first selection.

In 1974, Ian Gordon joined with Stuart Dawes on a DSIR research programme planned to find the best macadamia varieties for commercial production in the New Zealand environment. GT1 was planted in bulk at the Woodhill Forest north of Muriwai. They were planted close together in rows. After approximately 30 years of development, GT1 has proved to be a good pollinator for Beaumont and is common in New Zealand macadamia orchards.

Features of GT1 include:

- ❖ Produces small round nuts suitable for chocolate coating.
- ❖ Has good nut set and good kernel quality.
- ❖ Drops some nuts late in the season but the trees may be stripped by hand.
- ❖ As a young tree may be unruly and may suffer broken branches – may need special feeding to counter chlorosis. This leaf condition may be caused by a lack of nitrogen or by stress brought on by drought or water logging (Davison 1990).
- ❖ A self-pollinator.

GT1 is no longer produced by Ian Gordon for commercial sale as newer and more successful selections have been developed. The top three selections sold from Ian Gordon's Titirangi nursery are:

GT205

- ❖ has a strong, open tree form (similar to Renown).
- ❖ good pollinator
- ❖ has a high crackout of up to 43%
- ❖ needs handpicking - 10 – 20% drop

GT207

- ❖ tree shape is similar to Renown
- ❖ good pollinator
- ❖ crackout of 38 – 39% and good kernel quality
- ❖ drops much of its crop at maturity
- ❖ has a tendency to twinning

GT288

- ❖ a new selection with open habit
- ❖ drops most of its yield in September – October
- ❖ cropping rate still to be assessed in open orchard situation

PA 39
(Tet.)

This variety had its New Zealand origins as a seedling growing in the Kerikeri district. Mr Brian Piper, a government citrus adviser, picked up a number of nuts when he was making an annual visit. He put the nuts in his pockets and planted them as shelter on his new citrus orchard and nursery north of Tauranga. The new seedlings grew quickly and some of the nuts were planted in two shelter belt rows at the Te Puke Research Station. The nuts were given a name and number so that if any proved promising they could be identified for further research. One proved to be promising and was given the appellation PA 39.

P = Piper

A = The first row of the shelter belt

39 = The thirty-ninth tree.

Thus this Bay of Plenty selection of the late 1970's became a popular choice as a pollinator for Beaumont on many New Zealand macadamia orchards.

- ❖ It is a hybrid bearing medium –large round nuts of good quality.
- ❖ Most nuts drop in a 4 – 7 week period but some nuts may have to be hand harvested.
- ❖ In many areas harvest begins in June – July, earlier than most varieties.
- ❖ Crops in its fourth or fifth year, a year later than most varieties.

- ❖ Has a vigorous dense form.
- ❖ Kernel quality is good and crack-out is 30 – 33%.

Own Choice (Int) An Australian cultivar often planted in New Zealand near, or beside, Beaumont. It was hoped that it would be a successful pollinator for Beaumont but proved to be largely a self-pollinator and failed the function of cross-pollination for the main crop. In some areas, especially on cooler sites, Own Choice had a low yield although the kernel was good quality with a high percentage of number ones. It is often used as rootstock in grafting other varieties.

- ❖ It does not drop nuts.
- ❖ A large nut but is not widely grown in other countries as the nuts must be picked by hand.
- ❖ Has a dense form with few prickles on leaves.
- ❖ Overall it does not produce as well as other top varieties. (Tables 10-12 showing yield and kernel characteristics, and Table 13 showing nut quality test results 1993).

Renown (Int) This is an early Australian selection used as a rootstock for many grafting experiments in Australia. In New Zealand it has been a good pollinator for Beaumont on local orchards. Renown has a large spindle shaped nut with a thick shell but it is not popular with some processors who prefer round shells for easy cracking.

- ❖ Does not drop nuts consistently
- ❖ the tree has an open form and hand stripping is easy.
- ❖ Tends to be very early bearing.
- ❖ Has strong flowering and the ability to crop well in cooler New Zealand conditions.
- ❖ Has an average crack-out but the large kernel is too big for some processors.

Nelmac 2 This is a South African selection thought to have been introduced into
(Int) New Zealand by Jim Pringle of Tauranga. It has a large, elliptical
shaped nut and although it drops consistently in the Bay of Plenty it fails
to do the same in Northland.

- ❖ It has a strong show of flowers and is a good pollinator for Beaumont.
- ❖ It has had quite good yields in the Bay of Plenty but has not performed well in Northland and is not widely planted there.

Other varieties, which have been planted in New Zealand but have not been successful for a number of reasons, include:

- ❖ The Hawaiian selections Keau, Keahou, Ika Ika, Mauka, Jordon, Mackay, Hinde and the HAES selection. Maroochy and Sewell were planted at Mt Albert in 1958 and other Australian selections which were trialled at a number of different locations included Nutty Glen, Cate, Elimbah, Collins, Taylor's Triumph and Greber.

In the 1990's there was an effort made to find a tree or trees which drop the crop for ease of harvesting by mechanical means. Larger orchards had a need to eliminate hand-harvesting costs and to find a variety with higher nut quality than the popular Beaumont.

HortResearch, Kerikeri, imported five 'A' series in 1990 from Australia for varietal trialling of droppers. Ted Dawson propagated these and in 1993 sent some to several orchards in Northland, Auckland and the Bay of Plenty. Also Vince Kerr imported some 'A' series and, in 1996, sent some to other orchards for trial.

This writer contacted several of the growers, who planted the 'A' series, in an effort to obtain recent yield figures. Unfortunately none of those contacted could provide results.

Vanessa Hayes imported fifteen more dropping varieties in 2002 and as they are still in quarantine it will be at least 8 – 10 years before any judgements may be made on performance under New Zealand conditions.

The following limited evaluations of A4 and A16 are not sufficiently detailed for informed conclusions about suitability for local planting especially in cooler sites.

A4 This was an early Henry Bell selection (1980) and one of the original varieties planted in the Kerikeri trials in 1990. Dropped the yield over a 4 – 6 week period but some picking still required. Quality was excellent with a crackout over 40% and number 1 kernel of close to 100%. It may do well in warm New Zealand sites where there is not too much rain at blossom time. A hybrid progeny from Renown.

A16 Another early Bell selection and a hybrid from more upright tree which appears to be hardier than A4 with a late nut fall.

From trials conducted by Vanessa Hayes from the mid 1990's at Torere, six 'A' series varieties were identified as being worthy for sale in New Zealand. These were released from her nursery in 2002 and are - A4, A29, A38, A104, A217 and A268 (Plate 22-24). A4 and A38 are sold to growers as being protected under the Australian Plant Rights Act which requires that Torere Macadamias Limited should act as agent for Hidden Valley Plantations and enforce conditions of sale which protect the Intellectual Property Rights of the breeders, Hidden Valley Plantations.

The fifteen varieties still under quarantine at Torere include the following – A203, A387, A408, A417, A422 and A439.



Plate 22: A4 variety, 4 years old, planted 5m apart

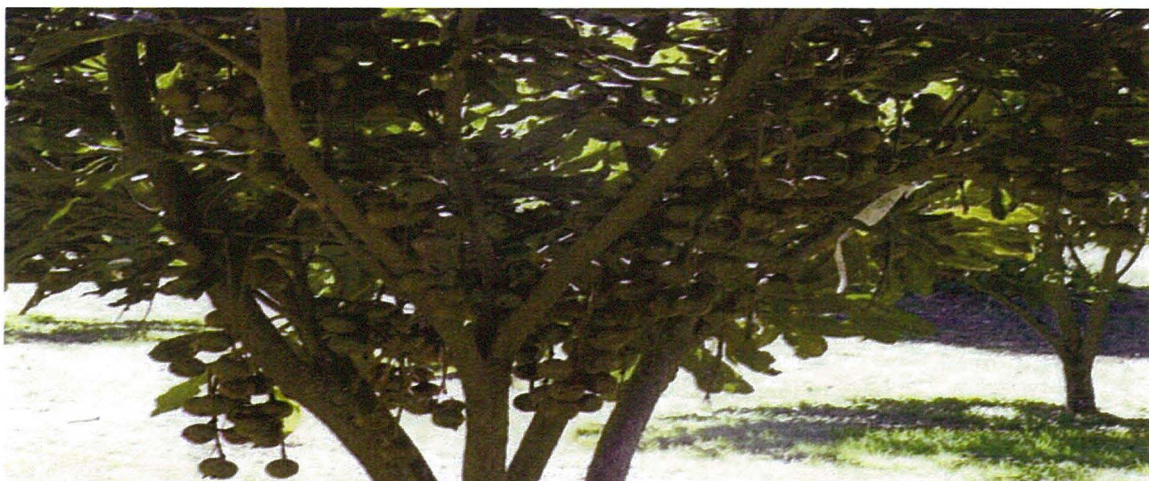


Plate 23: A29 variety, 4 years from graft



Plate 24: 268 variety, 4 years old

(Photos: V. Hayes)

The search for varieties to suit growing conditions has suffered because of the lack of long term funding from Government. None of the trials at HortResearch stations reached any conclusions and development of the local industry was affected. Research is expensive and requires a commitment lasting a number of years. Professor R.A. Hamilton from Hawaii talked to Ian Gordon in the late 1970's and suggested that New Zealand should develop its own high quality varieties to suit its climate and conditions (Gordon 2002).

Apart from these few varieties most interest has focussed on the 'A' series and other new Australian selections. It is hoped that some of these may adapt to local conditions but, to date, the form of these has differed from the Australian shapes and they have yet to prove that their performances are superior to those from existing cultivars.

4.38 Discussion

It is possible to identify several significant aspects of the New Zealand macadamia industry.

- ❖ Based on climate data the best sites for commercial growing of macadamias in New Zealand should be located in Auckland and Northland. Sheltered north facing sites in the Bay of Plenty and Coromandel may be suitable but those in New Plymouth and Gisborne would be marginal. Whilst temperature is the most important factor influencing growth and development, it should be noted that ideal growing areas in Queensland have warm wet summers and are dry from autumn to spring providing good conditions for pollination, final nut set and machine harvesting. In New Zealand local northern areas tend to have dryer summers and autumns with wet cool winters and springs which are difficult conditions for successful cross-pollination.

- ❖ It appears that only two macadamia enterprises in New Zealand are financially independent currently. Ian Gordon has a macadamia nursery, orchard and consultancy business. South Head Madacamias, owned by Rob Garden who has a background in business, is an expanding commercial concern following his major organisational changes and concentration on processing.

Dr Lykho at Okaihau has the largest macadamia orchard in New Zealand. Since 2000 he has commenced an extensive re-grafting programme, which will limit his orchard yield for some years. He has some NIS for sale each year but not enough to cover orchard expenses and living costs.

There was not enough information available from two orchard/processing operations to assess their commercial viability. Mr and Mrs Ward at Whanarua Bay were achieving satisfactory crops from their small orchard and had good markets for their added-value products. However it did appear that there would not be enough income to sustain a family with dependent children without additional finance. James Lin at Waiuku had a similar sized orchard and a modern processing factory. His 650 trees produced 4 tonnes NIS in 2002, which would not be sufficient to cover orchard and living expenses.

- ❖ There has been little research carried out by the industry in New Zealand since the Co-op ceased operation in 1999. Ian Gordon continued his private research on the GT varieties using his own money and facilities. Vanessa Hayes has had access to some Government funding and has built a quarantine facility at Torere. She has imported several new varieties for evaluation at her nursery.

The Macadamia Society has helped to finance research on the insect pests Green Vegetable Bug and Guava Moth. There is an urgent need for research to be commenced immediately on a number of priority topics if local industry is to expand and prosper. A major priority project is the need to obtain new varieties that will crop well in the cool climate of northern New Zealand. Research on optimising pollination

and final nut-set in such cool climate conditions is required. As variety trials are a long-term project this work should take priority. All research programmes must be undertaken as a partnership between scientist and the industry with financial contributions from both industry and government.

As most orchards in New Zealand were established as lifestyle projects the search for new varieties is not as urgent for orchards with less than 1000 trees. The variety Beaumont has produced up to 25kg NIS per tree in this country and, in warm sites profitable yields over 15kg NIS per tree are possible with improved orchard management strategies. Research on this variety to improve yields should include pruning trees to a single leader, developing an optimal tree nutrition programme based on soil, leaf and nut analyses, determining optimum ratios of compatible pollinators with an orchard and overall improvement in orchard practices. Beaumont has been shown to have a good crack-out and percentage of No1 kernel over 90% in New Zealand trials. If harvesting costs can be managed then Beaumont may continue to be satisfactory for smaller orchards.

The GT selections, PA39 and Renown have proved to be satisfactory pollinators for Beaumont. Large commercial orchards need different requirements for their varieties than small orchards. Harvesting costs in an orchard of 5000 macadamia trees would be prohibitive if hand picking was required. Plantations in Australia and Hawaii grow varieties, that drop their nuts that are then harvested from the ground by mechanical appliances. Harvesting in Australia begins in March and continues until October/November. This is possible because of the dry ground under trees during autumn and spring. In addition varieties have different pollination time making it possible to have nuts dropping throughout nine months of the year. Most varieties drop more than 70% of their crop.

Although yield data is not available from those local growers who were selected to evaluate the Bell varieties in the early 1990's, it appears that the nut crop of these varieties do not drop in New Zealand. If this is the case then the major advantage of

planting dropping varieties from the Bell selections will be negated. Vanessa Hayes is selling some of these dropping varieties to new growers. At least one grower has planted 5000 trees but the trees are too young to discover if harvesting will be possible from the ground with dropped nuts or whether nuts have to be stripped from the trees.

Variety research for commercial macadamia orchards would hope to find selections, which possess the following requirements:

1. Selections would have the ability to drop at least 70% of the crop between late March and early June and/or between September and early December. This would allow machine harvesting from the ground and would spread the processing season through the year.
2. Selections would have a cool climate requirement for successful pollination and final nut set.
3. Selections would have a crack-out percentage over 35% and achieve No1 kernel over 90%.
4. Selections would have a yield of 15kg – 20kg NIS by 10 years and reach 25kg NIS by 12 years.
5. Some selections would be pollinators producing similar yields as main crop trees.

- ❖ There are too many processing plants for the scale of the New Zealand macadamia industry. The factory at South head produces products of a high quality. It provides an outlet for NIS from small growers and imports NIS in an effort to increase volume added-value products for New Zealand markets.

Apart from the plant at Okura, near New Plymouth, most processing plants in New Zealand are small and their products vary widely in quality. The factory built by Mr and Mrs Charteris at Okura is under utilised by its owners and this situation is likely to continue for some years. The circumstances may become more cluttered if Vanessa Hayes builds another large processing factory in the Bay of Plenty/Waikato region in the near future.

Given the small area growing macadamias and the low weight of kernel produced each year some rationalisation of the processing industry in New Zealand would be advisable.

The next chapter will look at possible future developments of the New Zealand macadamia industry. It will suggest possible growth strategies particularly in processing and marketing and some overall conclusions will be made about the macadamia industry.

CHAPTER 4: REFERENCES

- Atkinson, Jim, Bryne, Kerry and Ladro, Phil. 2002. Examples Of Post-Harvest Processing Practices in the South African Macadamia Industry. Reprinted in NZMS Newsletter No 30, Oct.
- Beere Ernie. 2002. Audio tape No 8, 3/12/02
- Bull, P., Jackson, D., Bedford, Tom. 1985. Edible Tree Nuts in New Zealand. Government Printing Office, Wellington, Revised edition, p1
- Canning, Anne. 2002. Audio tape No. 8, 27 Aug.
- Chamberlain, Clive. 2002. Audio tape No. 3, 16 Jul
- Charteris, Christine and Bill. 2002. Audio tape No. 14, 29 Oct.
- Corbet, Sarah A. 1986. Macadamia Pollination : some questions. Department of Applied Biology, Cambridge University, England. Reproduced in the News Bulletin, Aug: 7–11.
- Davison, R.M. 1990. Kiwifruit Science And Management, Edited by I.J. Warrington and G.C. Weston for the New Zealand Society for Horticultural Science. Published by Ray Richards: p139, pp 143 – 144.
- Dawes, Stuart. 1972. Macadamian Nut Culture. Reprinted from the proceedings of the Citrus and Subtropical Symposium, held at Waitangi, Bay of Islands, 24 Aug.
- Dawes, Stuart. 1985b Macadamia Varieties and Culture for Commercial Production Information Services, MAF, Private Bag, Wellington, New Zealand. Nov.

- Dawson, Ted. 1991. Macadamia Nut evaluation at Kerikeri Research Orchard
- Ferguson, Laetitia and Lindo. 2004. Guava Moth and the “Fight Back” at Butler Point. NZMS Newsletter No 41, Nov. (Appendix 5)
- Ferguson, Laetitia and Lindo. 2005. Audio tape No. 24, 21 Feb
- Gallagher, E.C., Stephenson, R.A. 1986. The use of ethephon to promote uniform harvest drop of mature macadamia nuts in south east Queensland. Queensland Journal of Agricultural and Animal Science 42: 83-88
- Garden, Robert. 2004. Audio tape No. 2, 24 May
- Gordon, Ian. 2002. Audio tape No. 10, 29 Sep.
- Graham, John. 2003. Audio tape No. 19, 24 Apr.
- Hayes, Vanessa. 2002. Audio tape No. 16, 29 Nov.
- Heard, Timothy A. 1993. Pollinator Requirements and Flowering Patterns of *Macadamia integrifolia*, Australian Journal of Botany, 41, 491-97.
- Henderson, Bruce. 2002. Notes of visit, Jul.
- Hill, R.J. 2000. Crop Guide – Macadamia. Version 4, Apr. Hill Laboratories, Private Bag 3205, Hamilton.
- Hobson, L. 1976. Macadamia quality – some questions answered. The Citrus and Subtropical Fruit Journal, Dec: 14-22.

- Jamieson, I.E., Seldon, D.S., Froud, K.J. 2003(a). Green Vegetable Bug on macadamia nuts – A sustainable pest management system, HortResearch, Auckland, NZMS Newsletter, No 38, May 2004: 6–11.
- Jamieson, I.E., Seldon, D.S., Dawson, T., Gibb, A.R., Suckling, D.M., Dymock, J.J., Froud, K.J., Hoare, R.J.B. 2003(b). Guava Moth, *Coscinoptycha improbana* (Lepidoptera: Carposinidae) – larval identification, biology, distribution, hosts and phenology. HortResearch, Dec.
- Kadman, A., Ben – Tal, Y. 1983. Inducing macadamia nut drop with ethephon. HortScience 18: 240–242.
- Kerr, V. Rats 1996–1997. New Zealand Macadamia Nutgrowers Co-operative Company Limited News Bulletin, Dec '96/Jan '97.
- Kerr, Vince. 1997. Cropping New Zealand Macadamias. NZMS Workshop Proceedings held at Parakai, Apr 25–27.
- Kerr, Vince. 2000. Light In The Orchard. NZMS Newsletter No. 14, Feb: 4–5.
- Laurenson, Wendy. 1998. Just One More Magical Macadamia. NZ Growing Today. Nov, 12 (11), 6 – 15.
- Liang, T., Chin, L., Mitchel, J.B. 1984. Modelling moisture influence on macadamia nut kernel recovery. Transactions ASAE, 27: 1538–1541.
- Lin, James. 2002. Audio tape No. 13, 27 Oct.
- Lykho, Anatoly. 2004. Notes of visit, 7 Jul.
- Mackie, Jim. 2002. Audio tape No. 2, 14 May.

McClelland, Tom. 2002. Audio tape No.7, 22 Aug.

McGregor, S.E. 1976. Insect pollination of cultivated crop plants. USDA Handbook No. 496.

News Bulletin, Aug 1986: 7–10.

NZMS Newsletter No, 27, Apr 2002, 4–6.

NZMS Newsletter No. 30, Oct 2002, 15–20.

NIWA Climate Statistics 2004, Table 4.

Oldham, John and Lorena. 2002 Audio tape No 15, 29 November.

Pest Management – IPM Rodent Control. 2003. Paper by Cisse W. Spraggins, Ph.D., Bell Laboratories Inc, USA, received from Pest Management, PO Box 121, Waikato. 20 Oct.

Rhodes, J. 1986. Macadamia Pollination. Australian Macadamia Society News Bulletin, Vol. 13, No 4, 1–4, Nov.

Richards, Grahame. 2002. Audio tape No. 7, 8 Aug.

Richardson, Annette and Dawson, Ted. 1988. Macadamia Maturity Assessment and Determination of the Effects of Storage Both on and off Trees After Maturity on Nut Quality. MAF Tech, Kerikeri, Research project by the Co-op.

Richardson, A., Dawson, T. 1991. New Zealand Macadamia: the industry and its research needs. The Orchardist of New Zealand, Jul, 30.

- Richardson, A., Dawson, T. 1993a. Effects of Orchard Factors and Drying Methods on the Incidence of Basal Stain of Macadamia Kernel. HortResearch Client Report No. 93/96, May.
- Richardson, A., Dawson, T. 1993b. Enhancing abscission of mature macadamia nuts with ethephon. NZ Journal of Crop and Horticultural Science, 21: 325–329.
- Richardson, A., Dawson, T. 1993c. The Nutrition of Macadamia Trees in New Zealand. The Orchardist of New Zealand, Oct , p40.
- Searles, Mr and Mrs. 2004. Written report, Apr.
- Sedgley, D.M. 1982. Pollination biology of fruit and nuts. Pollination '82, Proceedings of a Symposium held in Melbourne.
- Sedgley, M., Bell, F.D.H., Bell, D., Winks, C.W., Pattison, S.J., and Hancock, T.W. 1990. Self-and cross compatibility of macadamia cultivars. Journal of Horticultural Science, 65 (2), 205–213.
- Stace, Peter. 1986. The Behaviour Of Honey Bees In Macadamia Orchards. News Bulletin, Aug. 12–14.
- Trochoulis, Tim. 1992. Letter to AGM of the Co-op.
- Trochoulis, Tim. 2004. Impaired Root Systems is the Main Cause of Macadamia Decline, NZMS Newsletter No. 41 Nov. (Appendix 1)
- Trueman, S.J., Turnbull, C.G. 1994. Effects of Cross-pollination and Flower Removal on Fruit Set in Macadamia. Annals of Botany 73: 23–32.

- Vithanage, H.I.M.V. and Ironside, D.A. 1986. Insect Pollination of Avocado and Macadamia. *Acta Horticulturae* 175, 07–99.
- Vithanage, Vasanthe, Meyers, Noel and McConachie, Cameron. 2004. Maximising the Benefits from Cross-Pollination in Macadamia Orchards. Project MC 98027. Australian Society News Bulletin, Mar, Vol. 31, No 2.
- Ward, Debbie and Phil. 2002. Audio tape No. 17, 30 Nov.
- Warren, Virginia. 2002. Audio tape No. 5, 23 May.
- Wilkinson, B. 1983. Food Briefs. Macadamia Nuts – On Farm Handling. Quality and Composition. Factory Processing. Food Technology Research Centre, Massey University, Palmerston North.
- Williams, Barry and Watson, Suzanne. 2004. Notes and email, 27 Jun.

CHAPTER FIVE : FUTURE DIRECTIONS

It could be debated that the formation of three commercial operations, from the late 1970's, was a major reason for the slowing down of the development of the New Zealand industry. Each of the three organisations started with serious handicaps which led to their failure before 2000. Their collective neglect to carry out research on such matters as, the development of better varieties to suit local conditions, pollination and nut set and the identification of the best sites for future growth, all contributed to industry lethargy in the 1990's and through to the twenty-first century.

It is most unlikely that New Zealand will become a major macadamia producer in world terms. Limitations set by climatic factors, shortage of suitable land and the lack of funds to carry out the necessary research mean that it is doubtful that this country could become self-sufficient in macadamia production. Small scale exporting of added-value macadamia goods should be possible.

Trochoulis (1992) made the following observation about the limitations for the New Zealand macadamia industry.

“Glasshouse and field research in Australia has shown that 25°C is optimum for vegetative growth and below 18°C for fruiting.(sic) The limitation to macadamia growth in New Zealand is temperature..... The long term solution is to improve the environment with mounding, tree nutrition, growth manipulation and tree protection. The long term solution is to select new cultivars which can produce heavy yields of high quality nuts which fall to the ground at maturity.....”

Dawson (1991) made the comment that:

“Marketable kernel and yield are the two most important criteria to be considered when selecting macadamia cultivars for planting. However ease of harvesting and adaptability of cultivars to the growing region must also be considered.....”

5.01 Torere Macadamias Limited

Vanessa Hayes and her partner Rod Husband commenced an ambitious scheme to set up the largest commercial macadamia enterprise in New Zealand. The size of the scheme will rival similar operations in Australia and Hawaii. Vanessa formed a company in 2003 called Torere Macadamia Limited (TML) with Vanessa and Rod as directors and Damian Lawsen as marketing manager. The main aims of the company are:

- ❖ To evaluate dropping varieties, imported from Australia, to find if any are suited for commercial plantations in New Zealand.
- ❖ To run a commercial macadamia nursery at Torere to supply 30000 grafted trees per year in 2004 and 100,000 by 2009.
- ❖ To facilitate the planting of dropping varieties in more than 40 ha at Gisborne, Eastern Bay of Plenty and Northland each year from 2004 – 2009.
- ❖ To form a growers co-operative in 2005. Shareholders with preference would be those who bought trees, in bulk, from TML.
- ❖ To build, in 2006, a centrally located Growers Co-operative processing factory with the first crop of 24,000kg NIS (est) in 2007.

Although Vanessa and Rod live and work in Gisborne their macadamia interests lie at Torere Bay where the nursery and quarantine facility and orchard occupy 11 hectares of whanau land. In 2001 the Opotiki District published a “Maori Land Use Options Resource Kit” and Vanessa and Ian Gordon wrote a profile on macadamia possibilities in the area (Opotiki District Focus. 2001). By that stage they had planted shelter belts on the orchard block, planted over 2000 seedlings and grafted trees on this block and commenced trials of eight dropping varieties from Australia. In 2002 a Government Keyworker was appointed for two years and three full-time nursery trainees and two casuals were employed from December 2002. In addition, a Government Social Entrepreneur grant of \$15,000 allowed Vanessa to take key employees to Queensland to research a successful co-operative (Suncoast Gold) and a processing factory.

From the eight Henry Bell varieties planted in a trial block in 1994, six have shown promising features. (Table 28). These trees are planted in the orchard and are being sold to customers for field planting. All are available from the nursery and all buyers are expected to attend a field day at Torere as a condition of purchase. Buyers are given the chance to see each variety grown for 10 years, to ask questions and learn about field planting, maintenance and orchard practice and to fill in order forms and a growers-propagator agreement.

At the end of 2003 TML received a large order from a prospective grower in the Rodney area. He ordered 1200 trees for 2004 and a forward order of 10000 trees in the following three years. The buyer is a retired engineer and hopes to design netting under trees to catch the harvest before it hits the wet soil in the rainy season.

In an Email (June 28, 2005) Vanessa Hayes made the following comments about the varieties described in Table 28:

- ❖ “All these varieties are self-pollinating BUT will crop better with another variety/ies in the same block. You may have up to 6 – 8 rows of one variety then 2 – 4 of another and repeat this across your block with a minimum of three varieties to minimise risk of crop loss due to weather affecting one of the varieties at blossom set. The varieties blossom-set must run into each other – eg they don’t have to set at the same time. A4 is proven as one of the best known pollinators because it has a very long flowering period.
- ❖ All varieties are 100% clean dropping except A39 95% and A17 75%.

Table 28: Attributes of macadamia varieties supplied by Henry Bell, Australia (Revised by Torere Macadamia Limited November 2003).

PARTICULARS	A4	A29	A38
Kernel Weight	3.0g	2.22-2.99g	2.47-2.75g
Kernel Recovery	43-46.9%	40.14-40.74%	38.76-38.83%
Kernel 1 st Grade	97.3-99.3%	96.02-98.77%	97.77-99.57%
Kernel Whole	43.8-45.1%	40%	64%
Kernel Colour	Creamy	White	Creamy
Kernel Shape	Good, large uniform	Good, medium uniform	Good, medium uniform
Blossoms	Creamy, medium length	White, medium length	Creamy
Origin-Parentage	Renown OP	Haes OP	Own Choice OP
Tree Appearance	Open, dainty, spreading	Upright, medium	Upright, tall, strong
Leaf Appearance	Small, prickly, light green	Long, prickly, dark green	Medium, smooth
Shell Appearance	Dark brown, shiny, smooth	Dark brown, shiny, smooth	Dark brown, white spots
Drop Response	Clean – holds under stress	Clean	Clean
Selected	1987	1981	1981
Harvest Times	Long – July to late Sept	Short – June to late July	Sept to late Oct
Harvest Results	Excellent – many closed husks	Good – mainly open husks	Excellent – open husks
First Crop Expected	3 yrs from planting	4 years from planting	4 years from planting
Planting Suggestion	6x3 or 4	6x3 or 5x2.5	6x3 or 5x2.5
Problems	Wind tender, prolific feeder	Nil	Nil
General Comments	Many singles	Good bunches	Good big bunches

PARTICULARS	A104	A217	A268
Kernel Weight	2.88g	2.65g	3.31-3.55g
Kernel Recovery	44.11%	34.50%	37.25-39.12%
Kernel 1 st Grade	97.01%	100%	91.42-92.13%
Kernel Whole	45%	58%	46.90%
Kernel Colour	Creamy	White	White
Kernel Shape	Very round and small	Acceptable – large	Acceptable – very large
Blossoms	Creamy	White	White
Origin-parentage	Renown OP	#	Haes 344 OP
Tree Appearance	Upright, gangly	Open, spreading, short	Open, strong, spreading
Leaf Appearance	Medium, light green, smooth	Big, long, dark, prickly	Big, long, dark, prickly
Shell Appearance	Fawny, smooth	Light brown, smooth	Light brown, rough
Drop Response	Clean	95% drop – some hang on	Clean
Selected	1983	1987	1987
Harvest Times	Short – early July to late Aug	Long – July to late Oct	Late – June to Aug
Harvest Results	Good – mainly open husks	Heavy – open husks	Heavy – mainly open husks
First Crop Expected	4 years from planting	3-4 years from planting	3-4 years from planting
Planting Suggestion	6x3 or 5x2.5	6x3 or 4	6x3 or 4
Problems	Regular top-trimming early	Chlorotic leaves	Nil
General Comments	Good big bunches	Singles – tree shape like A4	Singles and bunches

Note: The letters OP placed after 5 varieties in the Origin-Parentage lines indicate Open Pollinated.

A4 drops from July to late August. A29 drops from late May to mid July
 A38 drop from Sept. to October. A104 drops from late May to mid July
 A217 drops from July to Sept. A268 drops from June to late July.

The above comments are descriptions made by Henry Bell in Australian conditions. However there is no data available in New Zealand to evaluate these six varieties for dropping percentages or pollination success in our cool climate conditions.

It will be interesting to see how the TML venture develops. Fifteen new varieties were imported in 2002. Bud wood was uplifted from the Auckland Airport Quarantine Station on 17 March, 2002. There were six Bell 'A' series and four other new cultivars (814, NG8, 835 and 816). The other five varieties are suitable for mid-low density planting and were grouped together in the TML quarantine house. Essentially this project is long-term but if one or more varieties are found to be suitable in our cooler climate it would be very beneficial to the future development of the New Zealand macadamia industry.

5.02 Macnut Farms and Macadamia Plantations of N.Z.

The future role of the two existing plantations is promising for Macnut Farms at South Head but more uncertain for Macadamia Plantations at Okaihau. At South Head Rob Garden is content to buy NIS from local growers and to supplement this with imports from Australia or Kenya. At present Mr Garden markets his kernel in New Zealand only and sees no need to move into exporting in the near future. His processing plant is modern and meets all Ministry of Health and Occupational Safety and Health Service standards.

Major changes in tree grafting at Okaihau and removal of some varieties will mean reduced yields for the next few years. If the grafts take, the major problem may be the harvesting of the crop from 10000 (approx) trees many of which require hand picking. Cattle fencing is being up graded and sheep fencing is being erected to allow sheep to

graze in the macadamia blocks to save money by much less mowing. Dr Lykho will not consider building a processing plant until the grafting has proved to be successful and the increased yield warrants the expenditure.

5.03 Processing the Crop

Although the NZMS does not include all the macadamia growers in New Zealand, data from its membership in 2002 shows the following statistics:

Table 29: New Zealand macadamia statistics – 2002

No. of trees	69,655
Main varieties grown in New Zealand	Beaumont, GT1, Own Choice, Renown, PA39, A4, A217, A38, A29 and A104
Trees over 5 years old	52,468
Production 2002	35,468kg
No. of processing plants	12

(NZMS Newsletter No. 39)

The New Zealand macadamia industry includes hobby growers, lifestyle and small orchards (200 – 300 trees), medium size orchards (300 – 1500 trees) and larger plantations hoping to stand alone as commercial operations. The fact that there are 12 processing plants reflects the belief, held by many growers, that processors make all the profit and growers want a share of the takings. Thus there is a range of processing plants, some with crude machinery at one end of the scale to the modern facility at Oakura, New Plymouth. (Plates 15-17)

The quality of the processing plant built by Mr and Mrs Charteris, near New Plymouth, does meet international standards. Present yield from their orchard is small and the facility does not operate anywhere near capacity. The main problem is that there are no commercial growers close to New Plymouth and the home orchard will not provide enough nuts to run the plant economically for several years yet.

The possibility of another large processing plant, to be run as a co-operative, being built in the South Auckland region by Vanessa Hayes adds another complication considering the early stage of her industry. Present trends indicate that the bulk of plantings will continue to be north of Auckland and the existing South Head plant could handle increased yields. They presently import NIS from overseas to supplement the local supply. Two modern plants, south of Auckland, would not seem to be a viable option in the medium term.

The NZMS does not have the political strength to enforce quality standards, and to set benchmarks for product and packaging. Fortunately the largest processor at South Head, has adopted the highest New Zealand standards for all its macadamia products that are sold in this country. Packaging is attractive, informative and geared to the local market.

The Australian Macadamia Society has its members operating under Code of Sound Practices for orchard performance and processing facilities to meet the highest international quality standards (Appendix 6). These standards are available to the New Zealand macadamia industry but to be effective major growers and processors must pull together to agree upon and set national benchmarks which would be accepted by food retailers alike. The sale of inferior quality nuts, either in a natural or added value form, by small processors or at the orchard gate will retard the growth of a desirable gourmet product on local food shelves.

The successful processors may be the ones to take a lead and set New Zealand standards printed clearly on the packaging. These standards could be registered and be mandatory for all sales to Health Shops, Supermarkets, Food Halls and other food outlets selling speciality foods. To obtain agreement from the food outlets, the Society, or the main New Zealand macadamia producers, would need to be united using an agreed national logo, publish full contents information in packages and provide a firm unconditional guarantee regarding replacement. Each processor would have details, on the packaging,

of the firm's address, date of packaging and description of the contents. Extensive advertising and publicity costs would be incurred which would be a part of the processing expenses. Australia uses a levy on growers for research and development and another for marketing. These levies are collected by the processor and paid to the Macadamia Society to develop further the research and marketing strategies.

One of the beneficial attributes of the macadamia nut is its ability to hold its flavour and texture for a long time under favourable storage conditions. Important factors regarding packaging and storage include:

- ❖ Macadamia kernel packed in cans, glass jars or in flexible packs may suffer damage during transit due to excessive vibration, rough handling and so on. Outer packaging should be printed with warnings about very careful handling and low vibration carriage.
- ❖ Mixing macadamia kernel with other food products such as other species of nuts, dried fruit and so on is not recommended as the other material may have a moisture content higher than 1.5% and have different flavours and odours which will affect the texture, flavour and aroma of the macadamia kernel.
- ❖ The main factors which affect stored macadamia kernel are moisture and oxygen content. As mentioned above, sealed glass containers are excellent storage vessels especially when kept in cool conditions. When flexible packaging materials are used the kernel should be enclosed in an environment which is low in moisture and oxygen content – less than 2% residual oxygen. Tests have shown that the flavour and texture of natural and roasted macadamia kernel is severely affected if the packaging material allows moisture absorption. Shelf life of at least 6 – 7 months can be expected if flexible material is used with a water vapour transmission rate of less than 0.02g/645cm²/24hr at 90% relative humidity and 55°C (Cavaletto and Yamamoto, 1968).

In 1984 the quality of the nylon/surllyn/LD polyethylene film used by the Queensland macadamia industry for raw kernel exports, was shown to be inadequate. The quality of the kernel deteriorated rapidly when stored in the film under ambient conditions.

Several different packaging materials were assessed and the main result showed that raw kernel packaged in biaxially – oriented nylon/foil/linear low-density polyethylene bags could be stored for at least eighteen months under Brisbane ambient conditions, with virtually no deterioration in quality. Tests with these materials under vacuum and no vacuum showed no significant difference in the quality of the kernel (Bowden and Reeves 1984). These materials, or others of the same quality are available in New Zealand.

5.04 Marketing the Crop

Compared to food crops such as apples, oranges and bananas, macadamias are a new commodity on the world market. Only four new fruit crops were introduced to world trade in the 20th century – avocados, blueberries, kiwifruit and macadamias.

For more than thirty years the nut has been publicised as a superior product in both its raw state and with many added – value styles. International retail prices are high taking it into the luxury class for many buyers. First the Hawaiians and then the Australians exported to affluent food outlets in America and Europe, and although macadamias are only a small percentage of the world's total nut market, the quantity marketed is increasing annually (Hargreaves 2004).

With New Zealand's proximity to Australia the local market for macadamia sales is affected severely by the volume of products arriving from across the Tasman. This is particularly so when an Australian macadamia export market is blocked, or restricted and the New Zealand market is able to absorb surplus product.

As far as it is known no New Zealand processor is exporting any local macadamia products. To compete with imports, mainly from Australia and a growing quantity from

South Africa, local growers and processors must raise standards in both quality and quantity. The body to best able to monitor and advise on these improvements is the New Zealand Macadamia Society. Members of the Society have available a Code of Sound Orchard Practices (based on the Australian model) and another Code for processing standards and a host of recommendations for such important matters as minimum standards for kernel, storage of NIS, on farm drying and food safety. The Society, with the co-operation of the major processing plants, has the opportunity to raise quality standards in all stages of the local industry, to lead discussion on product branding, packaging and to achieve political recognition.

5.05 Nutrition Facts and Health Benefits

One obvious target for aggressive marketing is the health business. Television, newspapers and magazines consistently feature overweight problems which are increasing, together with the need for diets and healthy eating habits to counter the current problem of obesity in society. Macadamias offer a healthy addition to foods which may help weight loss and bring additional health benefits to the reduction of cholesterol in the blood and a protective effect against coronary heart disease (Kris – Etherton 2002 Livesey 2000).

In Australia, research into nutrition and health benefits is funded by the macadamia growers with a subsidy from the government (McConachie 2001). Other research, using different tree nuts, shows that the daily consumption of tree nuts will have significant health benefits (Kris – Etherton 2002). The local macadamia industry must encourage the need to maintain a healthy diet. With the co-operation from medical practitioners, nutritionists and food scientists to reinforce the advantages of moderate consumption of macadamias the profile of macadamias in New Zealand would be promoted.

What then are the reasons why the macadamia nut should be shown as healthy as well as tasty? The composition of macadamias may vary slightly by variety, growing conditions and growing district but, in general, the raw, dried and dry roasted kernel are a rich

source of dietary fibre, carbohydrates, minerals, protein, vitamins and phytochemicals. (Table 30)

Table 30: The composition of macadamia nuts.

Natural Oils	75 %	Dietary Fibre	7.7%
Moisture	1.5%	Carbohydrates	4.7%
Protein	9.4%	Mineral Matter (including potassium, phosphorus, copper, iron, magnesium, calcium, zinc and selenium)	1.6%
Vitamins: B1, B2, B5, B6, E, niacin and folate.		Phytochemicals: Antioxidants, including polyphenols, amino acids, selenium and flavanols plus sterols	
Energy values	3000 kilojoules per 100 gms (727 calories)		

(McConachie 2001)

- ❖ Macadamias contain no cholesterol.
- ❖ Phytochemicals are an important group of natural chemicals of plant origin and they are important in maintaining our health. Research is being done to identify, and better understand the health role of the phytochemicals in macadamia nuts and it is likely that they reduce risk factors with a number of diseases (McConachie 2001).

It is important to emphasise that, in any publicity regarding the health benefits of macadamias, macadamias eaten daily in moderate quantities, are not fattening. Depending on other factors in one's diet it is recommended that 30 – 60 grams per day may actually result in weight loss (Livesey 2000).

One Australian study claimed that by eating 10 – 15 natural nuts per day there would be a 50% reduction in heart disease (Walker, 2002).

5.06 Macadamia Oil

This oil contains a higher percentage of monounsaturated oils (83.5%) than any other product (McConachie 2001). The oil may be used in cooking, similar to the use of olive oil, and it is an ingredient in some cosmetic products.

Unfortunately an oil processing facility is not a viable option for New Zealand. Australia, with its present yield, has only one commercial oil factory. First grade nuts are required for oil pressing and the market price of \$3 per kg NIS at 10% moisture makes the processed oil expensive. It takes an assured supply of suitable nuts to justify a factory working throughout the year. There is at least one importer of macadamia oil in New Zealand and it is brought in, in bulk, and bottled locally.

5.07 Export Possibilities

One of the important attributes of macadamias is that under controlled temperatures the kernel (or the NIS) will retain its taste and consistency for at least a year if the packaging is adequate. This flexibility could allow a group of growers to pool their kernel, to make a variety of high quality specialised added-value products and to export the whole crop to a single wealthy, top end speciality market. This may be termed “Boutique” marketing.

For example, a group of growers in the Bay of Islands could aggregate their kernel and sort it into different styles. Perhaps there may be two tonnes of kernel altogether. In the area there is a fine chocolate maker, a maker of macadamia liqueurs, a fudge factory and so on. There are a wide variety of products which could be made and a joint packaging and labelling agreed on.

This local group could, at first, join with New Zealand Trade and Enterprise and link with other food producers. A combined venture would attract more attention and publicity at the market place. For example, a market in New York would be sought. A major firm may agree to hold a “New Zealand Food and Wine Day” and this could be held at Easter or Thanksgiving Day or similar. If the quality of goods were excellent this could become an annual event.

Such a venture would have several advantages to the macadamia sales group of small orchard growers. It would gain synergy by joining others and would overcome the common export difficulty of having enough quantity to meet an on going demand for

product throughout the year. In addition it would get rid of the total crop at once, providing immediate payment and would present local businesses with additional work opportunities.

5.08 Conclusions

There was not a formal beginning to the New Zealand macadamia industry. From the late 1940's a few government employees of the Department of Agriculture, Ministry of Agriculture and Fisheries and the Department of Scientific and Industrial Research were engaged in macadamia variety evaluation. However, as the agendas for the enthusiastic scientists and technicians working on macadamia research, were set by those who were responsible for funding few, if any, projects reached fruition.

During the 1960's and 1970's some nurserymen became interested in semi-tropical horticultural crops including macadamias. Three men stood out: Dick Endt at Oratia, Jim Pringle at Te Puna and Don Boyes-Barnes at Kerikeri. All travelled separately overseas to observe developments in Hawaii, South Africa and Australia. Following their visits they all imported seed or scion wood and built a trade in selling trees to the public.

Thus the industry was driven by nursery sales rather than by government or grower leadership.

From the late 1970's and early 1980's there were two clear groups within the industry. More than a hundred hobby or novelty growers had small and medium sized orchards with the owners not making a living from the sale of macadamia products. Many growers hoped to retire to the orchard and add something extra to their superannuation payments. They joined the Co-operative to learn about tree management and cures to problems caused by pests. The growers Co-operative, Macadamia Plantations of New Zealand at Okaihau and Macadamia Enterprises near the Kaipara Harbour set up separate commercial operations. All were sold or ceased trading within twenty years.

From these uncoordinated beginnings there has been little growth and development. The industry needs to increase research efforts to provide information crucial for future success. In particular there is an urgent need to undertake two critical areas in variety evaluation and pollination studies. One variety, Beaumont, makes up nearly 90% of all plantings in New Zealand. Although this variety has some favourable features it is not suitable for major plantings of 5,000 – 50,000 trees unless picking costs can be reduced. As the nut does not drop when mature high labour costs for picking makes the variety not viable in large orchards. Despite the efforts of Ian Gordon, who has developed a number of New Zealand selections (named GT), local growers on larger orchards need new varieties which drop their crops between March – June. Wet winters in Auckland and Northland make mechanical harvesting a muddy and unpleasant operation. Catching the nuts before they hit the ground is possible, but expensive, and would not be feasible using existing harvesting equipment. Variety evaluation is a long – term project and the work commenced by Vanessa Hayes may prove to be invaluable.

Five Henry Bell ‘A’ series varieties were planted in the Kerikeri HortResearch Orchard in the early 1990’s. In 1993 – 94 several orchards and nurseries received a number of trees from these selections to plant and evaluate in local conditions. These trees are now ten years old and this writer visited many of the orchards hoping to obtain yield comments and assessments. No results were available to me. This information would be invaluable to the New Zealand macadamia industry as a backdrop to any future evaluation of varieties. Some of the growers receiving the Bell trees are members of the Macadamia Society and perhaps this body could collate the results. In January 2005, Ted Dawson, HortResearch, Kerikeri, spoke to the President and Vice President of the New Zealand Macadamia Society. They looked over the “Forgotten Macadamia Variety Trial” at the Kerikeri Research Station. The trial trees are likely to be removed, in the near future, to make way for another crop – probably kiwifruit. Mr Dawson noted that none of the dropping varieties in the orchard actually dropped their whole crop at maturity. He informally rated the five varieties from best to worst as A268, A217, A4, A104, A16 (Dawson 2005).

Cross-pollination and nut-set research in Australia continues in an effort to improve yields and profits. The close cooperation between the Australian and New Zealand Macadamia Society allows the results from Australian research to flow to this country but, as local conditions are quite different, it is important that New Zealand should carry out its own studies. Our yield per tree is so low that improved final nut set is an essential for future growth.

Funding for research has always been a problem in New Zealand. Government finance in horticulture has been used to help the major export earners such as kiwifruit growers. The Co-operative carried out useful research through HortResearch in Kerikeri but when the Co-operative ceased operations, research discontinued. The Macadamia Society has been able to carry out some research on insect pest damage, with some help with a government grant but the small membership of the Society generates limited funds. The Society does not have a commercial role and the industry, at the moment, has only one major trading company at South Head. Until other commercial organisations operate, (Torere Macadamias Limited and the Emacadamia Company at Oakura, New Plymouth owned by Bill and Christine Charteris, are the only ones on the horizon) funding is going to be difficult to attract. Industry funding is essential for the development in the future.

The role of the Society will be pivotal for industry growth. It is important to gain access to government agencies, national and local. A firm base has been established but the small number of members continues to be a worry. One possible avenue for wider industry involvement could be for the Society to join the body which represents the combined nut industry in New Zealand. NUTNZ is made up of representatives from the NZ Chestnut Council, the Hazelnut Growers of New Zealand and the NZ Walnut Industry Group. This group share a quality certification mark. The Macadamia Society has been invited to join and this, in future, may lead to a having a representative on the new organisation called Horticulture NZ.

One research topic which the Society could undertake now is to identify the best sites for macadamia plantations. Using the limits set by climate the area is not too large. The

rising value of rural land, especially near the coast, is a major consideration but there are large areas of Northland, Coromandel and Eastland which are not productive at the moment. A proportion of this unused land is under Maori ownership and may attract monetary grants to establish macadamia enterprises. Although there would be a large pool of labour required for the initial establishment and planting, a successful operation would not require a large work force to operate.

In addition to the research function the Society should continue to urge members to maintain high standards in growing the crop and processing and packaging the products. Better orchard management should lead to an increase in yield especially if insect and rodent pests are controlled. Tree nutrition should be monitored and adjusted when necessary. There are too many processing plants in the country and standards are often unsatisfactory. South Head is doing a good job and more growers supporting this venture may prevent the need to import NIS. The taste of the New Zealand macadamia is excellent and this may be due to the fact that most local orchards pick their crop when mature. However, this value of good taste may be lost because of inferior processing and packaging methods. Information is available regarding packaging materials and shelf life of products but much of the local produce, reaching the market, does not stand up to the standards reached by imported goods.

The aim for all sections of the New Zealand macadamia industry should be to produce a high value product meeting international standards. In the short term the yield should be raised closer to international levels with the goal to make New Zealand self-sufficient in this market. The health market is worthy of close attention. Available research indicates the moderate and regular eating of macadamia products in the diet may help to prevent heart problems. In addition, this moderation in macadamia consumption may aid slimming.

The macadamia nut is expensive to produce and, with pine nuts and cashew nuts, command the high prices on world markets. To attain high retail prices the local industry must lift quality standards to international levels. There are many added value macadamia products available in specialist outlets and health shops. It lowers the public

image if inferior packaging is used or if soft second-grade nuts are sold in supermarket bins for inflated prices. Quality before quantity could be the catchy-cry for all sections of the New Zealand macadamia industry.

Bon Appetite!

CHAPTER 5: REFERENCES

- Bowden, R.P., Reeves, R.K. 1984. Packaging of Raw Macadamia Kernels. Food Research and Technology Branch, Queensland Dept of Primary Industries, Hamilton, Brisbane. Published in the Proceedings of the Second Australian Macadamia Research Workshop, 1987.
- Cavaletto, Catherine G., Yamamoto, Harry Y. 1968. Criteria for Selection of Packaging Materials of Roasted Macadamia Kernels. Food Technology, 22, 1: 97–99.
- Dawson, Ted. 1991. Macadamia Nut Evaluation at Kerikeri Research Orchard, Internal notes, unpublished.
- Dawson, Ted. 2005. Some Passing Notes on a Forgotten Macadamai Trial, Printed in NZMS News Letter No 41 Feb: 8
- Hargreaves, Graeme. 2004. Growth of the macadamia industry. Australian Nutgrowers, Sept, 26–29
- Hayes, Vanessa. 2005. Email dated June 28.
- Kris-Etherton, Penny. 2003. Nuts May Protect From Heart Disease. Source Penn State University. Reprinted from Australian Macadamia Society. NZMS Newsletter No. 32, Feb: 7.
- Livesey, John. 2000. Nuts To Heart Attacks. NZMS Newsletter No. 37, Mar: 5–6.
- Macadamia Industry Code of Sound Orchard Practices. 1992. Australian Macadamia Society, Jan.
- McConachie, Ian. 2001. Australian Macadamias – The Healthy Nut!
2001. AMS, November: 39 - 41

NZMS. Newsletter, No. 39, Jul 2004: 9–10.

Opotiki District Focus. 2001. Maori Land Use. Options Resource Kit.

Trochoulis, Tim. 1992. Letter to AGM of the Co-op.

Walker, Ross. 2002. Reversing heart Disease. Paper presented at the Conference Proceedings of the Australian Nut Industry Council and the Australian macadamia Society, 2002



May 2002

Institute of Food, Nutrition
and Human Health - Albany
Private Bag 102 904,
North Shore Mail Centre,
Auckland,
New Zealand
Telephone: 64 9 443 9653
Facsimile: 64 9 443 9640

Dear

**The Macadamia Nut Industry in New Zealand
Information Sheet**

1. I am Bernard Coleman from Kerikeri, and in 2002 I am starting a thesis for a Master of Philosophy degree. My telephone number is ([REDACTED])

My supervisor is Professor Errol Hewett, Professor of Horticultural Science, Massey University, Albany Campus, Auckland.

Phone: [REDACTED]
Email: e.w.hewett@massey.ac.nz

2. The purpose of my study is to record the history of the macadamia industry in New Zealand, to investigate the present state of the industry and to suggest options for future development.
3. Those who will be asked to participate in this research will be visited by me for discussion and to record, on tape, their experiences and views on the macadamia industry. A visit should last for approximately one hour and, where necessary, a follow-up visit or phone contact may occur.
4. I obtained the names of those who have been asked to participate from the period when I was a grower and processor in Kerikeri and from prominent people still engaged in the industry (eg. from the Macadamia Society Newsletters).
5. The information obtained from this research project will be used in my thesis or in any publication arising from this research project.
6. At the conclusion of this research project all information obtained, including audio-tapes made, will be disposed of in one of the following ways:
 - (a) the participants may retain the tape(s); or
 - (b) agreement that the tapes be destroyed; or
 - (c) all data will be kept in storage in a research archive.

Te Kūmenga ki Pūrehuroa

Inception to Infinity: Massey University's commitment to learning as a life-long journey

7. Participants in the project may be assured that any information given will be confidential to the research or any publication resulting from it.
8. The rights of the participants include the right to:
 - (a) decline to participate
 - (b) to refuse to answer any particular questions
 - (c) to withdraw from the study at any time
 - (d) to ask any questions about the study at any time during participation
 - (e) to provide information on the understanding that your name will not be used unless you give permission to the researcher.
 - (f) to be given access to a summary of the findings of the study when it is concluded.

I am looking forward to discussing these matters with you in the near future.

Bernard Coleman

[REDACTED]

Phone: [REDACTED]

[REDACTED]



Institute of Molecular BioSciences
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Private Bag 102 904
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Auckland
New Zealand
Telephone: 64 9 443 9799 extn 9860
Facsimile: 64 9 443 9640
Email: IMBS@massey.ac.nz

The Macadamia Nut Industry in New Zealand

Consent Form

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I understand I have the right to withdraw from the study at any time and to decline to answer any particular questions.

I agree to provide information to the researcher on the understanding that my name will not be used without my permission.

(The information will be used only for this research and publications arising from this research project).

I agree/do not agree to the interview being taped.

I also understand that I have the right to ask for the audiotape to be turned off at any time during the interview.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signed:

Name:

Date:



CERTIFICATE OF INCORPORATION

of

NEW ZEALAND MACADAMIA SOCIETY INCORPORATED (AK/875370)

This is to certify that NEW ZEALAND MACADAMIA SOCIETY INCORPORATED was incorporated under the Incorporated Societies Act 1908 on the 2nd day of December 1997.

A handwritten signature in black ink, reading "Neville Harris".

Neville Harris
Registrar of Incorporated Societies
3 December 1997



CONSTITUTION OF THE NEW ZEALAND MACADAMIA SOCIETY INCORPORATED.

1.0 NAME:

The name of the Society shall be "The New Zealand Macadamia Society Incorporated".

2.0 REGISTERED OFFICE:

The Registered Office of the Society shall be situated at 725 Harrisville Road, Pukekohe or such other place in New Zealand as the Executive may, from time to time, determine.

3.0 AIMS AND OBJECTIVES:

- (a) To promote the development of a vigorous macadamia industry in New Zealand which can compete effectively in local and world markets;
- (b) To foster and promote goodwill amongst members by providing a national forum for interaction and discourse;
- (c) To encourage the exchange of ideas and information on all aspects of macadamia growing, processing, storage, marketing and consuming, and allied industries through field days, seminars, workshops, newsletters and whatever other media is appropriate at the time;
- (d) To promote macadamia nut consumption locally and internationally and to facilitate greater consumer awareness of the dietary and health benefits of macadamias and to increase awareness of macadamia byproducts through appropriate educational and promotional channels;
- (e) To encourage research into, and recording of, all aspects of macadamia growing, processing, packaging, storage, marketing, wholesaling, consumption, health properties and allied industry aspects as may from time to time be desirable and as funds permit;
- (f) To encourage the exchange of ideas and information by documenting trials, experiments and other acquired knowledge providing a reference source available to members;
- (g) To be a lobby group to government for funds and on any aspect of governmental activity which effects or relates to the macadamia industry;
- (h) To develop a set of criteria and quality standards for all producers, processors and marketers to meet and to allow them to register to use a quality assurance mark for their products. To continually monitor and update these as necessary so as to achieve a consistent quality in macadamias available for consumption;
- (i) To promote the Society's quality assurance mark as a guarantee of high quality to consumers and to encourage all participants in the macadamia industry to meet the criteria and quality standards necessary to allow them to use the mark;
- (j) To inform and educate and encourage all industry participants in the formation and implementation of a Hazard Analysis Critical Control Point Plan (HACCPP);
- (k) To do all such acts or things and make such arrangements whatsoever which in the opinion of the Society are incidental or conducive to the objects of the Society in which in the opinion of the Executive can advantageously be carried out, performed, done or executed for the benefit of the society and for the furtherance of its objects.

In the event of any ambiguity, this clause and every other clause shall

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be construed in such a way as to widen and not restrict the powers of the Society.

4.0 **POWERS:**

The Society shall have the power to do all such lawful acts and things that are incidental or conducive to the attainment of the above mentioned objects or any of them or any other objects which the Society may, from time to time, be authorized to undertake. Without in any way limiting the generality of the foregoing powers, the Society shall have power to:

(a) To use the funds of the Society in payment of all costs and expenses properly incurred in carrying out the objects of the Society including the employment of such Officers, Agents and Servants as shall appear expedient to the Society's Executive.

(b) To invest monies and assets belonging to the Society and not immediately required for use, in such forms of investments as the Executive sees fit and as are reasonable and prudent.

(c) Purchase, take on lease, hire or otherwise acquire or hold on any tenure any real or personal property.

(d) Make grants or donations to any person or body undertaking work which in the view of the Executive will further the objects for which the Society is established or assist the Society in furthering such objects.

(e) Raise or borrow such sum or sums of money as the Executive may from time to time, see fit, with or without security as approved by a general meeting of the Society.

5.0 **MEMBERSHIP:**

There shall be three classes of member:

(a) **FULL MEMBERS:**

Who are any person(s) or Body Corporate who subscribe to the objects of the society and who are approved for membership by the Executive.

(b) **STUDENT/ASSOCIATE MEMBERS:**

Those persons who have a limited interest in the Macadamia industry. The extent of the limitation will be decided by the Executive and the membership of the person concerned may be reviewed on an annual basis.

(c) **HONORARY MEMBERS:**

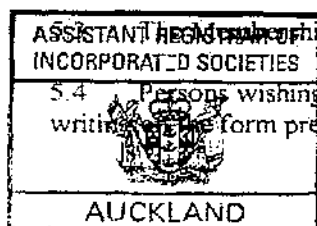
Being persons, firms or corporate bodies who may not be engaged directly in the Macadamia industry nevertheless because of special and active interest in the affairs of the Society are in the opinion of the Executive worthy of admission. Members of this class will not be liable for a subscription or levy.

5.1 Members other than Full Members shall not have nomination or voting rights at any meetings of the Society, nor shall such person or persons be eligible to hold any office of the Society.

5.2 A Register of Members shall be kept by the Secretary of the Society.

5.3 The Register of the Society shall be kept at the registered Office of the Society.

5.4 Persons wishing to become members of the Society must make application for membership in writing in the form prescribed for that purpose to the Executive for approval.



5.5 A corporate member may, by resolution of its directors or other governing body, authorise one person only, as it thinks fit, to act as its representative either at a particular meeting or at all meetings of the Society or to serve on the Committee. A person so authorized is, until notice that such authority is revoked by the corporate member is received by the Society, entitled to exercise the same powers as the corporate member, serve on the Committee and hold office and serve on any other committee of the Society on behalf of the corporate member as if that person were a natural person and a member of the Society.

6.0 CESSATION OF MEMBERSHIP:

(a) A Member may resign at any time by giving notice in writing to the Secretary.

(b) If by resolution of the Executive passed by a majority of at least two thirds of those present and voting at a duly summoned meeting of the Executive it is declared that the conduct of a Member has been prejudicial to the interests of the Society and it be resolved that his or her or its membership be terminated then such membership shall be terminated as at the time of the passing of the resolution. Provided always that twenty one (21) days notice in writing of such meeting of the Executive and its purpose shall be sent to such member of the Society at the Member's last known postal address and that the Member be given the opportunity of stating his/her case to the Executive if the Member so desires.

(c) Any Member who no longer qualifies for membership under Section 5 of this constitution or whose subscription has been requested and which remains unpaid after the expiration of six (6) calendar months from the date of the invoice shall cease to be a member and shall be struck off the Register by the Secretary provided that, in the absolute discretion of the Executive such Member's name may be restored to the Register any time upon payment of all arrears due at the date of striking off. All arrears due at the date of striking off shall be recoverable by the Society notwithstanding such striking off.

7.0 AFFILIATION FEES, SUBSCRIPTIONS AND LEVIES:

A. The Executive shall determine the proposed subscriptions payable by each Member for each year and recommend to the Membership the proposed new fees at each Annual General Meeting. The proposed fees are subject to approval by the members at the Annual General Meeting which will be free to set the new fee at the proposed level or any other level.

B. In addition to the annual subscription the Society in the Annual General Meeting may determine an affiliation fee or entrance fee to be charged to applicants on admission to Full Membership or on rejoining the Society after a lapse or other cessation of membership.

C. In addition to the affiliation fees, or subscriptions, the Society may in a General Meeting make a special levy on members for the purpose of attainment of the objects of the Society. The particular purpose for which the levy is required must be determined by the Annual General Meeting and the monies raised from such levy may not be applied by the Executive for any other purpose without the approval of the Society in General Meeting.

D. The affiliation fees or subscription payable by each member shall become due and payable for each financial year on the first day of April with the Exception of the inaugural subscription which will be due on a date set by the first Annual General Meeting.

8.0 OFFICERS OF THE SOCIETY

8.1 There shall be five officers of the Society, being the President, Vice President, Secretary, Treasurer and Editor.

ASSISTANT REGISTRAR OF
INCORPORATED SOCIETIES

8.2 All officers shall be elected by the Society in Annual General Meeting. Nominations for election shall be received by the nominee and two members of the Society and lodged with the Secretary of the Society not less than 6 weeks prior to the Annual General Meeting to allow time for the names of the

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nominees to be included with the notice to members of that Annual General Meeting. In the event of no or insufficient nominations being lodged with the Secretary further nominations may be taken from the members present at the Annual General Meeting or from those members who have given their consent to being nominated.

8.3 The President shall be elected for a period of 3 years and on expiry of this term of office may be elected on an annual basis for a maximum term of a further 2 years. Further re-election to the office of President is allowable after a stand down period of at least 1 year. During the term of office the President is spokesperson for the Society.

8.4 All other officers of the Society shall be elected for a period of 2 years but there shall be no limit on the number of times a person may be elected as such an officer of the Society.

8.5 Newly elected officers will take office at the close of the Annual General Meeting at which they were elected.

8.6 In the event of the President being unable to carry out their duties these will be taken over by the Vice President or failing that person being available by a person decided by the Executive.

9.0 THE EXECUTIVE:

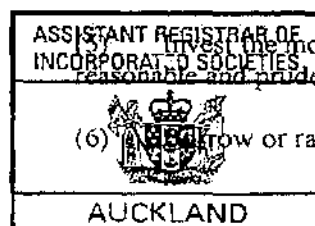
A. The governing body of the Society shall be an Executive consisting of the following persons:

- (1) The five officers of the Society; and
- (2) Up to six full members of the Society elected at the Annual General Meeting.

B. The general management and control of the Society and the control and investment of its funds shall vest in the Executive. The Executive shall exercise all the powers and perform all the duties for which the Society has been established and shall have full power to do all such things as may be necessary to attain the objects of the society.

In particular, but without limiting the generality of the foregoing, the Executive may:

- (1) Determine regulations for the conduct of any business of the Society and any other matter affecting the general conduct of the Members of the Society.
- (2) Demand payment of all subscriptions, fees or other monies due to the Society and to grant any rights and privileges to the Members.
- (3) Appoint such Committee of any two or more Members for such purposes as the Executive may, from time to time, think fit and may co-opt any person or persons to any committee and each such committee shall carry out such functions and exercise such powers as the Executive may prescribe provided that the Executive may at any time revoke any appointment or any authority so made or given and may disband any Committee by notice to that effect.
- (4) Control the funds of the Society and open and maintain accounts at a bank as the Executive deems necessary in the name of the Society.



(5) Invest the money of the Society not immediately required in such securities as are deemed reasonable and prudent or place the same on deposit with a Bank as the Executive determines.

(6) Borrow or raise moneys with or without security in such manner as the Executive thinks fit.

(7) Purchase, hire, take on lease, or receive by way of gift or otherwise acquire for the purpose of the Society any real or personal property and to likewise dispose of the same on such terms and conditions as the Executive deems fit.

(8) Construct, maintain, alter, improve, enlarge, pull down, remove or replace, manage or control any offices, rooms, houses, sheds or any other buildings, yards or improvements likely to advance the Societies interest directly or indirectly.

(9) Engage and dismiss employees on such salary, terms and conditions as the Executive deems fit.

(10) Enter into all such negotiations, contracts, agreements in the name of and on behalf of the Society as the Executive considers expedient for the purpose of the Society.

C. Each member of the Executive shall be entitled to vote on any motion before the Executive. A quorum for a meeting of the Executive shall be 51% of its members.

D. The Executive may carry on the business of the Society notwithstanding any vacancy in its Membership and may fill any casual vacancy up to a maximum of 3 by appointing another Member of the Society who shall hold office until the next Annual General Meeting and who shall have full voting rights. Vacancies in excess of 3 shall be filled by the Society at a General Meeting called for that purpose.

E. If a casual vacancy occurs in the Offices of President, Vice-President or Secretary, or if any other such Officer is unable to perform the duties of the Office for any reason, the Executive shall appoint a Member to that Office until the next Annual General Meeting.

H. The Executive may, by resolution, co-opt any person for any special or advisory purpose during the year, but such person shall not be a Member of the Executive; Such co-opted persons shall be co-opted for a specified period of time.

10.0 THE CHAIRPERSON

A. The President shall be Chairperson at each General meeting of the Society and at each meeting of the Executive. In the absence of the President the Vice President shall take the Chair. In the absence of either then the Members present shall elect a Chairperson for that meeting.

B. The Chairperson of any meeting shall have a deliberate vote and in the case of an equality of votes shall have casting vote.

11.0 GENERAL MEETINGS:

A. General Meetings of the Society shall be held as may be considered necessary by the Executive provided that such a meeting will be held at least once each financial year.

B. A number of members comprising not less than twenty five percent (25%) of all financial Members may require the President of the Society to call a General Meeting to discuss any matters specified in the Notice of the Meeting and at such Meeting may make recommendations to the Executive which will take action if it sees fit.

C. The Executive shall meet within one (1) month following the Annual General Meeting and thereafter as the Executive determines but for a total of not less than three meetings each year.

ASSISTANT REGISTRAR OF
INCORPORATED SOCIETIES



AUCKLAND

whose subscription is more than six (6) months in arrears shall be entitled to vote at any General Meeting or Executive Meeting of the Society.

E. The Annual general Meeting of the Society shall be held during the months of June in each year at such time and place as the Executive shall determine after taking into account the wishes of Members as expressed at a prior Annual General Meeting.

F. Notice of the Annual General Meeting, and any Special General Meeting shall be sent by post to each financial Member of the Society not less than thirty (30) days before the date appointed for holding the same.

G. The agenda for the Annual general Meeting will include the President's annual report, the financial statement of the Society, Committee reports, election of officers, appointment of auditor, setting of subscriptions and levy if applicable, general business as appropriate.

12.0 PROCEEDING IN GENERAL MEETINGS:

A. Twenty (20) Members of the Society present and entitled to vote shall constitute a quorum. If at the expiration of thirty minutes after the time appointed for the commencement of a meeting a quorum is not present then the meeting shall be abandoned.

B. Every voting Member of the Society present in person shall have one vote.

C. The mode of voting shall be by a show of hands however a poll will be conducted if called for by any voting member.

13.0 APPOINTMENTS AND DUTIES OF OFFICERS:

A. The Executive may appoint officers, servants and agents as it sees fit and on such terms and under such conditions as it may, from time to time, consider necessary for the effective carrying out of the objects of the Society. The Executive shall define in writing the duties of each officer, servant or agent.

B. No Member shall receive or obtain any remuneration except by honorarium approved by the Executive or as a salaried Officer from the property or operations of the Society.

14.0 FINANCE:

A. The Treasurer shall ensure that proper books of account are kept for the Society and shall duly prepare the financial statement for each financial year ending 31st March, have it audited by the Auditor and presented at the next Annual General Meeting of the Society.

B. The Treasurer shall deposit all money received in the Bank of the Society as promptly after receipt as circumstances may permit. The account of the Society at such Bank should be operated upon and cheques and other bills of exchange and instruments endorsed by such signatories and otherwise in such manner as the Executive may from time to time determine provided that all cheques will require at least two signatories.

C. Reasonable out of pocket expenses incurred by members of the Society on approved Society business may with the approval of the Executive be reimbursed on application by the Member. Such application shall be supported by appropriate documentation.

15.0 AUDITOR:

The Auditor of the Accounts of the Society shall be appointed at each Annual General meeting of the Society. The Auditor shall retire annually from Office but shall be eligible for re-election. The Auditor shall examine the books and Accounts of the Society and shall verify and certify the Annual Balance Sheet and Accounts of the Society.

16.0 INTERPRETATION OF RULES:

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In case any matter at any time arises not provided for in the rules or any doubt arises to the interpretation of these rules, the same shall be determined by the Executive whose decision is final.

17.0 ALTERATION OF RULES:

No alteration or addition to or revision of these Rules shall be made except by a resolution passed by a two thirds majority of the Members present and entitled to vote at an Annual or Special General meeting of which notice shall be given in the manner provided for in Rule 11.0. Such notice shall include the proposed amendment or alteration to the Rules and a brief explanation of its purpose.

18.0 DISSOLUTION.

A. The society may be wound up voluntarily if the Society at a General Meeting of Members passes a resolution requiring the Society so to be wound up, and the resolution is confirmed at a subsequent General Meeting held no sooner than thirty (30) days nor more than two (2) calendar months after the date on which the resolution so to be confirmed was passed.

B. If, upon the winding up or dissolution of the society there remains after the satisfaction of all debts and liabilities any property whatsoever, the same shall be transferred to or applied towards any organisation, concern or Society engaged in similar objects and activities to those of this Society in such sums and to such extent as the Executive may determine.

19.0 INDEMNITY:

A. The Members of the Executive shall be indemnified from all losses and expenses incurred by them in or about the discharge of their respective duties, except such as happen from their own respective willful default.

B. No Members of the Executive shall be liable for any other member of the Board, or for the joining in any receipt or document, or for any act or omission, or for any loss or expense happening to the Society unless the same happens from their own willful default.

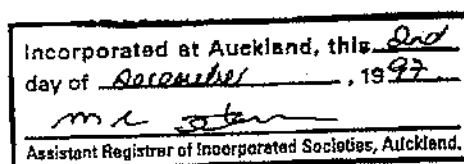
20.0 COMMON SEAL:

A. The Common Seal of the Society shall be that approved by the Executive who shall be responsible for the safe custody and control thereof.

B. Whenever the Common Seal of the Society is required to be affixed to any deed, document, writing or other instrument the Seal shall be affixed thereto pursuant to a resolution of the Executive and in the presence of two Executive Members who shall sign the document or instrument to which the Seal is so affixed.

This is the document marked "A" referred to in the annexed declaration of Virginia Valentine Warren made at Auckland this 21st day of November 1997 before me.

Paul Lewis



Impaired Root System is the Main Cause of Macadamia Decline

Tim Trochoulias

Reproduced with the kind permission of the Australian Macadamia Society

Agprobe Consultancy Services, Brisbane

This article has been prompted from discussions at MacGroup meetings and reading chat sessions in MACMAN NET on symptoms of macadamia decline and macadamia die-back which describes a whole host of symptoms for weakened and unproductive trees. Various factors that relate to macadamia decline are reviewed in this article.

Site selection

The site of a macadamia plantation strongly affects its capacity to produce a profitable crop of nuts for the macadamia farmer. Growers must give considerable attention to the physical and chemical qualities of the soil and encourage biological activity to gain a profit from growing and harvesting macadamias and then to try to work out how to make a living from it usually spells disaster.

Soil

To quote from Department of Primary Industries and NSW Agriculture sources:

'Macadamias will grow in a wide range of free draining soil types but perform best on deep, well drained soils, rich in organic matter. A minimum depth of 0.5m of well drained topsoil is essential for successful commercial production. A depth of one metre is preferred. This is necessary for optimum tree growth and productivity, to minimise decline in bearing trees and to avoid trunk canker.' (O'Hare *et al.* 1996)

'Soil should be 1-2m deep and well drained...' (Trochoulias *et al.* 1990)

Unfortunately when considering all aspects of orchard preparation, site selection is given less than the required attention it deserves. Although macadamias adapt to a wide variety of soils in the early years, trees produce best where roots develop without chemical or physical restriction. It is not until the trees approach maturity that constraints of the soil profile begin to impact on tree productivity by which time a grower is fully committed to a particular property.

Physical soil condition

Texture, depth and arrangement of sedimentary rocks in distinct layers describe the physical soil condition. Macadamias thrive in a wide range of soil textures which provide aeration for root growth and have a moderate water holding capacity. Soils that have distinct layers of sedimentary rocks, or a hard impervious layer of clay resistant to drainage and root growth should be avoided.

Soil Chemistry

Trees produce well in moderately acid soils (water pH of 5.0 to 5.5, Aitken *et al.* 1992). Basic (alkaline) or sodic soils should be avoided as poor structure impedes water penetration and drainage. Saturated soil conditions kill macadamia roots, contributing to decline. Macadamias require a whole range of elements but extra care should be made to provide adequate phosphorus (Stephenson *et al.* 2003) calcium (Trochoulias, 2003), zinc (Huett *et al.* 2003, Trochoulias, 2000) and boron (Stephenson and Gallagher, 1987)

Soil Organic Matter

The use of macadamia husks was first used experimentally in nursery potting media for macadamias (Trochoulias, 1980). Firth *et al.* (1994) in a five year trial at Dunoon demonstrated the value of husk mulch in improving yield of macadamias in various stages of decline. In most cases where growers have applied husk mulch to weakened and unproductive trees over the past 15 years these trees have shown renewed growth. It is important to differentiate between applying a thin layer of intact husks compared to compost 10cm deep as trailed by Cox *et al.* 2003. Composting procedures have been detailed by Jenkins and Van Zwielen (2003).

The main argument from growers against composting on their properties is the logistics of handling large volumes of moist material. Husks from the previous harvest can only provide a limited quantity of organic matter compared to what is required for the whole orchard. The alternative is to import composted broiler litter or use dehydrated pelletised fowl manure. Although the macadamia industry is strongly dependant on chemical fertilisers it is essential to apply some form of organic matter to help preserve organic carbon levels in the soil. Macadamia trees perform best when both inorganic and organic fertilizers are used (Trochoulias, 1992).

Erosion

Most growers are conscious of the detrimental effects of erosion and take measures to preserve their soil which is the resource for their future income. In the past it was difficult to control erosion in mature orchards as vegetation to stabilize soil was shaded out by maturing canopies. With the advent of shade tolerant cover crops like sweet smother grass (*Dactyloctenium australe*) it is now possible to stabilize soil and reduce erosion in mature orchards (Firth, 2002).

Impeded soil drainage

In well-drained soils the bulk of roots of most macadamia trees will be located between the surface and 1.0

Impaired Root System is the Main Cause of Macadamia Decline - contd

to 1.5m of soil. In the presence of rock strata or extremely tight layers of soil such as hardpan, root development will be severely limited.

Sometimes after abundant rainfall trees suffer a setback. The likely cause in poorly drained sites is that excess water reduces the supply of oxygen to roots which die due to anaerobic conditions. In a poorly aerated soil a tree cannot take up water and nutrients. Both water and oxygen are needed for tree roots to thrive.

Irrigation and nutrition management at sites with impeded drainage

Areas with impeded drainage have a smaller soil moisture reservoir (water holding capacity) to refill between irrigations. More frequent irrigations will be required to avoid moisture stress. Like wise nutrient applications will be more frequent than those applied to trees with deep soil profiles. Instruments that measure soil moisture content can help growers apply optimum irrigation to trees.

In deep soils macadamias have been found to have the capacity to extract moisture approximately 2.5 times more effectively than citrus (Lloyd *et al.* 1991). Stephenson *et al.* 1995 grew macadamias in large concrete tanks (lysimeters) in which water and nutrients were closely monitored and controlled. By withholding water they were able to impose stress on mature macadamia trees at specific growth stages. They showed that stress reduced nut quality particularly at the oil accumulation stage which has not been replicated under plantation conditions where tree roots can access both vertically and laterally during dry times.

Searle and Lu (2003) found that water use in variety 741 is 10-30% higher than 344 under Bundaberg conditions during summer. This could have ramifications for current practice and future irrigation design in the Bundaberg region and be adapted for trees in Gympie.

Macadamia decline

Trees affected by macadamia decline show lack of vigour, smaller leaves and early leaf fall. Leaves may be spotted, yellowing with burnt margins. Twig dieback develops that can extend to larger limbs. Some trees set a heavy crop before further decline and may become unproductive and sometimes die.

According to Fitzell (1994) "There is no one cause of macadamia decline, rather the disease appears to be caused by a combination of related soil conditions which lead to the rundown of tree function. Contributing factors include phytophthora root rot; deficiencies in elements like phosphorus; shallow marginal soils; and low soil organic matter."

Burnside (1983,1987) dealt with the subject of macadamia decline at both the First and Second Macadamia Research Workshops. He attributed macadamia decline to mainly nutrition problems and lack of organic matter.

Trials to overcome macadamia decline

Firth and Loebe! (1987) used calcium, magnesium amendments and macadamia husk mulch to improve trees with macadamia decline. They noted that fibrous root development of H2 variety was significantly ($P<0.05$) greater under a gypsum treatment compared to dolomite in two years out of three. After four years macadamia husk mulch improved yield but reduced quality due to mould-infected kernel. The likely contributor to mould was that fallen nuts were subjected to higher moisture in the mulch treatment compared to dry soil in the control and fertilizer treatments. Trochoulias and Johns (1992) showed that nuts harvested under irrigated trees had significantly less ($P<0.05$) grade 1 kernels than from non-irrigated trees.

The evidence of the benefits of cover crops to improve organic matter and reduce erosion has been extensively researched over many years (Firth, 2000). The fact that cover crops and mulches surround fallen nuts with high moisture that encourages nut deterioration compared to dry ground should not dissuade growers from applying organic materials to the soil. Organic matter preserves tree health and provides nutrition and soil moisture to tree roots. The marginal deterioration from increased humidity surrounding nuts may require more frequent harvests to prevent quality deterioration.

Explanations of macadamia decline - Allocation of assimilates (plant foods)

Landsberg (1987) stated "The greatest increase in flower numbers appears to take place in the 6-10 year age range. This is the period when the symptoms of macadamia decline are observed, caused by the effects of the heavy demands of fruit growth and the subsequent 'decline of leaves'. He presented data from fruit trees that showed as the number of fruits carried by a tree increases the quantity of assimilates channelled to the roots decreases. As trees age, roots are subjected to a competitive disadvantage compared to fruit, leaves, stems and branches.

To add to these observations, after viewing hundreds of plantations in the past 30 years I have noticed that macadamia decline is usually manifested in trees that reach approximately 10 years of age after they have produced two or three commercial crops. Tree reserves are usually exhausted when

Impaired Root System is the Main Cause of Macadamia Decline - contd

roots are not foraging properly due to inadequate root development caused by a physical obstruction like a hardpan or bedrock. Trees continue producing nuts at the expense of roots and reserves in the limbs and trunks of trees. Ultimately depletion of tree reserves affects leaf production causing excessive leaf fall which reduces canopy density.

Reduction in canopy is followed by terminal die-back and yield reduction with lowering of kernel quality. *Once a tree suffers macadamia decline it will never reach the yield level of healthy trees in the same orchard.* Attempts have been made to rejuvenate trees in decline by applying extra phosphorus, husks, fowl manure, organic matter. The response is usually marginal at best, and in most cases, not cost effective.

Trunk canker

Trunk canker in macadamia is caused by the fungus *Phyophthora cinnamomi*. In new orchards the mode of infection is usually from contaminated nursery stock. This can be aggravated by bark damage from stones thrown by mulching and slashing machinery. During storms large hail can cause injury to exposed branches and major limbs. After a hail storm a registered fungicide should be sprayed on to trees to protect damaged bark from trunk canker infection.

In plantations with free draining soil it is possible to control the disease by applications of a registered systemic fungicide in white, water based, flat paint. In poorly drained sites control is much more difficult as the disease spreads to limbs higher up in the canopy.

Other factors contributing to decline

Many other factors have an impact on macadamia like manganese toxicity and soil erosion (Fitzell, 1994). Compaction can inhibit root growth and overuse of chemical fertilizers can cause excessive mineralisation of organic matter. Macadamias produce best when trees receive both organic and inorganic fertilizers (Trochoulas, 1992). The main factor that can include macadamia decline faster than any other is restricted root development caused by a hardpan, bedrock or heavy clay.

In areas where soil erosion is apparent it is essential to preserve the resource by reducing the impact of erosion. Trees that have been planted in gullies should be removed and replaced by grass ways to carry torrential rainfall. A number of orchards in the Northern Rivers have been treated this way with minimal loss of production and maximum reduction of soil erosion.

Fast or slow decline affecting a small number of trees in a plantation

There can be situations where individual trees or a few trees in a planting, may show decline symptoms while the majority of neighbouring trees are healthy. This can happen due to faster development at the juncture of the graft union of either the scion or rootstock (rootstock-scion incompatibility). This constriction can impede normal tree development. Likewise the existence of a rock-shelf under a particular tree in deeper soil.

Decline can be caused by severe stress suffered by the tree at some stage during its life, like wind causing a blow down. The tree may have been staked upright but the damaged root system can precipitate decline symptoms. Mature trees that die almost overnight have been observed occasionally with leaves turning brown and attached to limbs. The cause can be from infection by a bacterium *Ralstonia solanacearum* (Vock, 2003). The disease is mostly found in shallow marginal soil that can become waterlogged. Large trees can sometimes give the appearance as though a fire has gone through and burnt them. Lightning strike is sometimes responsible. Macadamia decline can sometimes be confused with insect damage. Macadamia felted coccid (*Eriococcus ironsidei*) can cause serious damage to mature trees if left unchecked (Ironsides, 1981). It is usually noticed in upright varieties with leaves showing a yellow tinge.

Site selection is a very important decision

It is hard for a grower to accept that he/she has chosen a site with limited soil depth after macadamia decline overtakes a significant part of the orchard. It is a bitter pill to swallow after expectations had been so high when buying the land. Macadamia roots cannot prosper in a hostile environment. If the rest of the orchard is on deep soil and can carry the loss from the poor part it may be possible to make some improvements such as breaking hardpans with large equipment. This is difficult to do with established trees as trees will sustain major root damage. Deep ripping and placement of calcium is best carried out before planting trees.

Some growers in poorly drained areas have resorted to mounding. That involves moving topsoil from the inter-row to the area close to the tree roots. This has had limited success in well drained sites to control erosion but is not cost effective in poorly drained sites as a large part of the root system is destroyed and harvesting is made more difficult.

Impaired Root System is the Main Cause of Macadamia Decline - contd

Pruning – reduces the impact of decline in orchards with shallow soils

In mature orchards with deep soils pruning is determined by management requirements of harvesting and spray coverage (McFadyen *et al.* 2003). By contrast in shallow soils pruning can offer a partial solution to overcome tree decline before the issue of tree crowding arises. When top growth is removed some of the storage reserves in the top of the tree are lost temporarily until they are recycled. After top pruning most of the reserves in the roots remain the same but the tree gets a better balance of roots to shoots. Shoots react to pruning by strong re-growth depending on the extent of the pruning and its timing. If vegetative regeneration is effective the next season's crop has a chance of improving.

Pruning of orchards with impeded drainage is better done after a bumper crop because the following crop is likely to be below average and crop removal from the pruning action will be minimal. The alternative is to prune after a very stressful year when high temperatures have caused visible damage to trees. This reduces the chance of trees being seriously drained by a moderate crop which exacerbates macadamia decline and affects the long term health of the orchard. There are no hard and fast rules about pruning. Growers have to examine their own orchards and see what pruning suits their requirements.

Conclusions

The best way to avoid problems caused by impeded drainage is to choose deep well drained sites. They are usually more expensive compared to poorly drained sites but 'you only get what you pay for'. The investment in a macadamia orchard should be considered over a time frame of 30-50 years. Over such a long period the amortised cost of land becomes a minor part of the total cost structure while the cost of labour dwarfs all other inputs as time goes by.

This begs the question 'why put so much time and effort into poor soil in the first place?' Cheap land is usually located in areas where soil may be shallow, rainfall is limited and temperatures are more extreme. Just like any form of investing it pays to do the required home work first. Potential macadamia growers should undertake a thorough investigation of a site including examination of the soil profile and assessment of internal soil profile drainage. If water seeps out of the soil at the lower parts of the property for weeks after major rainfall this is an indication of a poorly drained profile and should be investigated.

Good nutrition and water management can help growers on shallow soils; in the short term, but as time goes by it will be difficult to compete with growers on better sites. Plantation owners need to examine the profiles in their soils and determine what practical steps they may need to take to improve the productivity of their orchards.

References

- R.L. Aiken, P.W. Moody, B.L. Compton and E.C. Gallagher, Plant and soil diagnostic tests for assessing the phosphorus status of seedling *Macadamia integrifolia*. *Australian Journal of Agricultural Research*, 1992, 43:191-201.
- A. Burnside, Macadamia decline in the Lismore District. In *Proceedings of the Second Australian Macadamia Research Workshop*, Bangalow, NSW (Eds. T. Trochoules and I. Skinner), 1987, pp. 243-244. (Australian Macadamia Society Ltd, Brisbane).
- Burnside, Macadamia decline in the Lismore District. In *Proceedings of the First Australian Macadamia Research Workshop*, Marcoola, QLD (Eds. R.A. Stephenson and E.C. Gallagher), 1983, Session: 15/1, pp. 1-3. (Australian Macadamia Society Ltd, Brisbane).
- J. Cox, L. Van Zwieten and M. Ayres, Composted macadamia husks for soil improvement and sustainability. In *Proceedings of the 2nd International Macadamia Symposium 2003*, Tweed Heads, NSW (Co-ordinators, ACCLAIM, NEW FARM, Australian Macadamia Society Special Issue – October, 2003, pp. 149-152).
- D.J. Firth and M.R. Loebel, Effect of calcareous amendments and mulch on macadamia trees with decline symptoms in *Proceedings of the Second Australian Macadamia Research Workshop*, Bangalow, NSW (Eds. T. Trochoules and I. Skinner), 1987, pp. 252-264. (Australian Macadamia Society Ltd, Brisbane).
- D.J. Firth, M.R. Loebel and G.G. Johns, Effect of mulch, Ca and Mg on growth, yield and decline of macadamia. *Tropical Agriculture (Trinidad)*, 1994, 71(3): 170-175.
- D. Firth, Sweet smothergrass – a perennial groundcover for subtropical orchards, 2nd ed, Agnote DPI 392, NSW Agriculture, 1994, pp.31.
- D.O. Huett, I. Vimpary and L. Bryan, Efficiency of foliar fertilizer application to macadamia: experimental evidence. In *Proceedings of the 2nd International Macadamia Symposium 2003*, Tweed Heads, NSW (Co-ordinators, ACCLAIM, NEW FARM, Australian Macadamia Society Special Issue, October 2003, pp. 181-183).
- D.A. Inneside, Insect Pests of macadamia in Queensland. Queensland Department of Primary Industries, Miscellaneous Publications 81007, 1987, pp. 25.
- A. Jenkins and L. Van Zwieten, How to compost on farm, Agnote DPI-448, NSW Agriculture, 2003, pp. 4.
- J.J. Landsberg, Macadamia decline: Disorder or a matter of resource allocation? In *Proceedings of the Second Australian Macadamia Research Workshop*, Bangalow, NSW (Eds. T. Trochoules and I. Skinner), 1987, pp. 226-235. (Australian Macadamia Society Ltd, Brisbane).
- J. Lloyd, T. Trochoules, R. Ernsbey and R. Skemmel responses and whole-tree hydraulic conductivity of orchard *Macadamia integrifolia* under irrigated and non-irrigated conditions. *Australian Journal of Plant Physiology*, 1991, 18, pp. 861-871.
- L.M. McFadyen, S.C. Morris, M.A. Oldham, C.A. McConchie, D.O. Huett, N.M. Meyers and J. Wood, Canopy management in macadamia. In *Proceedings of the 2nd International Macadamia Symposium 2003*, Tweed Heads, NSW (Co-ordinators, ACCLAIM, NEW FARM, Australian Macadamia Society Special Issue, October 2003, pp. 129-142).
- P.J. O'Hara, I. Skinner and M.R. Loebel, Growing macadamias in Australia. Queensland Department of Primary Industries, AGDEX 248/20, 1996, pp. 54.
- C. Seale and P. Lu, Whole tree water use and irrigation scheduling in macadamia. In *Proceedings of the 2nd International Macadamia Symposium 2003*, Tweed Heads, NSW (Co-ordinators, ACCLAIM, NEW FARM, Australian Macadamia Society Special Issue, October 2003, pp. 125-130).
- R.A. Stephenson and E.C. Gallagher, Effects of foliar boron sprays on yield and quality of macadamia nuts, *Scientia Horticulturae*, 1987, 32, pp. 97-103.
- R.A. Stephenson, E.C. Gallagher and P.M. Pepper, Macadamia yield and quality responses to phosphorus. In *Proceedings of the 2nd International Macadamia Symposium 2003*, Tweed Heads, NSW (Co-ordinators, ACCLAIM, NEW FARM, Australian Macadamia Society Special Issue, October 2003, pp. 175-179).
- R.A. Stephenson, T. Trochoules and D.R. Belgent, Effect of environment, nutrition and water on production and quality of macadamia. Horticultural Research and Development Corporation Report no. MC015, 1995, pp. 145.
- T. Trochoules, Comparison of potting mixes for macadamia nut trees, *Proceedings of the International Plant Propagators' Society*, 1980, 30, pp. 603-612.
- T. Trochoules and G.G. Johns, Poor response of macadamia to irrigation in a high rainfall area of subtropical Australia. *Australian Journal of Experimental Agriculture*, 1992, 32: 507-512.
- T. Trochoules, Progress with nutrition program for accession stock Tropical Fruit Research Station, Alstonville. *Australian Macadamia Society News Bulletin*, 1992, 19(4), pp. 37-41.
- T. Trochoules, Foliar fertilising macadamias. *Australian Macadamia Society News Bulletin*, 2000, 27(1), pp. 41-43.
- N. Vock, F. & G. – Macadamia problem solver and bug/denitrifier. Queensland Department of Primary Industries, 2003, pp. E2-E3.

GUAVA MOTH AND THE "FIGHT BACK" AT BUTLER POINT

Description of Macadamia Plantings

There are 6 blocks of varying numbers i.e. 137, 54, 57, 23, and 2 smaller ones of 9 and 13. These trees are of several different varieties and are all mature, the oldest planted in 1977.

Guava Moth Signs

Visible signs are a split husk with frass showing. On opening out the husk the small grub was easily seen on the inside of the husk with channels showing where it had burrowed between the shell and the husk.

First signs of damage were noticed in May 2002 in Integrifolia varieties and subsequently identified by Karen Froud at Hort Research in October 2002.

That year after husking, instead of composting as we usually do in large bays we literally drowned them all. We placed the husks in large containers and filled them with water from the hose. Later they were in fact used as mulch in the other orchards. At least we prevented any further spread from the husks. Free ranging hens could then have helped clear up any debris.

Trapping

We began putting out traps in January 2003 using 8 traps, placing in about 3 blocks at a time. In the first 6 months we caught 1018 moths. The following 6 months 970. As numbers dropped over a period of time the traps were moved on to other blocks. Occasionally there were surprises. For example a trap was moved back to a previously low count block. Result was 70 moths in the one trap over a week.

Another trap with weekly counts of 3, 5, and 2 suddenly produced 38 moths. This was in July 2003.

It was noticed that higher counts were near bush areas rather than in the middle of macadamia trees.

Damage to other Orchard fruit in 2003.

Feijoas The small number of trees, 4 of them, were next to the macadamias and were ALL inedible, brown, soft and rotten.

Citrus Some citrus had brown patches/quarters

Quince Brown rot inside was possibly not due to the Guava moth

Peaches No damage other than the (usual) brown rot.

Damage to produce in 2004

- # No sign of frass on any nut so far.
- # No sign of any Guava grub on any fruit including feijoas.
- # Trapping in 2004 showed decreasing numbers of moths caught. In the first 8 months January to August the traps caught 560 moths.
- # The first 20 kgs of this year 2004 produced good nuts, all integrifolias with guava damage to only 27 nuts. This showed as blackish sharply defined irregular lines ranging up to 10mm long. Presumably this would have happened at some stage in 2003.

Reasons for improvement

1. Trapping proves to be well worthwhile and will be an ongoing programme. It shows a slow but steady decline in numbers.
2. Regular mowing around all nut trees, although this has always been a practice.
3. Introduction of 2 kunekune pigs in about October 2003. They quickly became addicted to nuts and spent a lot of time turning over leaves etc. looking for them even if there was nothing much to find. As they moved through the trees they would be followed by a family of wild pheasants who in turn were followed by quail - all looking for their own particular favourite bug and hopefully many could be the guava moth grub, egg, and even the moth itself. The kunes were moved out before picking and can't wait to get back (so they say).

Future plans

1. To keep trapping and possibly concentrate on one block at a time until a nil count for at least a week before moving on to the next.
2. Extend trapping in to the surrounding bush area - possibly to locate host plants or trees.

Laetitia & Lindo Ferguson

Shelf Life Testing Results.

(These results have been very generously shared with us by Peter Kermond, Macadamia Exports Australia.)

Summary:

Product was subjected to an extreme shelf life test in order to assess if the food safety issues (e coli, plate count, salmonella, yeast count & mould count) would be linked to deterioration in the food quality issues of Peroxide value and free fatty acids.

The aim of the experiment was to allow microbiologically sound good quality Macadamias to go stale, and to see if the food safety indicators changed markedly during that quality deterioration.

In other words ask the question; is shelf life a quality issue only or also a food safety issue?

Methods

Batches from early in the 2002 season were tested for a range of chemical and microbiological variables in June of 2002. Batches are made on a delivery-by-delivery basis, so all nut from a given batch will be from the same orchard and the same delivery.

"Leaker" Cartons from those same batches were kept in extreme storage conditions (20 months, over two summers with no air conditioning) and then were re-tested. "Leakers" are cartons where the foil laminate pouch has no

visible defects, however the vacuum has not held due to tiny faults in either the pouch or the sealing.

Previous research suggests that properly packaged macadamia kernel can be stored in ambient conditions (Brisbane climate) for 18 months with virtually no deterioration in quality. That shelf life is entirely dependent on using a high moisture and oxygen barrier packaging of bi-axially orientated nylon foil linear low-density polyethylene bags. (Bowden & Reeves, published in proceeding of the second Australian Macadamia research workshop 1987).

To push the kernels into a deliberately stale state the kernels were stored in a hot location and the "leakers" were assessed. The kernels were also stored for over 20 months.

Nuts were taste-tested to confirm a 'stale' taste and one batch was chemically tested to assess Peroxide value and Free fatty acids. Both batches were edible but markedly stale, with the dry roasted chips tasting more stale than the raw half kernels.

In the writers' experience, the taste test is more accurate than either Peroxide values or Free fatty acids. Industry standards suggest that Peroxide values of over 3 are generally becoming stale and Free Fatty Acid value of over 0.5 are also consistent with rancidity.



Shelf Life Testing Results - contd.

Results.

The results of initial test and re test were as follows.

10 – 14mm halves Batch 2006

	First Test (June 2002)	Second Test (February 2004)
Peroxide meq/kg	0.14	12.4
Free Fatty Acids %w/w	0.13	0.61
Aflatoxin total aflatoxin.	< 2ppb	< 2ppb
Salmonella	Not detected in 250 g	Not detected in 250 g
Yeast & Mould	29,000 CFU/gram	3,000 CFU/gram
E coli	N/D in 0.1 g	ND in 0.1g
Plate count.	1,400 CFU/gram	600 CFU/gram

4-7mm dry roasted chips batch 2001

	First Test (May 2002)	Second Test (not conducted)
Peroxide meq/kg	0.0	
Free Fatty Acids %w/w	0.2	
Aflatoxin total aflatoxin.	< 2ppb	
Salmonella	Not detected in 250 g	ND in 250g
Yeast & Mould	500 CFU/gram	<100CFU/gram
E coli	N/D in 0.1 g	ND in 0.1g
Plate count.	150 CFU/gram	6000 CFU/gram

Discussion.

The small number of tests make the results indicative rather than conclusive and the results need to be treated with caution until this is done.

The results seem to indicate that Macadamia nuts can become quite stale over time (high pv) with no change to the major food safety areas of Salmonella, E coli, yeast & mould, and plate count.

Indeed, where there was a marked difference in the before and after readings it was an improvement in two cases and a deterioration in the other. This may also indicate that microbiological tests on the same batch of product can produce very different results. As the laboratory is trying to culture an organism there is scope for a great variance in the individual nuts as well as the process of culturing.

Conclusions.

This same experiment should be replicated over a wider number of samples and, if similar results are observed, shelf life deterioration can be shown to be a quality issue and not a safety issue.

It may even be the case that storage in a nitrogen infused atmosphere will improve some of the microbiological readings of plate count and yeast & mould count over time.

SECTION 2.
MACADAMIA INDUSTRY CODE OF SOUND ORCHARD PRACTICES

MACADAMIA INDUSTRY CODE OF
SOUND ORCHARD PRACTICES

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INTRODUCTION

Quality assurance in the macadamia industry involves every step in production. The orchard is a key link in the chain. The grower must provide processors with nuts of the required quality if they are to satisfy the needs of the market place.

Supplying a guaranteed consistent product of the required quality will increase the demand for Australian macadamias. Failure to do so will threaten the future of the industry.

The *Macadamia Industry Code of Sound Orchard Practices* addresses the critical steps in macadamia production where quality may be affected, up to the delivery of nuts to the processor. Nut quality for macadamia growers can be defined as conforming to the specifications of the processor.

Four steps require particular attention to prevent quality being compromised. These steps are marked in the code with an asterisk. They are:

- * pest management,
- * harvesting,
- * nut-in-husk storage, and
- * nut-in-shell handling, drying and storage

The code is not designed as a guide to growing macadamias. Growers seeking such a guide should consult the publications listed in the Further Reading section.

In developing this document, the task force was aware that no two orchards are the same. Many orchardists have different methods of completing the same task without compromising quality. The processor should be made aware before taking delivery of nuts, however, of steps where quality may have been affected.

Hygiene

Hygiene is essential in macadamia production to prevent contamination of nuts. Contamination can be by insects, vermin or other pests, chemical or microbial contaminants or other objectionable substances.

Precautions should be taken to prevent contamination. All equipment and containers used for handling nuts should be kept clean and maintained in good order.

The FAO/WHO Codex Alimentarius Commission publication *Recommended International Code of Hygienic Practice for Tree Nuts* details practices to prevent contamination of the nuts during growing, harvesting, handling, storage and transport (Refer to Appendix 1).

Records

Accurate records are an integral part of efficient management. They provide a basis for monitoring the effects of management on kernel yields and quality and for improving future decision making.

Attached to the code are examples of simple recording charts for pest control treatments, fertiliser programs and harvest details. Growers can expand them further to meet their own requirements. Other records they may wish to keep include irrigation, equipment calibration etc.

Maintaining records takes time and effort. The sample charts are designed to assist growers keep simple but useable records of their management practices and orchard performance.

Tree performance

Many of the practices outlined are aimed at maintaining healthy tree growth and performance. Poorly performing trees are subject to decreased first grade kernels, reduced kernel recovery, smaller nuts, poor flavour and shortened shelf life.

ORCHARD ESTABLISHMENT

SITE SELECTION

Avoid marginal soils, contaminated sites and excessively steep slopes.

Macadamias perform best on deep, well drained soils, rich in organic matter. Trees planted on shallow, poorly drained or otherwise unsuitable soils are more prone to poor growth and performance, tree decline and trunk canker, and subsequent poor kernel quality.

Contaminated sites *e.g.* old cattle dips or dumps used for agricultural chemicals, increase the risk of contamination of the nuts.

Excessively steep slopes are susceptible to soil erosion, leading to reduced tree performance and possible tree decline. Soil erosion will also lead to an increase in foreign matter adhering to the nuts and an increase in the risk of microbial contamination. Harvesting, pesticide application and other management operations are more difficult on steep slopes and can be delayed, particularly during wet weather.

Avoid extremely hot or wet sites, or locations exposed to high cyclone or storm activity.

Trees planted where temperatures regularly exceed 35°C may be subject to increased premature nut drop, and decreased kernel recovery, kernel size and first grade kernels.

Sites with extremely wet weather are prone to:

- difficulties and delays with harvesting, sorting and drying nuts with a subsequent increase in germination, mould and rancidity,
- difficulties and delays with pesticide applications,
- increased incidence of diseases such as husk spot,
- increased foreign matter adhering to the nuts,
- increased risk of bacterial contamination.

Extremely overcast conditions during the later stages of nut development will also lead to a decrease in first grade kernels.

Macadamia trees are very brittle and break easily. Windfalls and tree damage during storms and cyclones can lead to an increased level of immature nuts.

NURSERY TREES

Select clean, healthy nursery trees.

Nursery trees with:

- stem damage or trunk canker,
- damaged or deformed root systems, or
- insect pests such as felted coccid or Iatania scale,

have a greater risk of poor tree performance and reduced kernel quality when they begin to bear.

ORCHARD MANAGEMENT

TREE NUTRITION

Monitor soil and leaf nutrient levels and correct any deficiencies and imbalances.

Soil and leaf analysis provides a guide to the availability of nutrients in the soil and uptake by the tree. Comparisons can be made with optimum levels set for healthy, bearing trees. Nutrient deficiencies and imbalances can lead to poor tree performance and reduced kernel quality.

Avoid heavy nitrogen applications during summer.

Nitrogen applications during summer can promote excess vegetative growth. This competes with the developing kernel for carbohydrate reserves, leading to decreased first grade kernels, kernel recovery and shelf life.

Avoid the application of raw animal manures at least one month prior to mature nut drop until the completion of harvest. Notify the processor if any animal manures are used.

Raw animal manure applications immediately prior to mature nut drop until the end of harvest increase the risk of microbial contamination.

Maintain records of the fertiliser program.

Accurate records are an important part of monitoring the effects of fertiliser applications on yield and quality. They also provide a basis for decision making for future applications. An example of a sample recording chart is attached to this document.

IRRIGATION

If irrigating, ensure the irrigation water is of good quality.

Unsanitary irrigation water poses a risk of microbial contamination to the nuts. Irrigation water with excessive salt levels may also result in poor tree performance and reduced kernel quality.

SOIL MANAGEMENT

Maintain sound cultural practices which will sustain soil structure and provide an environment for healthy root development.

Soil compaction and low levels of organic matter can cause reduced root development leading to poor tree performance and reduced kernel quality.

Water flowing along tree rows can:

- remove nuts and soil from beneath trees,
- expose tree roots,
- increase the amount of foreign matter adhering to the nuts, and
- increase the risk of microbial contamination.

Surface drains can assist/control water flow.

*** PEST MANAGEMENT**

Monitor regularly for pests. Pests include insects, fungi, vermin, weeds etc.

Fruit spotting bugs, nut borers and other insects can increase unsound kernel and premature nut drop. Damage by vermin such as rats can cause kernel loss, reduced kernel recovery and possible microbial contamination. Husk spot and anthracnose can result in increased premature nut drop.

'Where control measures are undertaken, treatment with chemical, biological or physical agents should be done in accordance with the recommendations of the appropriate official agency, by or under the direct supervision of personnel with a thorough understanding of the hazards involved, including the possibility of toxic residues being retained by the crop.' (*Recommended International Code of Hygienic Practice for Tree Nuts - CODEX ALIMENTARIUS COMMISSION*).

Failure to follow the appropriate treatment recommendations, a lack of understanding of the pest or the control method, or an inappropriate treatment application can result in:

- ineffective control of the pest,
- safety problems for the operator and for others, and
- possible chemical contamination of the nuts and the environment. Unacceptable chemical residues may jeopardise domestic and export nut sales.

Maintain records of pest levels and treatment if undertaken.

Accurate records are an important part of monitoring pest levels, including the identification of hot spots of pest activity, and monitoring the effects of pest control treatments. An example of a simple recording chart may be found on page 56.

HARVEST AND POST HARVEST HANDLING

PRE-HARVEST PREPARATION

If the crop is to be harvested off the ground, ensure any significant quantities of unsound, old or immature nuts, leaf or foreign matter are removed or finely chopped before mature nut drop.

Nuts from the previous season, and immature or insect damaged nuts reduce the kernel quality of the harvest if not cleared from under the trees prior to mature nut drop.

Inadequate orchard floor preparation can lead to harvesting difficulties and delays and an increase in unsound kernel.

A thick layer of fallen leaves or coarse mulch can cause an increase in germination, particularly during wet weather.

*** HARVESTING**

Where ground harvesting, nuts should be harvested at least every 4 to 6 weeks. Growers should notify processors if nuts have been on the ground longer than 8 weeks.

Kernel quality will deteriorate due to increased mould and rancidity, and increased germination during wet weather if nuts are left on the ground longer than:

- 4 weeks where the nuts are exposed to direct sunlight
 - 6 weeks where the nuts are shaded from direct sunlight
 - 4 weeks during wet weather.
-

*** NUT-IN-HUSK STORAGE**

Dehusk nuts within 24 hours after harvest. If dehusking cannot be accomplished within 24 hours, nut-in-husk must be stored in a container with adequate and even forced air ventilation or spread out in thin layers to allow sufficient air flow between them. Growers should notify processors if the nut-in-husk has been stored longer than 24 hours.

Nut-in-husk generates respiratory heat in storage particularly where the husk is wet or fleshy and green. This can cause an increase in mould, rancidity and germination.

DEHUSKING AND NUT-IN SHELL SORTING

The building should be maintained in an orderly, sanitary condition. Waste containers should be provided and waste frequently removed from the working area. Maintain the equipment used for dehusking and sorting in a sound, clean condition. Sort rocks if present from nuts before dehusking.

Poor hygiene increases the risk of contamination to the nuts. Incorrectly set and maintained dehusking machinery can cause cracking of the shell increasing the risk of contamination and bruising of the kernels. Unsorted rocks can damage the machinery leading to inefficient dehusking and damaged nuts.

Following dehusking, inspect the nuts and remove foreign matter and nut-in-shell that is defective or less than 18 mm in diameter. The nut-in-shell sorters should be adequately trained.

Insufficient or ineffective sorting can result in increased levels of unsound immature or small nuts, or foreign matter being included in the consignment to the processor.

On-farm flotation grading of nut-in-shell is not recommended at this stage.

Flotation grading presents a major risk of microbial contamination. Careful monitoring of chlorine levels is necessary to prevent this risk. Monitoring is extremely difficult on-farm as there is a continuous and inconsistent stripping of the chlorine from solution. Too high levels of chlorine may also contaminate

nuts.

*** NUT-IN-SHELL HANDLING, DRYING AND STORAGE**

Equipment and containers should be kept clean and maintained in good order. Precautions should be taken to prevent contamination or wetting of nuts during handling, drying and storage.

Unclean and poorly maintained equipment, and unsecured containers increase the risk of contamination of nuts from insects, vermin and other pests, and from chemical or microbial contaminants or other objectionable substances. Old nuts not removed from equipment and containers before use can also reduce the quality of consignments.

Condensation inside containers or leakage from outside can lead to an increase in the nut-in-shell moisture content.

Commence drying immediately following dehusking and sorting or washing.

Storage of nut-in-shell before drying can increase mould and rancidity.

Avoid drop heights exceeding 2 metres.

Excessive drop heights cause increased fracturing and bruising of kernels. As the moisture content of nut-in-shell decreases, it is more prone to damage and the acceptable drop height decreases. The maximum acceptable drop height at 10% moisture content is 2 metres.

Avoid prolonged exposure to direct sunlight.

Prolonged exposure of nuts to direct sunlight increases rancidity and increases cracking of the shell leading to possible contamination.

Ensure drying and storage facilities maintain even and adequate air flow.

Uneven or inadequate air flow and ventilation causes increased mould, rancidity and germination and reduced shelf life. Information on silo design, air velocity and volume, maximum depth of nut-in-shell and heating is detailed in:

- *On Farm Drying of Nuts in Shell* by John Simpson
- *Silo Design and Air Control for Drying Macadamia Nuts* by Gary Smith
- *Macadamias - post harvest handling* by Richard Mason.

If heating is used during drying, do not use air temperatures greater than 38°C if the nut-in-shell moisture content is above 10%.

Air temperatures greater than 38°C while nut-in-shell moisture content is above 10% can cause internal browning and discolouration of the kernel during roasting and reduced shelf life. Growers should be very cautious to reduce the risk of fire damage if using heating.

Store the nut-in-shell at or about 10% moisture content. Notify the processor of the harvest dates and length of storage.

Storage at moisture contents greater than 10%, or for longer than one month, can increase rancidity and off-flavours and shorten shelf life.

TRANSPORT OF NUT-IN-SHELL TO THE PROCESSOR

Suitable precautions should be taken to prevent contamination of nut-in-shell. The grower or another responsible person should inspect the transport vessel before loading and ensure it is clean, particularly of animal waste. Secure and cover loads for long distance travel.

Unclean containers increase the risk of contamination.

Failure to secure or cover loads can lead to contamination of the consignment by dirt, gravel, broken glass etc.

Avoid drop heights greater than 2 metres. Where possible, avoid uneven routes, rough handling and vehicles with excessive vibration.

Excessive drop heights cause increased bruising and fracturing of kernels. The maximum acceptable drop height for nut-in-shell at 10% moisture content is 2 metres. Rough road or vehicle conditions, or rough handling can also lead to increased fracturing.

Delivery to the processor should be direct once air flow through the nuts has ceased. Transport the nut-in-shell to the processor at or about a moisture content of 10%.

Delivery times to the processor of greater than 24 hours at 10% m.c. can lead to an increase in rancidity, the development of off flavours and a reduction in shelf life. At higher moisture contents, this reduction in kernel quality is accelerated. At moisture contents less than 10%, there is an increased risk of fracturing or bruising of the kernel.

***Macadamia tetraphylla* nuts must be consigned separately to the processor from nuts of *Macadamia integrifolia*. Confirm with processors before consigning whether they will accept *M. tetraphylla* nuts. Check also with processors which hybrids or seedlings are acceptable before consigning.**

Macadamia tetraphylla nuts have a higher sugar content which leads to excessive browning if they are roasted at temperatures suitable for *M. integrifolia*. The range of hybrids grown vary in characteristics between the two species. Hybrids which have been evaluated and found suitable for processing with *M. integrifolia* include H.V.A4 and H.V.A16. Nut quality of seedlings is also variable.

Ensure there are adequate details on the consignment documents.

Inadequate information to the processor can lead to inappropriate handling and processing of the consignment.

FURTHER READING

FAO/WHO publications

Codex Alimentarius Volume D - Recommended International Code of Hygienic Practice for Tree Nuts. (1972), FAO/WHO Codex Alimentarius Commission.

QDPI books

Insect Pests of Macadamias in Queensland, Ironside, D.A. (1981), QDPI, Brisbane.

Fruit and Nut Crops - a disease management guide, Persley, D.M., Pegg, K.G. and Syme, J.R. (1989), QDPI, Brisbane.

Application of Total Quality Management to Food Processing, Jones, M.K. (1989), QDPI, Brisbane.

Growing Macadamias in Queensland, O'Hare, P.J. and Vock, N.T. (1990), QDPI.

Chemicals for the Protection of Fruit and Nut Crops, Beavis, C., Simpson, P., Syme, J., and Ryan, C. (1991), QDPI, Brisbane.

QDPI farmnotes

Macadamias - harvesting and maturity testing, Mason, R.L. (1983), QDPI, Brisbane.

Macadamias - post harvest handling, Mason, R.L. (1983), QDPI, Brisbane.

NSW Agfacts

Macadamia Decline, Firth, D.J. (1986), New South Wales Agriculture, Sydney.

Macadamia Culture in NSW, Trochoulias, T., Chaiker, F.C. and Loebel, M.R. (1990), New South Wales Agriculture, Sydney.

NSW Agnotes

Nitrogen Fertilising of Macadamias, Trochoulias, T. (1988), New South Wales Agriculture, Sydney.

The Effect of Cultural Factors on Macadamia Nut Quality, Trochoulias, T. (1988), New South Wales Agriculture, Sydney.

Reducing Soil Degradation, Runoff and Erosion in Macadamia Orchards, Firth, D.J. and Loebel, M.R. (1989), New South Wales Agriculture, Sydney.

Growing Macadamia Seedlings, Trochoulas, T. (1991), New South Wales Agriculture, Sydney.

Insect Pests affecting Macadamia Nut Yield or Quality, Treverrow, N. (1991), New South Wales Agriculture, Sydney.

Diseases and Disorders of Macadamia, Fitzell, R. and Loebel, M.R. (1991), New South Wales Agriculture, Sydney.

Buying Quality Macadamia Trees, Loebel, M.R. and McPhee, G. (undated), New South Wales Agriculture, Sydney.

Silo Design and Air Control for Drying Macadamia Nuts, Smith, G. (undated), New South Wales Agriculture, Sydney.

AMS publications

Proceedings of the First Macadamia Research Workshop, Eds, Stephenson, R.A. and Gallagher, E.C. (1983), Australian Macadamia Society, Brisbane (out of print).

Proceedings of the Second Australian Macadamia Research Workshop, Eds. Trochoulas, T. and Skinner, I. (1987), Australian Macadamia Society, Brisbane.

Report on Research Projects Funded during 1990, Ed. Skinner, I. (1990), Australian Macadamia Society, Brisbane.

On Farm Drying of Macadamia Nuts in Shell, Simpson, J. (1992), News Bulletin, 19, (1), May 1992, Australian Macadamia Society Ltd, Brisbane.

Back to Basics - Maximising Kernel Recovery and Kernel Quality, Simpson, J. (1992), News Bulletin, 19, (2), Australian Macadamia Society Ltd, Brisbane.

Other reading

Further reading is available at the Farmer Information Centres at the Maroochy Horticultural Research Station, Mayers Road, Nambour and the Tropical Fruit Research Station, Alstonville.

The Australian Macadamia Society has also collected a large range of technical and general interest information. It has made this available to the public through the Caloundra City Public Library, Omrah Avenue, Caloundra and the Tropical

Fruit Research Station, Alstonville.

SAMPLE RECORDING CHARTS

Pest Control Treatments

Accurate records are essential for monitoring pest levels and the effects of control measures. Growers may wish to expand this chart to include other information they consider appropriate *e.g.* weather conditions, spray additives, equipment used etc.

Date

Block Pest and

Infestation Level

Action taken

Remarks

Fertiliser Programme

Record details of all fertiliser applications including organic additives.

Where varying amounts are given to trees within blocks, these are recorded separately. The amount can be recorded either on a per tree basis for products applied to individual trees or on a per hectare basis for products broadcast over the whole block. Method means the way the fertiliser is applied, e.g. broadcast, spread under the tree, foliar application etc.

Leaf and soil analysis results should be kept with these records for reference.

Growers may wish to expand this chart to include other information they consider appropriate e.g. varieties within the block, etc.

Date	Block	Product	Amount	Method
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Harvest Details

Accurate harvest records enable you to monitor the yield and quality of the crop, including from problem areas within the orchard. If possible, details from trees of different age, size, variety or from within blocks where performance is likely to vary, should be recorded separately.

The amount harvested can be recorded by weight e.g. tonnes or by volume e.g. bins. Record either nut-in-husk or nut-in-shell, depending on the shed arrangement.

Growers may wish to expand this chart to include other information they consider appropriate e.g. weather conditions during harvest, method of harvest, amount of reject nuts etc.

Harvest

harvested	Remarks	Date	Block	Amount	NIH/NIS
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UPDATE ON MACADAMIA INDUSTRY CODE OF SOUND ORCHARD PRACTICES January 1993

The *Macadamia Industry Code of Sound Orchard Practices* was distributed by the Australian Macadamia Society to the industry in May 1992. The Code was one of the initial stages in the AMS implementing an industry Quality Assurance system.

The Code was developed to identify and address the critical steps in macadamia production where quality may be affected. The Code aims to assist growers to increase orchard productivity and profitability, while improving the quality of the product supplied to processors and marketers.

A major emphasis in the Code was placed on the need for growers to keep accurate records. Records are a vital part of management. They allow growers to monitor the effects of management practices on kernel yield and quality and enable improved future decision making.

The Code was designed to be regularly updated and feedback was invited. We would like to thank those growers who have forwarded their comments. The major areas requiring clarification were: harvest interval, on-farm flotation grading of nut-in-shell, storage time and moisture contents of nut-

in-shell and air circulation during on-farm storage.

Harvest interval

There was concern by some growers that a harvesting interval of 4 to 6 weeks was too long and would lead to a deterioration in quality. Others were concerned that a harvesting interval of 4 to 6 weeks would be difficult to achieve, particularly if delays due to inclement weather were experienced.

The trials conducted by Richard Mason and Ian Wells indicated that the processed recovery, proportion of first grade kernels, quantity of reject kernels, eating quality and storage life of macadamia nuts left on the ground under the conditions used in their work were not affected for up to 4 weeks. Thereafter, some quality losses resulted but mainly with respect to the processed recovery of nuts exposed to sunlight. Exposure to sunlight also appeared to be the main cause of loss of eating quality after the initial one month period on the ground. Germination of thin shelled cultivars was also considered a potential problem after 4 weeks on the ground in shaded or wet conditions.

It is recommended to growers to maintain the 4 to 6 week harvest interval. Growers wishing to harvest more frequently and who consider it economically feasible, however, should also be encouraged.

With the harvesting season fast approaching, it is important that growers prepare their orchards before mature nut drop begins. Weeds need to be controlled and nuts from the previous season, immature or insect damaged nuts, and any material which may interfere with the harvest needs to be cleared from under the trees. With the increasing use of mechanical harvesting, it is also very important to prepare an even soil surface to maximise the pickup of nuts and minimise the carry over to the following harvest.

On-farm Flotation Grading of Nut-in Shell

On-farm flotation grading of NIS is practised by a significant proportion of the macadamia industry. The practice relies on NIS with sufficient air space inside the shell floating. The best use of flotation grading of NIS is in sorting nuts where kernels are either insect damaged, shrunken or degraded.

A problem which arises as nuts dry is that the kernels shrink and air space forms inside the shell. If there is sufficient air space in the shell, NIS containing mature kernel will also float. If flotation grading of NIS is practised, it is important to regularly test samples of the floaters and sinkers by cracking the nuts and floating the kernels.

It is extremely important that NIS found to contain immature, insect damaged, shrunken or otherwise degraded kernels be discarded appropriately and not sold. Sale of such nuts, particularly to retail outlets, will have detrimental consequences for the reputation and future sales of Australia macadamias.

Flotation grading of NIS also present a serious risk of the spread of microbial contamination where the chlorine levels in solution are not able to be carefully monitored and maintained. This is particularly so where there are cracks in the shell which enable the solution to come in contact with the kernel.

Chlorine is continuously and inconsistency stripped from the solution by organic matter. It is extremely difficult on-farm to monitor the rate of stripping. Too high levels of chlorine may also cause chemical contamination of the nuts.

Storage Time and Moisture content of Nut-in Shell

Concern has been expressed by some growers over storage of NIS at 10% m.c. for longer than 1 month leading to deterioration in quality due to increasing rancidity and off flavours and shortened shelf life.

Macadamia NIS can have a moisture content greater than 20% at harvest. It is important to commence drying immediately following dehusking and sorting or washing to prevent deterioration of the kernel quality.

NIS should be dried to about 10% m.c. It is difficult to reduce the moisture content below 10% without heating. At moisture contents lower than 10%, the kernels are also more prone to physical damage during handling and transport.

Storage time before deterioration occurs is closely related to moisture content. A project to further investigate storage of NIS is currently proposed by the University of Queensland and IFIQ. At this stage, it is recommended to store NIS at 10% m.c. for up to one month. Communication with the processor handling your crop is very important to organise regular deliveries.

Air Circulation during On-farm Storage

There was some confusion with regard to the note on shutting down the fan at night in the article *On-farm Drying of Macadamia Nuts in Shell* by John Simpson. The fan should only be shut down at night when:

- nut in shell moisture content has been reduced to 10%, and
- ambient relative humidity is greater than 60%.

More Further Reading

The Effect of Harvest Interval on the Quality of Ground-Harvested Macadamia Nuts, Mason, R.L., and Wells, I.A. (1984), Food Technology in Australia, Volume 36, 373-374 and 378.

Some Notes on Sorting Macadamia Nuts, Skinner, I. (1990) AMS News Bulletin, Vol. 17, Number 2.

P O'Hare

SENIOR HORTICULTURIST

Summary Climate Information for Selected New Zealand Locations

Location	Rainfall	Wet-days	Sunshine	Temperature			Ground Frost	Wind	Gale Days	Heat Units
	mm	>=1.0mm	hours	Mean °C	Very Highest °C	Very Lowest °C	days	Mean speed km/h	Mean speed at least 63km/h	
KAITIA	1334	134	2070	15.7	30.2	0.9	1	15	2	N/A
WHANGAREI	1490	132	1973	15.5	30.8	-0.1	11	16	1	N/A
AUCKLAND	1240	137	2060	15.1	30.5	-2.5	10	17	2	1601
TAURANGA	1198	111	2260	14.5	33.7	-5.3	42	16	5	1365
HAMILTON	1190	129	2009	13.7	34.7	-9.9	63	12	2	1147
ROTORUA	1401	117	2117	12.8	31.5	-5.2	57	13	1	
GISBORNE	1051	110	2180	14.3	38.1	-5.3	33	15	2	1266
NEW PLYMOUTH	1432	138	2182	13.7	30.3	-2.4	15	20	5	1144
KERIKERI	1709	136	1996	15.2	34.3	-2.0	18	2.0m/sec	2	1432
KAIKOHE	1598	144	1873	14.7	30.5	-0.9	3	3.2m/sec	N/A	N/A
PUKEKOHE	1302	143	1830	14.6	29.8	-1.0	20	2.3m/sec	4	N/A
OPOTIKI	1358	109	2161	14.1	29.8	-4.2	32	N/A	2	N/A

N/A = Not Available

(NIWA Table 2)

Mean Monthly Rainfall (mm)

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KAITIA	82	79	78	95	119	149	166	152	133	93	94	97	1334
WHANGAREI	90	112	142	129	120	179	151	146	130	116	80	92	1490
AUCKLAND	75	65	94	105	103	139	146	121	116	91	93	91	1240
TAURANGA	74	78	128	105	91	128	122	115	104	94	85	87	1198
HAMILTON	85	71	87	95	102	119	126	117	102	96	93	95	1190
ROTORUA	99	101	115	112	104	134	130	148	119	122	102	115	1401
GISBORNE	54	78	99	103	97	125	119	93	101	63	65	67	1050
NEW PLYMOUTH	97	95	117	131	124	145	143	127	110	124	108	103	1432
KERIKERI	107	115	126	144	157	182	171	191	157	126	113	104	1709
KAIKOHE	111	99	115	134	126	180	169	155	136	112	103	107	1598
PUKEKOHE	86	71	99	101	118	135	144	129	121	107	100	105	1302
OPOTIKI	85	93	118	122	123	137	122	131	109	110	98	107	1358

(NIWA Table 3)

Mean Monthly Sunshine (hours)

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
KAITIA	212	201	197	155	140	123	137	159	162	182	187	219	2070
WHANGAREI	227	182	158	144	139	110	134	144	154	175	192	209	1973
AUCKLAND	229	201	180	162	142	111	140	144	149	181	187	225	2060
TAURANGA	253	211	197	175	164	132	152	161	164	201	215	232	2260
HAMILTON	231	199	185	164	131	103	121	138	145	176	197	221	2008
ROTORUA	241	205	191	167	148	116	132	148	149	187	202	221	2117
GISBORNE	241	201	185	156	148	124	130	154	173	210	215	234	2180
NEW PLYMOUTH	244	223	202	173	144	118	134	154	160	190	204	228	2182
KERIKERU	222	177	167	150	135	123	137	144	157	178	204	211	1996
KAIKOE	219	172	151	139	139	108	126	130	138	167	175	209	1874
PUKEKOE	204	171	160	144	131	102	128	132	129	151	172	190	1830
OPOTIKI	232	202	193	183	155	128	150	155	169	191	204	211	2161

(NIWA Table 4)

Mean Monthly Air Temperature (°C)

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KAITIA	19.7	20.0	18.6	16.9	14.8	12.7	12.2	12.1	13.1	14.5	15.8	17.9	15.7
WHANGAREI	19.9	20.0	19.0	16.5	14.0	12.2	11.2	11.7	12.9	14.3	16.4	18.2	15.5
AUCKLAND	19.3	19.8	18.5	16.2	13.7	11.6	10.8	11.3	12.6	14.1	15.8	17.8	15.1
TAURANGA	19.2	19.2	17.9	15.4	12.5	10.4	9.7	10.5	12.1	13.6	15.6	17.5	14.5
HAMILTON	18.3	18.7	17.1	14.5	11.6	9.4	8.7	9.8	11.4	13.1	15.0	16.8	13.7
ROTORUA	17.8	17.9	16.4	13.5	10.5	8.4	7.6	8.7	10.4	12.3	14.3	16.1	12.8
GISBORNE	19.2	18.9	17.4	14.8	12.0	10.0	9.3	10.2	11.8	13.8	15.9	17.8	14.3
NEW PLYMOUTH	17.7	17.9	16.9	14.7	12.1	10.3	9.4	10.1	11.5	12.7	14.4	16.1	13.6
KERIKERI	19.0	19.5	18.3	16.2	13.9	11.8	11.0	11.5	12.8	14.2	15.8	17.7	15.2
KAIKOE	18.5	19.0	17.8	15.7	13.5	11.7	10.7	11.0	12.0	13.3	15.0	17.0	14.6
PUKEKOHE	18.6	19.5	17.8	15.5	13.1	11.1	10.2	10.7	12.2	13.6	15.2	17.1	14.6
OPOTIKI	18.5	19.0	17.6	15.1	12.3	10.0	9.4	10.1	11.5	13.4	15.1	17.1	14.1

(NIWA Table 5)

Mean Number of Days of Ground Frost

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KAITIA	0	0	0	0	0	0	0	0	0	0	0	0	1
WHANGAREI	0	0	0	0	1	3	4	2	1	0	0	0	11
AUCKLAND	0	0	0	0	1	3	4	2	1	0	0	0	10
TAURANGA	0	0	0	1	5	9	12	9	4	2	1	0	42
HAMILTON	0	0	1	3	8	11	14	11	7	3	1	0	63
ROTORUA	0	0	0	2	8	12	14	11	7	3	1	0	57
GISBORNE	0	0	0	0	3	8	9	8	3	1	0	0	33
NEW PLYMOUTH	0	0	0	0	1	4	4	3	1	0	0	0	15
KERIKERI	0	0	0	0	1	4	6	4	2	1	0	0	18
KAIKOHE	0	0	0	0	0	0	1	1	1	0	0	0	3
PUKEKOHE	0	0	0	0	1	4	5	3	1	1	1	0	20
OPOTIKI	0	0	0	0	3	8	10	7	3	1	0	0	32

(NIWA Table 6)

Mean Relative Humidity (%)

LOCATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KAITIA	85.1	86.0	84.5	85.4	87.1	88.9	88.7	87.1	85.3	84.3	83.0	83.8	85.9
WHANGAREI	80.7	83.6	83.8	86.4	87.4	89.0	88.0	84.6	80.2	81.2	77.9	78.5	83.1
AUCKLAND	77.1	78.3	79.0	82.2	85.2	89.0	88.5	85.7	80.2	76.8	76.3	75.9	81.1
TAURANGA	74.2	75.9	77.8	80.8	83.0	85.6	83.5	79.8	75.9	76.1	72.0	72.1	78.0
HAMILTON	79.4	82.4	82.4	85.1	88.5	90.2	89.7	87.0	81.5	79.6	78.7	78.8	83.6
ROTORUA	77.9	80.0	80.3	81.9	84.9	85.0	84.9	83.4	79.0	78.4	76.2	78.1	79.0
GISBORNE	69.6	76.7	75.7	78.2	78.9	80.1	80.6	76.4	71.7	69.9	68.0	66.7	74.4
NEW PLYMOUTH	82.3	83.8	80.4	80.3	83.4	84.6	84.1	82.9	80.4	80.4	77.3	80.7	83.5
KERIKERI	78.3	79.6	84.0	84.4	89.3	92.5	91.0	87.7	83.4	78.2	81.0	77.4	84.3
KAIKOE	84.2	87.2	85.9	86.5	87.5	89.1	88.7	87.1	83.7	82.5	83.5	82.0	85.9
PUKENOE	78.6	80.7	80.4	82.4	85.5	88.2	87.4	85.8	81.8	79.4	78.6	78.3	82.6
OPOTIKI	80.4	80.0	82.6	84.6	88.0	90.1	88.6	86.8	82.7	80.7	79.7	80.0	84.1

(NIWA Table 7)